File Ref.No.102466/GA - IV - J1/2023/Admn

UNIVERSITY OF CALICUT

Abstract

General & Academic IV - Faculty of Science - Modified Scheme and Syllabus of B.Sc Zoology Honours Programme with effect from 2024 admission - in tune with the CUFYUGP Regulations 2024, Approved by the Vice Chancellor - Implemented - Orders Issued

G & A - IV - J

U.O.No. 6753/2025/Admn Dated, Calicut University.P.O, 05.05.2025

Read:-1. U.O.No. 9579/2024/Admn dated: 19.06.2024
2. U.O Note No. 89198/EX-III-ASST-2/2024/PB dated: 24.08.2024
3. Minutes of the Board of Studies in Zoology (UG) held on 10.04.2025
4. Remarks of the Dean, Faculty of Science dated: 28.04.2025
5. Orders of the Vice Chancellor in the file of even No. dated: 30.04.2025

ORDER

1. Vide paper read as (1), the Scheme and Syllabus of B.Sc Zoology Honours Programme in tune with CUFYUGP Regulations 2024, has been implemented with effect from 2024 admission.
2. Vide paper read as (2), Pareeksha Bhavan had pointed out certain discrepancies in the syllabus of B.Sc Zoology Honours programme.
3. Accordingly, the Board of Studies in Zoology (UG), vide paper read as (3), incorporated the corrections pointed out by Pareeksha Bhavan and approved the modified scheme and syllabus of B.Sc Zoology Honours programme with effect from 2024 admission, in tune with CUFYUGP Regulations 2024, .
4. The Dean, Faculty of Science, vide paper read as (4), approved the minutes of the meeting of Board of Studies in Zoology (UG).
5. Considering the above, the Vice Chancellor has approved the minutes of the meeting of the Board of Studies in Zoology (UG) and accorded sanction to implement the modified scheme and syllabus of B.Sc Zoology Honours programme with effect from 2024 admission, exercising the powers as per sectioin 10(13) of Calicut University Act 1975.
6. The modified Scheme and Syllabus of B.Sc Zoology Honours programme in tune with CUFYUGP Regulations 2024, is thus implemented with effect from 2024 admission.
7. The U.O vide paper read as (1) stands modified to this extent.
8. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

Principals of all Affiliated Colleges
Copy to: Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE II/JCE IV/DoA/EX and EG Sections/GA I F/CHMK Library/SUVEGA/FYUGP Cell/SF/DF/FC

Forwarded / By Order

Section Officer

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UNIVERSITY OF CALICUT

B. Sc. ZOOLOGY HONOURS (MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS & MODEL QUESTION PAPERS

w.e.f. 2024 admission onwards

(CUFYUGP Regulations 2024)

B. Sc. ZOOLOGY HONOURS (MAJOR, MINOR AND GENERAL FOUNDATION COURSES)

SYLLABUS

UNIVERSITY OF CALICUT
MEMBERS, BoS ZOOLOGY – UG

Sl. No.	Name	Designation and address
1	Dr. Sheena. P. Chairperson, BoS Zoology - UG	Associate Professor, Sree Neelakanta Govt. Sanskrit College, Pattambi
2	Dr. Araty Sasikumar	Assistant Professor, Sree Narayana College Alathur
3	Smt. Soumya K. C.	Assistant Professor, KKTM Government College
4	Dr. Thejass. P.	Associate Professor, Govt. College, Madappally
5	Dr. Lakshmi Priyadarsini.	Assistant Professor, Govt. Victoria College, Palakkad
6	Dr. Nishi Ann	Assistant Professor, Providence Women's College, Calicut
7	Smt. Shijina. K.	Assistant Professor, Govt. Arts & Science College, Calicut
8	Dr. K. M. Shereena.	Assistant Professor, MES Ponnani College
9	Dr. Sudhikumar. A. V.	Associate Professor, Christ College (Autonomous), Iringalakkuda
10	Dr. Aneesh. E. M.,	Assistant Professsor, Department of Zoology, University of Calicut
11	Dr. Sabu. K. Thomas Chairperson, BoS Zoology - PG	Professor, Department of Zoology, University of Calicut

Experts in Syllabus restructuring (Other than BoS)

Sl. No.	Name	Designation and address
1	Sri. Radhakrishnan. P.	Associate Professor (Rtd.) Former Chairperson, BoS Zoology - UG
2	Sri. Janish P. A.	Assistant Professor, Maharajas College (Autonomous), Ernakulam
3	Dr. Leyon Varghese	Assistant Professor, Christ College (Autonomous), Iringalakuda
4	Dr. Vimala K. John	Assistant Professor, St Thomas College (Autonomous), Thrissur
5	Dr. Preethi N.	Assistant Professor, NSS College Ottapalam
6	Sri. Jain J Therattil	Assistant Professor, St. Aloysius College Elthuruth
7	Sri. Sudheesh Kumar. T. K.	Assistant Professor, Govt. College, Madappally, Vatakara
8	Dr Sreedevi N. Kutty	Associate Professor, NSS College, Nemmara
9	Dr. Krishna Prabha K. S.	Assistant Professor, MES Keveeyam College, Valanchery
10	Dr. Binitha V. S.	Assistant Professor, Sree Narayana College Nattika
11	Dr. Santhosh. P. P	Assistant Professor, Sreekrishna College Guruvayur
12	Dr. K. Sudheer	Assistant Professor, The Zamorin's Guruvayurappan College, Kozhikode
13	Dr. Vineesh P. J.	Assistant Professor, St. Joseph's College (Autonomous), Devagiri, Calicut
14	Dr. Feebarani John	Associate Professor, Vimala College (Autonomous), Thrissur
15	Smt. Shabana T. P.	Associate Professor, Farook College (Autonomous), Calicut
16	Dr. Sheenaja K. K	Assistant Professor, Sree Kerala Varma College Thrissur
17	Dr. Girija. R.	Assistant Professor, Mercy College, Palakkad
18	Dr. Sheeba. M.	Assistant Professor, NSS College, Manjeri
19	Dr. Santhosh Sreevihar	Assistant Professor, Malabar Christian College
20	Dr. Sunilkumar. P.	Assistant Professor, Sree Kerala Varma College, Thrissur
21	Dr. Julie. E	Assistant Professor, Providence Women's College (Autonomous), Calicut
22	Dr. Ajaykumar. A. P.	Assistant Professor, Sree Neelakanta Govt. Sanskrit College, Pattambi

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Semester	Course Name	Page No.
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3	FOUNDATIONS OF BIOSTATISTICS AND BIOTECHNIQUES	290
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2	FOOD PROCESSING & QUALITY CONTROL	304
3	LIFE SKILL TECHNIQUES	309
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Semester	Course Name	Page No.
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1	NUTRITION, HEALTH & HYGIENE	318
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PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at Calicut University, a student would:

PO1	Knowledge Acquisition: Demonstrate a profound understanding of knowledgetrends and their impact on the chosen discipline of study.
PO2	Communication, Collaboration, Inclusiveness, and Leadership: Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Professional Skills: Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Digital Intelligence: Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Scientific Awareness and Critical Thinking: Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Human Values, Professional Ethics, and Societal and Environmental Responsibility: Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Research, Innovation, and Entrepreneurship: Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the B. Sc. Zoology Honours programme at Calicut University, a student would:

PSO1	Identify various scientific terms like the names of organs of human body, different hormones, names of animals, ecosystem components, various pollutants, taxonomic hierarchies,cellular inclusions, ; terms related to concepts in evolution, animal behaviour, zoogeography, genetics, molecular biology, biotechnology, biostatistics, biotechniques, developmental biology, endocrinology, reproductive biology,biochemistry,microbiology, immunology, enzymology, computational biology, cytogenetics, comparative anatomy and entomological and aquaculture and fishery practices.
PSO2	Describe the physiological functioning of human body, features of animal diversity, their classification, the inter- relationships of various life forms, and their role in the environment, impact of anthropogenic activities on environment, the principles and patterns of animal behaviour, the structural details of the cell, molecular basis of life, structure and reactions of biomolecules, and various other concepts in evolution,animal behaviour, zoogeography, genetics, molecular biology, biotechnology, biostatistics, biotechniques, developmental biology, endocrinology, reproductive biology, biochemistry, microbiology, immunology, enzymology, computational biology, cytogenetics, comparative anatomy and entomological and aquaculture and fishery practices.
PSO3	Compare the structural details of various animal groups, features of zoogeographical realms, evolutionary theories, different ecosystems, developmental stages of different animal groups, etc.
PSO4	Perform laboratory procedures as per standard protocols in the areas of animal diversity, systematics, cell biology, genetics, biochemistry, molecular biology, microbiology, physiology, immunology, developmental biology, environmental biology, ethology, and vocational applications of entomology and aquaculture and fishery science.
PSO5	Applies the knowledge acquired by studying the various concepts in animal diversity, evolution, animal behaviour, zoogeography, genetics, molecular biology, biotechnology, biostatistics, biotechniques, developmental biology, endocrinology, reproductive biology, biochemistry, microbiology, immunology, enzymology, computational biology, cytogenetics, comparative anatomy and entomological and aquaculture and fishery practices, in real life situations.
PSO6	Prepare reports after designing and executing surveys, field study, internships and project works to solve real life problems related to the various branches of Zoology

MINIMUM CREDIT REQUIREMENTS OF THE DIFFERENT PATHWAYS IN THE THREE-YEAR PROGRAMME IN CUFYUGP

<table>
<tr><th rowspan="3">Sl. No.</th><th rowspan="3">Academic Pathway</th><th>Major</th><th>Minor/ Other Disciplines</th><th rowspan="2">Foundation Courses
AEC: 4
MDC: 3
SEC: 3
VAC: 3</th><th rowspan="3">Internship</th><th rowspan="3">Total Credits</th><th rowspan="3">Example</th></tr>
<tr><td colspan="2">Each course has 4 credits</td></tr>
<tr><td colspan="2"></td><td>Each course has 3 credits</td></tr>
<tr><td>1</td><td>Single Major (A)</td><td>68

(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Zoology + six courses in different disciplines in different combinations</td></tr>
<tr><td>2</td><td>Major (A) with Multiple Disciplines (B, C)</td><td>68
(17 courses)</td><td>12 + 12
(3 + 3 = 6 courses)</td><td>39
(13 courses)</td><td>2</td><td>133</td><td>Major: Zoology + Chemistry and Botany</td></tr>
<tr><td>3</td><td>Major (A) with Minor (B)</td><td>68
(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Zoology
Minor: Chemistry</td></tr>
<tr><td>4</td><td>Major (A) with Vocational Minor (B)</td><td>68

(17 courses)</td><td>24

(6 courses)</td><td>39

(13 courses)</td><td>2</td><td>133</td><td>Major: Zoology
Minor: Vocational Botany</td></tr>
<tr><td>5</td><td>Double Major (A, B)</td><td>A: 48
(12 courses)

B: 44
(11 courses)</td><td>-</td><td>12 + 18 + 9</td><td>2</td><td>133</td><td>Zoology and Botany double major</td></tr>
<tr><td colspan="5">The 24 credits in the Minor stream are distributed between the two Majors.
2 MDC, 2 SEC, 2 VAC and the Internship should be in Major A. Total credits in Major A should be 48 + 20 = 68 (50% of 133)
1 MDC, 1 SEC and 1 VAC should be in Major B. Total credits in Major B should be 44 + 9 = 53 (40% of 133)</td></tr>
<tr><td colspan="8">Exit with UG Degree / Proceed to Fourth Year with 133 Credits</td></tr>
</table>

B. Sc. ZOOLOGY HONOURS PROGRAMME

COURSE STRUCTURE FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	**ZOO1CJ 101/ ZOO1M N100**	Core Course 1 in Major – AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS	75	5	4	30	70	100
		Minor Course 1	60/ 75	4/ 5	4	30	70	100
		Minor Course 2	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1– English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 1 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	**ZOO2CJ 101/ ZOO2M N100**	Core Course 2 in Major – ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	75	5	4	30	70	100
		Minor Course 3	60/ 75	4/ 5	4	30	70	100
		Minor Course 4	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3– English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75
		Multi-Disciplinary Course 2 – Other than Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	**ZOO3CJ 201**	Core Course 3 in Major – SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY	60	4	4	30	70	100
	ZOO3CJ 202/ ZOO3M N200	Core Course 4 in Major – PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE	75	5	4	30	70	100
		Minor Course 5	60/ 75	4/ 5	4	30	70	100
		Minor Course 6	60/ 75	4/ 5	4	30	70	100
		Multi-Disciplinary Course 3 – Kerala Knowledge System	45	3	3	25	50	75
	ENG3FV 108(2)	Value-Added Course 1 – English	45	3	3	25	50	75

		Total		**23/ 25**	**22**			**550**
4	**ZOO4CJ 203**	Core Course 5 in Major – ANIMAL DIVERSITY - I – NON-CHORDATA	75	5	4	30	70	100
	ZOO4CJ 204	Core Course 6 in Major – CELL BIOLOGY & GENETICS	75	5	4	30	70	100
	ZOO4CJ 205	Core Course 7 in Major – BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTICES	75	5	4	30	70	100
	ENG4FV 109(2)	Value-Added Course 2 – English	45	3	3	25	50	75
		Value-Added Course 3 – Additional Language	45	3	3	25	50	75
	ENG4FS 111(2)	Skill Enhancement Course 1 – English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	**ZOO5CJ 301**	Core Course 8 in Major – ANIMAL DIVERSITY - II – CHORDATA	75	5	4	30	70	100
	ZOO5CJ 302	Core Course 9 in Major – BIOSTATISTICS & BIO-TECHNIQUES	75	5	4	30	70	100
	ZOO5CJ 303	Core Course 10 in Major – FOUNDATIONS OF MOLECULAR BIOLOGY & BIOINFORMATICS	60	4	4	30	70	100
		ElectiveCourse 1 in Major	60	4	4	30	70	100
		ElectiveCourse 2 in Major	60	4	4	30	70	100
		Skill Enhancement Course 2	45	3	3	25	50	75
		Total		**25**	**23**			**575**
6	**ZOO6CJ 304/ ZOO8MN304**	Core Course 11 in Major – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	75	5	4	30	70	100
	ZOO6CJ 305/ ZOO8MN305	Core Course 12 in Major– BASICS OF BIOTECHNOLOGY, & IMMUNOLOGY	75	5	4	30	70	100
	ZOO 6CJ 306/ ZOO8MN306	Core Course 13 in Major – FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGY & REPRODUCTIVE BIOLOGY	60	4	4	30	70	100
		ElectiveCourse 3 in Major	60	4	4	30	70	100
		ElectiveCourse 4 in Major	60	4	4	30	70	100
	ZOO6FS 113	Skill Enhancement Course 3 – IT SKILLS IN BIOSTATISTICS & BIOINFORMATICS	45	3	3	25	50	75

	ZOO6CJ 349	Internship in Major (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
7	**ZOO7CJ 401**	Core Course 14 in Major –PHYSIOLOGY	75	5	4	30	70	100
	ZOO7CJ 402	Core Course 15 in Major – ENZYMOLOGY & CLINICAL BIOCHEMISTRY	75	5	4	30	70	100
	ZOO7CJ 403	Core Course 16 in Major – ADVANCES IN ECOLOGICAL & EVOLUTIONARY STUDIES	75	5	4	30	70	100
	ZOO7CJ 404	Core Course 17 in Major – MOLECULAR BIOLOGY & CYTOGENETICS	75	5	4	30	70	100
	ZOO7CJ 405	Core Course 18 in Major – COMPARATIVE ANATOMY & DEVELOPMENTAL BIOLOGY	75	5	4	30	70	100
		Total		**25**	**20**			**500**
8	**ZOO8CJ 406/ ZOO8MN406**	Core Course 19 in Major – COMPUTATIONAL BIOLOGY & STATISTICAL APPLICATIONS	75	5	4	30	70	100
	ZOO8CJ 407/ ZOO8MN407	Core Course 20 in Major – ADVANCES AND APPLICATIONS OF IMMUNOLOGY	60	4	4	30	70	100
	ZOO8CJ 408/ ZOO8MN408	Core Course 21 in Major – ADVANCES IN BIOTECHNOLOGY & MICROBIAL PROCESSING	60	4	4	30	70	100
	OR (instead of Core Courses 19 – 21 in Major)							
	ZOO8CJ 449	Project (in Honours programme)	360*	13*	12	90	210	300
	ZOO8CJ 499	Project (in Honours with Research programme)	360*	13*	12	90	210	300
		Elective Course 5 in Major / Minor Course 7	60	4	4	30	70	100
		Elective Course 6 in Major / Minor Course 8	60	4	4	30	70	100

		Elective Course 7 in Major / Minor Course 9 / Major Course in any Other Discipline	60	4	4	30	70	100
	OR (instead of Elective Course 7 in Major, in the case of Honours with Research Programme)							
	ZOO8CJ 489	RESEARCH METHODOLOGY IN ZOOLOGY	60	4	4	30	70	100
		Total		**25**	**24**			**600**
Total Credits for Four Years					**177**			**4425**

* The teacher should have 13hrs/week of engagement (the hours corresponding to the three core courses) in the guidance of the Project(s) in Honours programme and Honours with Research programme, while each student should have 24 hrs/week of engagement in the Project work. Total hours are given based on the student's engagement.

CREDIT DISTRIBUTION FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	**Major Courses**	**Minor Courses**	**General Foundation Courses**	**Internship/ Project**	**Total**
1	4	4 + 4	3 + 3 + 3	-	21
2	4	4 + 4	3 + 3 + 3	-	21
3	4 + 4	4 + 4	3 + 3	-	22
4	4 + 4 + 4	-	3 + 3 + 3	-	21
5	4 + 4 + 4 + 4 + 4	-	3	-	23
6	4 + 4 + 4 + 4 + 4	-	3	2	25
Total for Three Years	**68**	**24**	**39**	**2**	**133**
7	4 + 4 + 4 + 4 + 4	-	-	-	20
8	4 + 4 + 4	4 + 4 + 4	-	12*	24
*Instead of three Major courses					
Total for Four Years	**88 + 12 = 100**	**36**	**39**	**2**	**177**

DISTRIBUTION OF MAJOR COURSES IN ZOOLOGY
FOR PATHWAYS 1 – 4

1. Single Major
2. Major with Multiple Disciplines
3. Major with Minor
4. Major with Vocational Minor

Semester	Course Code	Course Title	Hours/ Week	Credits
1	**ZOO1CJ101/ ZOO1MN100**	Core Course 1 in Major – AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS	5	4
2	**ZOO2CJ101/ ZOO2MN100**	Core Course 2 in Major – ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	5	4
3	**ZOO3CJ201**	Core Course 3 in Major – SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY	4	4
	ZOO3CJ202/ ZOO3MN200	Core Course 4 in Major – PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE	5	4
4	**ZOO4CJ203**	Core Course 5 in Major – ANIMAL DIVERSITY - I – NON-CHORDATA	5	4
	ZOO4CJ204	Core Course 6 in Major – CELL BIOLOGY & GENETICS	5	4
	ZOO4CJ205	Core Course 7 in Major – BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTICES	5	4
5	**ZOO5CJ301**	Core Course 8 in Major – ANIMAL DIVERSITY - II - CHORDATA	5	4
	ZOO5CJ302	Core Course 9 in Major – BIOSTATISTICS & BIO-TECHNIQUES	5	4
	ZOO5CJ303	Core Course 10 in Major – FOUNDATIONS OF MOLECULAR BIOLOGY & BIOINFORMATICS	4	4
		Elective Course 1 in Major	4	4
		Elective Course 2 in Major	4	4
6	**ZOO6CJ304/ ZOO8MN304**	Core Course 11 in Major – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	5	4

	ZOO6CJ 305/ ZOO8MN 305	Core Course 12 in Major– BASICS OF BIOTECHNOLOGY, & IMMUNOLOGY	5	4
	ZOO6CJ 306/ ZOO8MN 306	Core Course 13 in Major – FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGY AND REPRODUCTIVE BIOLOGY	4	4
		Elective Course 3 in Major	4	4
		Elective Course 4 in Major	4	4
	ZOO6CJ 349	Internship in Major	-	2
Total for the Three Years				**70**
7	**ZOO7CJ 401**	Core Course 14 in Major – PHYSIOLOGY	5	4
	ZOO7CJ 402	Core Course 15 in Major – ENZYMOLOGY & CLINICAL BIOCHEMISTRY	5	4
	ZOO7CJ 403	Core Course 16 in Major – ADVANCES IN ECOLOGICAL & EVOLUTIONARY STUDIES	5	4
	ZOO7CJ 404	Core Course 17 in Major – MOLECULAR BIOLOGY & CYTOGENETICS	5	4
	ZOO7CJ 405	Core Course 18 in Major – COMPARATIVE ANATOMY & DEVELOPMENTAL BIOLOGY	5	4
8	**ZOO8CJ 406/ ZOO8MN 406**	Core Course 19 in Major – COMPUTATIONAL BIOLOGY & STATISTICAL APPLICATIONS	5	4
	ZOO8CJ 407/ ZOO8MN 407	Core Course 20 in Major – ADVANCES AND APPLICATIONS OF IMMUNOLOGY	4	4
	ZOO8CJ 408/ ZOO8MN 408	Core Course 21 in Major – ADVANCES IN BIOTECHNOLOGY & MICROBIAL PROCESSING	4	4
	OR (instead of Core Courses 19 – 21 in Major)			
8	**ZOO8CJ 449**	Project (in Honours programme)	13	12
	ZOO8CJ 499	Project (in Honours with Research programme)	13	12
		Elective Course 5 in Major	4	4
		Elective Course 6 in Major	4	4

		Elective Course 7 in Major	4	4
	OR (instead of Elective course 7 in Major, in Honours with Research programme)			
	ZOO8CJ 489	RESEARCH METHODOLOGY IN ZOOLOGY	4	4
Total for the Four Years				**114**

ELECTIVE COURSES IN ZOOLOGY WITH SPECIALISATION

Group No.	Sl. No.	Course Code	Title	Se-mes-ter	Total Hrs	Hrs/ Week	Cre dits	Marks		
								In-ter-nal	Ex-ter-nal	Total
1		**ENTOMOLOGY**								
	1	**ZOO5EJ 301(1)**	ENTOMOLOGY - I- STRUCTURE, ADAPTA-TIONS AND CLASSIFI-CATION OF INSECTS	5	60	4	4	30	70	100
	2	**ZOO5EJ 302(1)**	ENTOMOLOGY - II- AG-RICULTURAL ENTO-MOLOGY	5	60	4	4	30	70	100
	3	**ZOO6EJ 301(1)**	ENTOMOLOGY - III- IN-SECT ECOLOGY	6	60	4	4	30	70	100
	4	**ZOO6EJ 302(1)**	ENTOMOLOGY - IV- IN-SECT PEST MANAGE-MENT	6	60	4	4	30	70	100
2		**FISHERY SCIENCE**								
	1	**ZOO5EJ 303(2)**	FISHERY SCIENCE - I - FUNDAMENTALS OF FISHERY SCIENCE	5	60	4	4	30	70	100
	2	**ZOO5EJ 304(2)**	FISHERY SCIENCE II: FISH TAXONOMY, FISH BIOLOGY AND FISH PHYSIOLOGY	5	60	4	4	30	70	100
	3	**ZOO6EJ 303(2)**	FISHERY SCIENCE - III - CAPTURE AND CUL-TURE TECHNIQUES	6	60	4	4	30	70	100
	4	**ZOO6EJ 304(2)**	FISHERY SCIENCE - IV –HARVESTING AND POST - HARVESTING TECHNIQUES	6	60	4	4	30	70	100

3	**HUMAN GENETICS**									
	1	**ZOO5EJ 305(3)**	HUMAN GENETICS - I - INTRODUCTION TO HUMAN GENETICS	5	60	4	4	30	70	100
	2	**ZOO5EJ 306(3)**	HUMAN GENETICS - II - HUMAN CYTOGENETICS	5	60	4	4	30	70	100
	3	**ZOO6EJ 305(3)**	HUMAN GENETICS - III - GENETIC DISEASES AND COUNSELLING	6	60	4	4	30	70	100
	4	**ZOO6EJ 306(3)**	HUMAN GENETICS - IV - TECHNIQUES, GENOME AND COMPUTATION	6	60	4	4	30	70	100
4	**WILDLIFE BIOLOGY**									
	1	**ZOO5EJ 307(4)**	WILDLIFE BIOLOGY - I- BIODIVERSITY & BIOTA	5	60	4	4	30	70	100
	2	**ZOO5EJ 308(4)**	WILDLIFE BIOLOGY - II-ORNITHOLOGY AND MAMMALOGY	5	60	4	4	30	70	100
	3	**ZOO6EJ 307(4)**	WILDLIFE BIOLOGY - III-FIELD TECHNIQUES IN WILDLIFE STUDIES	6	60	4	4	30	70	100
	4	**ZOO6EJ 308(4)**	WILDLIFE BIOLOGY - IV-WILDLIFE CONSERVATION AND MANAGEMENT	6	60	4	4	30	70	100

ELECTIVE COURSES IN ZOOLOGY WITH NO SPECIALISATION

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
1	**ZOO8EJ 401**	ENVIRONMENTAL BIOLOGY - I -ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT	8	60	4	4	30	70	100
2	**ZOO8EJ 402**	ENVIRONMENTAL BIOLOGY - II - ENVIRONMENTAL CHEMISTRY	8	60	4	4	30	70	100

3	**ZOO8EJ 403**	ENVIRONMENTAL BIOLOGY - III - ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY	8	60	4	4	30	70	100
4	**ZOO8EJ 404**	PARASITOLOGY – I – GENERAL PARASITOLOGY & NON-HELMINTH PARASITES	8	60	4	4	30	70	100
5	**ZOO8EJ 405**	PARASITOLOGY – II – HELMINTHOLOGY	8	60	4	4	30	70	100
6	**ZOO8EJ 406**	PARASITOLOGY – III-BIOCHEMICAL, MOLECULAR AND IMMUNOLOGICAL ASPECTS OF PARASITISM	8	60	4	4	30	70	100
7	**ZOO8EJ 407**	FORENSIC BIOLOGY - I - BIOLOGICAL EVIDENCES & FORENSIC SEROLOGY	8	60	4	4	30	70	100
8	**ZOO8EJ 408**	FORENSIC BIOLOGY -II - WILDLIFE FORENSICS AND FORENSIC MEDICINE	8	60	4	4	30	70	100
9	**ZOO8EJ 409**	FORENSIC BIOLOGY - III-FORENSIC ENTOMOLOGY	8	60	4	4	30	70	100
10	**ZOO8EJ 410**	MARINE BIOLOGY - I-THREATS TO MARINE ECOSYSTEM	8	60	4	4	30	70	100
11	**ZOO8EJ 411**	MARINE BIOLOGY - II-MARINE RESOURCES AND PLANKTONOLOGY	8	60	4	4	30	70	100
12	**ZOO8EJ 412**	MARINE BIOLOGY - III-ADVANCES IN MARINE BIOLOGY	8	60	4	4	30	70	100

GROUPING OF MINOR COURSES IN ZOOLOGY

The minor courses given below should not be offered to the students, who have taken Zoology as the Major discipline. They should be offered to those students from the other Major disciplines only.

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
1		**GENERAL ZOOLOGY**								
	1	**ZOO1MN101**	FOUNDATIONS OF ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	1	75	5	4	30	70	100
	2	**ZOO2MN101**	INTRODUCTORY HUMAN PHYSIOLOGY	2	75	5	4	30	70	100
	3	**ZOO3MN201**	ANIMAL DIVERSITY, REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY	3	75	5	4	30	70	100
2		**HUMAN PHYSIOLOGY**								
	1	**ZOO1MN102**	BASICS IN CELLULAR PHYSIOLOGY	1	75	5	4	30	70	100
	2	**ZOO2MN102**	NEUROPHYSIOLOGY	2	75	5	4	30	70	100
	3	**ZOO3MN202**	PHYSIOLOGY OF BEHAVIOUR & SENSES	3	75	5	4	30	70	100

GROUPING OF VOCATIONAL MINOR COURSES IN ZOOLOGY

(Title of the Vocational Minor: **VOCATIONAL ZOOLOGY)**

Group No.	Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
								Internal	External	Total
		APPLIED ZOOLOGY								
1	1	**ZOO1VN101**	BASICS IN ENTOMOLOGICAL, POULTRY SCIENCE AND DAIRY SCIENCE APPLICATIONS	1	75	5	4	30	70	100
	2	**ZOO2VN101**	AQUACULTURE AND FISHERY SCIENCE PRACTICES	2	75	5	4	30	70	100

	3	**ZOO3VN 201**	FOUNDATIONS OF BIOSTATISTICS AND BIOTECHNIQUES	3	75	5	4	30	70	100
	4	**ZOO8VN 301**	COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATIONS	8	75	5	4	30	70	100
2		**SKILL ZOOLOGY**								
	1	**ZOO1VN 102**	ECOLOGICAL TOOLS AND TECHNIQUES	1	75	5	4	30	70	100
	2	**ZOO2VN 102**	FOOD PROCESSING & QUALITY CONTROL	2	75	5	4	30	70	100
	3	**ZOO3VN 202**	LIFE SKILL TECHNIQUES	3	75	5	4	30	70	100
	4	**ZOO8VN 302**	ADVANCES IN BIOTECHNOLOGY & MICROBIOLOGY	8	60	4	4	30	70	100

(i). Students in the Single Major pathway can choose course//courses from any of the Minor/ Vocational Minor groups offered by a discipline other than their Major discipline.

(ii). Students in Major with Multiple Disciplines pathway can choose, as one of the multiple disciplines, all the three courses from any one of the Minor/ Vocational Minor groups offered by any discipline, other than their Major discipline. If the students choose any one of the Minor/ Vocational Minor groups in Zoology as given above, then the title of the group will be the title of that multiple discipline.

(iii). Students in the Major with Minor pathway can choose all the courses from any two Minor groups offered by any discipline, other than their Major discipline. A student who selects Zoology as his/ her minor can select any two groups among the above listed four groups; including vocational minor groups, in such a way that one groups is from non-vocational group and the other from vocational group.

(iv). Students in Major with a Vocational Minor pathway can choose all the courses from any two Vocational Minor groups offered by any discipline, other than their Major discipline.

DISTRIBUTION OF GENERAL FOUNDATION COURSES IN ZOOLOGY

Semester	**Course Code**	**Course Title**	**Total Hours**	**Hours/ Week**	**Credits**	**Marks**		
						Internal	**External**	**Total**
1	**ZOO1FM105(1)**	Multi-Disciplinary Course 1 – NUTRITION, HEALTH & HYGIENE	45	3	3	25	50	75
	ZOO1FM105(2)	Multi-Disciplinary Course 1 – REPRODUCTIVE HEALTH & SEX EDUCATION	45	3	3	25	50	75

2	**ZOO2FM106(1)**	Multi-Disciplinary Course 2 – AQUACULTURE & ORNAMENTAL FISHFARMING	45	3	3	25	50	75
	ZOO2FM 106(2)	Multi-Disciplinary Course 2 – APICULTURE & SERICULTURE	45	3	3	25	50	75
	ZOO2FM 106(3)	Multi-Disciplinary Course 2 – BIOLOGY FOR COMPETITIVE EXAMS	45	3	3	25	50	75
3	**ZOO3FV 108**	Value-Added Course 1 – HEALTH - A HOLISTIC APPROACH	45	3	3	25	50	75
4	**ZOO4FV 110**	Value-Added Course 2 – ECOLOGICAL ECONOMICS & SUSTAINABLE LIFE	45	3	3	25	50	75
5	**ZOO5FS 112**	Skill Enhancement Course 2 – LABORATORY EQUIPMENT MAINTENANCE & MUSEUM CURATION	45	3	3	25	50	75
6	**ZOO6FS 113**	Skill Enhancement Course 3 – IT SKILS IN BIOSTATISTICS & BIOINFORMATICS	45	3	3	25	50	75

COURSE STRUCTURE FOR BATCH A1(B2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Zoology (Major A) ***B1: 68 credits in Major B***
A2: 53 credits in Zoology (Major A) ***B2: 53 credits in Major B***
The combinations available to the students: (A1 & B2), (B1 & A2)
Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	**ZOO1CJ 101 / ZOO1MN 100**	Core Course 1 in Major Zoology – AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	ZOO1CJ 102/ ZOO2CJ 102/ ZOO4CJ204	Core Course 2 in Major Zoology – CELL BIOLOGY & GENETICS (for batch A1 only)	75	5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	ZOO1FM 105(1) or ZOO1FM 105 (2)	Multi-Disciplinary Course 1 in Zoology – NUTRITION, HEALTH & HYGIENE or REPRODUCTIVE HEALTH AND SEX EDUCATION (for batch A1 only)	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
2	**ZOO2CJ 101/ ZOO2MN 100**	Core Course 3 in Major Zoology – ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	75	5	4	30	70	100
	BBB2CJ 101	Core Course 2 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB2CJ 102 / BBB1CJ 102	Core Course 3 in Major B – (for batch B2 only)	60/ 75	4/ 5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75

	ZOO2FM 106(1) or ZOO2FM 106(2) or ZOO2FM 106(3)	Multi-Disciplinary Course 2 in Zoology – AQUACULTURE & ORNAMENTAL FISH FARMING or APICULTURE & SERICULTURE or BIOLOGY FOR COMPETITIVE EXAMS	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	**ZOO3CJ 201**	Core Course 4 in Major Zoology – SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY	60	4	4	30	70	100
	ZOO3CJ 202 / ZOO3MN 200	Core Course 5 in Major Zoology – PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 1 in B –	45	3	3	25	50	75
	ZOO3FV 108	Value-Added Course 1 in Zoology – HEALTH - A HOLISTIC APPROACH (for batch A1 only)	45	3	3	25	50	75
		Total		**23/ 25**	**22**			**550**
4	**ZOO4CJ 203**	Core Course 6 in Major Zoology – ANIMAL DIVERSITY - I – NON-CHORDATA	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
	ZOO4CJ 205	Core Course 7 in Major Zoology – BASICS IN AQUACULTURE & FISHERY SCIENCE PRACTICES (for batch A1 only)	75	5	4	30	70	100
	ZOO4FV 110	Value-Added Course 2 in Zoology – ECOLOGICAL ECONOMICS & SUSTAINABLE LIFE	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 1in B –	45	3	3	25	50	75
	ZOO4FS 112 / ZOO5FS 112	Skill Enhancement Course 1 in Zoology – LABORATORY EQUIPMENT MAINTENANCE & MUSEUM CURATION	45	3	3	25	50	75

		Total		**23/ 24**	**21**			**525**
5	**ZOO5CJ 301**	Core Course 8 in Major Zoology – ANIMAL DIVERSITY - II - CHORDATA	75	5	4	30	70	100
		Core Course 7 in Major B –	60/ 75	4/ 5	4	30	70	100
	ZOO5CJ 303	Core Course 9 in Major Zoology – FOUNDATIONS OF MOLECULAR BIOLOGY & BIOINFORMATICS (for batch A1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Zoology	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	**ZOO6CJ 304/ ZOO8MN 304**	Core Course 10 in Major Zoology – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB6CJ 305	Core Course 9 in Major B – (for batch B2 only)	60	4	4	30	70	100
		Elective Course 2 in Major Zoology	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	ZOO6FS 113	Skill Enhancement Course 2 in Zoology – IT SKILLS IN BIOSTATISTICS & BIOINFORMATICS (for batch A1 only)	45	3	3	25	50	75
	ZOO6CJ 349	Internship in Major Zoology (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**
For batch A1(B2), the course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6.								

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH A1(B2)
IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in Zoology	General Foundation Courses in Zoology	Internship/ Project in Zoology	Major Courses in B	General Foundation Courses in B	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	3	-	4 + 4	-	3 + 3	21
3	4 + 4	3	-	4 + 4	3	-	22
4	4 + 4	3 + 3	-	4	3	-	21
5	4 + 4 + 4	-	-	4 + 4	3	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in Zoology	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
*Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

COURSE STRUCTURE FOR BATCH B1(A2)
IN PATHWAY 5: DOUBLE MAJOR

A1: 68 credits in Zoology (Major A) ***B1: 68 credits in Major B***
A2: 53 credits in Zoology (Major A) ***B2: 53 credits in Major B***
The combinations available to the students: (A1 & B2), (B1 & A2)
Note: Unless the batch is specified, the course is for all the students of the class

Semester	Course Code	Course Title	Total Hours	Hours/ Week	Credits	Marks		
						Internal	External	Total
1	**ZOO1CJ 101 / ZOO1MN 100**	Core Course 1 in Major Zoology – AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS	75	5	4	30	70	100
	BBB1CJ 101	Core Course 1 in Major B –	60/ 75	4/ 5	4	30	70	100
	BBB1CJ 102 / BBB2CJ 102	Core Course 2 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	ENG1FA 101(2)	Ability Enhancement Course 1 – English	60	4	3	25	50	75
		Ability Enhancement Course 2 – Additional Language	45	3	3	25	50	75
	BBB1FM 105	Multi-Disciplinary Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**21**			**525**
2	**ZOO2CJ 101 / ZOO2MN 100**	Core Course 2 in Major Zoology ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	75	5	4	30	70	100
	BBB2CJ 101	Core Course 3 in Major B –	60/ 75	4/ 5	4	30	70	100
	ZOO2CJ102/ ZOO1CJ 102/ZOO4CJ204	Core Course 3 in Major Zoology – CELL BIOLOGY & GENETICS (for batch A2 only)	75	5	4	30	70	100
	ENG2FA 103(2)	Ability Enhancement Course 3 – English	60	4	3	25	50	75
		Ability Enhancement Course 4 – Additional Language	45	3	3	25	50	75

	ZOO2FM 106(1) or ZOO2FM 106(2) or ZOO2FM 106(3)	Multi-Disciplinary Course 1 in Zoology – AQUACULTURE & ORNAMENTAL FISH FARMING or APICULTURE & SERICULTURE or BIOLOGY FOR COMPETITIVE EXAMS	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
3	**ZOO3CJ 201**	Core Course 4 in Major Zoology – SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY	60	4	4	30	70	100
	ZOO3CJ 202/ ZOO3MN 200	Core Course 5 in Major Zoology – PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE	75	5	4	30	70	100
	BBB3CJ 201	Core Course 4 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3CJ 202	Core Course 5 in Major B	60/ 75	4/ 5	4	30	70	100
	BBB3FM 106 / BBB2FM 106	Multi-Disciplinary Course 2 in B –	45	3	3	25	50	75
	BBB3FV 108	Value-Added Course 1 in B – (for batch B1 only)	45	3	3	25	50	75
		Total		**23 – 25**	**22**			**550**
4	**ZOO4CJ 203**	Core Course 6 in Major Zoology – ANIMAL DIVERSITY - I – NON-CHORDATA	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
		Core Course 7 in Major B – (for batch B1 only)	60/ 75	4/ 5	4	30	70	100
	ZOO4FV 110	Value-Added Course 1in Zoology ECOLOGICAL ECONOMICS & SUSTAINABLE LIFE	45	3	3	25	50	75
	BBB4FV 110	Value-Added Course 2 in B –	45	3	3	25	50	75
	ZOO4FS 112 / ZOO5FS 112	Skill Enhancement Course 1 in Zoology –IT SKILLS IN BIOSTATISTICS & BIOINFORMATICS	45	3	3	25	50	75
		Total		**22 – 24**	**21**			**525**

5	**ZOO5CJ 301**	Core Course 7 in Major Zoology – ANIMAL DIVERSITY - II - CHORDATA	75	5	4	30	70	100
		Core Course 8 in Major B –	60/ 75	4/ 5	4	30	70	100
		Core Course 9 in Major B – (for batch B1 only)	60	4	4	30	70	100
		Elective Course 1 in Major Zoology	60	4	4	30	70	100
		Elective Course 1 in Major B	60	4	4	30	70	100
	BBB5FS 112 / BBB4FS 112	Skill Enhancement Course 1 in B	45	3	3	25	50	75
		Total		**24/ 25**	**23**			**575**
6	**ZOO6CJ 304/ ZOO8MN 304**	Core Course 8 in Major Zoology – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	75	5	4	30	70	100
		Core Course 10 in Major B –	60/ 75	4/ 5	4	30	70	100
	ZOO6CJ 306/ ZOO8MN 306	Core Course 9 in Major Zoology – FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGY & REPRODUCTIVE BIOLOGY (for batch A2 only)	60	4	4	30	70	100
		Elective Course 2 in Major Zoology	60	4	4	30	70	100
		Elective Course 2 in Major B	60	4	4	30	70	100
	BBB6FS 113	Skill Enhancement Course 2 in B – (for batch B1 only)	45	3	3	25	50	75
	BBB6CJ 349	Internship in Major B (Credit for internship to be awarded only at the end of Semester 6)	60		2	50	-	50
		Total		**24/ 25**	**25**			**625**
Total Credits for Three Years					**133**			**3325**

To continue to study Zoology in semesters 7 and 8, batch B1(A2) needs to earn additional 15 credits in Zoology to make the total credits of 68. Suppose this condition is achieved, and the student of batch B1(A2) proceeds to the next semesters to study Zoology. The course structure in semesters 7 and 8 is the same as for pathways 1 – 4, except that the number of the core and elective courses is in continuation of the number of courses in the two categories completed at the end of semester 6, taking into account the number of courses in Zoology taken online to earn the additional 15 credits.

* The course code of the same course as used for the pathways 1 – 4

CREDIT DISTRIBUTION FOR BATCH B1(A2)IN PATHWAY 5: DOUBLE MAJOR

Semester	Major Courses in B	General Foundation Courses in B	Internship/ Project in B	Major Courses in Zoology	General Foundation Courses in Zoology	AEC	Total
1	4 + 4	3	-	4	-	3 + 3	21
2	4	-	-	4 + 4	3	3 + 3	21
3	4 + 4	3 + 3	-	4 + 4	-	-	22
4	4 + 4	3	-	4	3 + 3	-	21
5	4 + 4 + 4	3	-	4 + 4	-	-	23
6	4 + 4	3	2	4 + 4 + 4	-	-	25
Total for Three Years	**48**	**18**	**2**	**44**	**9**	**12**	**133**
	68			**53**		**12**	**133**
	Major Courses in B	Minor Courses					
7	4 + 4 + 4 + 4 + 4	-			-	-	20
8	4 + 4 + 4	4 + 4 + 4	12*		-	-	24
*Instead of three Major courses							
Total for Four Years	**88 + 12 = 100**	**12**					**177**

EVALUATION SCHEME

1. The evaluation scheme for each course contains two parts: internal evaluation (about 30%) and external evaluation (about 70%). Each of the Major and Minor courses is of 4-credits. It is evaluated for 100 marks, out of which 30 marks is from internal evaluation and 70 marks, from external evaluation. Each of the General Foundation course is of 3-credits. It is evaluated for 75 marks, out of which 25 marks is from internal evaluation and 50 marks, from external evaluation.
2. The 4-credit courses (Major and Minor courses) are of two types: (i) courses with only theory and (ii) courses with 3-credit theory and 1-credit practical.

- In 4-credit courses with only theory component, out of the total 5 modules of the syllabus, one open-ended module with 20% content is designed by the faculty member teaching that course, and it is internally evaluated for 10 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.
- In 4-credit courses with 3-credit theory and 1-credit practical components, out of the total 5 modules of the syllabus, 4 modules are for theory and the fifth module is for practical. The practical component is internally evaluated for 20 marks. The internal evaluation of the 4 theory modules is for 10 marks.

3. All the 3-credit courses (General Foundational Courses) in Zoology are with only theory component. Out of the total 5 modules of the syllabus, one open-ended module with 20% content

is designed by the faculty member teaching that course, and it is internally evaluated for 5 marks. The internal evaluation of the remaining 4 theory modules is for 20 marks.

Sl. No.	Nature of the Course		Internal Evaluation in Marks (about 30% of the total)		External Exam on 4 modules (Marks)	Total Marks
			Open-ended module / Practical	On the other 4 modules		
1	4-credit course	only theory (5 modules)	10	20	70	100
2	4-credit course	Theory (4 modules) + Practical	20	10	70	100
3	3-credit course	only theory (5 modules)	5	20	50	75

1. MAJOR AND MINOR COURSES

1.1. INTERNAL EVALUATION OF THEORY COMPONENT

Sl. No.	Components of Internal Evaluation of Theory Part of a Major / Minor Course	Internal Marks for the Theory Part of a Major / Minor Course of 4-credits			
		Theory Only		Theory + Practical	
		4 Theory Modules	Open-ended Module	4 Theory Modules	Practical
1	Test paper/ Mid-semester Exam	10	4	5	-
2	Seminar/ Viva/ Quiz	6	4	3	-
3	Assignment	4	2	2	-
Total		20	10	10	20*
		30		30	

* Refer the table in section 1.2 for the evaluation of practical component

1.2. EVALUATION OF PRACTICAL COMPONENT

The evaluation of practical component in Major and Minor courses is completely by internal evaluation.

- Continuous evaluation of practical by the teacher-in-charge shall carry a weightage of 50%.
- The end-semester practical examination and viva-voce, and the evaluation of practical records shall be conducted by the teacher in-charge and an internal examiner appointed by the Department Council.
- The process of continuous evaluation of practical courses shall be completed before 10 days from the commencement of the end-semester examination.

- Those who passed in continuous evaluation alone will be permitted to appear for the end-semester examination and viva-voce.
- The records of practical work should be hand written and hard-bound; commercially available, pre-bound record books may also be used. Field study reports, wherever necessary also should be hand-written and submitted along with the practical record at the time of the end-semester practical exam.

The scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be given as follows:

Sl. No.	Evaluation of Practical Component of Credit-1 in a Major / Minor Course	Marks for Practical	Weightage
1	Continuous evaluation of practical/ exercise performed in practical classes by the students (Performance in Lab - 7 marks; Attendance in the lab - 3 marks)	10	50%
2	End-semester examination and viva-voce to be conducted by teacher-in-charge along with an additional examiner arranged internally by the Department Council	7	35%
3	Evaluation of the Practical records, submitted for the end semester viva–voce examination, by the teacher-in-charge and additional examiner	3	15%
Total Marks		20	

1.3. EXTERNAL EVALUATION OF THEORY COMPONENT

External evaluation carries 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR MAJOR AND MINOR COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
2 Hours	Short Answer	10	8 – 10	3	24
	Paragraph/ Problem	8	6 – 8	6	36
	Essay	2	1	10	10
Total Marks					70

2. INTERNSHIP

- All students should undergo Internship of 2-credits during the first six semesters in a firm, industry or organization, or training in labs with faculty and researchers of their own institution or other Higher Educational Institutions (HEIs) or research institutions.
- Internship can be for enhancing the employability of the student or for developing the research aptitude.

- Internship can involve hands-on training on a particular skill/ equipment/ software. It can be a short project on a specific problem or area. Attending seminars or workshops related to an area of learning or skill can be a component of Internship.
- A faculty member/ scientist/ instructor of the respective institution, where the student does the Internship, should be the supervisor of the Internship.

2.1. GUIDELINES FOR INTERNSHIP

1. Internship can be in Zoology or allied disciplines.
2. There should be minimum 60 hrs. of engagement from the student in the Internship.
3. Summer vacations and other holidays can be used for completing the Internship.
4. The students should make regular and detailed entries in to a personal log book through the period of Internship. The log book will be a record of the progress of the Internship and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Internship supervisor should periodically examine and countersign the log book.
5. The log book and the typed report must be submitted at the end of the Internship.
6. The institution at which the Internship will be carried out should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours Programme.

2.2. EVALUATION OF INTERNSHIP

- The evaluation of Internship shall be done internally through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours Programme.
- The credits and marks for the Internship will be awarded only at the end of semester 6.

The scheme of continuous evaluation and the end-semester viva-voce examination based on the submitted report shall be as given below:

Sl. No.	Components of Evaluation of Internship		Marks for Internship 2 Credits	Weightage
1	Continuous evaluation of internship through interim presentations and reports by the committee internally constituted by the Department Council	Acquisition of skill set	10	40%
2		Interim Presentation and Viva-voce	5	
3		Punctuality and Log Book	5	
4	End-semester viva-voce examination to be conducted by the committee internally constituted by the Department Council	Quality of the work	8	40%
5		Presentation of the work	6	
6		Viva-voce	6	
7	Evaluation of the day-to-day records, the report of internship supervisor, and final report submitted for the end semester viva–voce examination before the committee internally constituted by the Department Council		10	20%
	Total Marks		50	

3. PROJECT

3.1. PROJECT IN HONOURS PROGRAMME

- In Honours programme, the student has the option to do a Project of 12-credits instead of three Core Courses in Major in semester 8.
- The Project can be done in the same institution/ any other higher educational institution (HEI)/ research centre/ training centre.
- The Project in Honours programme can be a short research work or an extended internship or a skill-based training programme.
- A faculty member of the respective institution, where the student does the Project, should be the supervisor of the Project.

3.2. PROJECT IN HONOURS WITH RESEARCH PROGRAMME

- Students who secure 75% marks and above (equivalently, CGPA 7.5 and above) cumulatively in the first six semesters are eligible to get selected to Honours with Research stream in the fourth year.
- A relaxation of 5% in marks (equivalently, a relaxation of 0.5 grade in CGPA) is allowed for those belonging to SC/ST/OBC (non-creamy layer)/ Differently-Abled/ Economically Weaker Section (EWS)/ other categories of candidates as per the decision of the UGC from time to time.
- In Honours with Research programme, the student has to do a mandatory Research Project of 12-credits instead of three Core Courses in Major in semester 8.
- The approved research centres of University of Calicut or any other university/ HEI can offer the Honours with Research programme. The departments in the affiliated colleges under University of Calicut, which are not the approved research centres of the University, should get prior approval from the University to offer the Honours with Research programme. Such departments should have minimum two faculty members with Ph.D., and they should also have the necessary infrastructure to offer Honours with Research programme.
- A faculty member of the University/ College with a Ph.D. degree can supervise the research project of the students who have enrolled for Honours with Research. One such faculty member can supervise maximum five students in Honours with Research stream.
- The maximum intake of the department for Honours with Research programme is fixed by the department based on the number of faculty members eligible for project supervision, and other academic, research, and infrastructural facilities available.
- If a greater number of eligible students are opting for the Honours with Research programme than the number of available seats, then the allotment shall be based on the existing rules of reservations and merits.

3.3. GUIDELINES FOR THE PROJECT IN HONOURS PROGRAMME AND HONOURS WITH RESEARCH PROGRAMME

1. Project can be in Zoology or allied disciplines.
2. Project should be done individually.
3. Project work can be of experimental/ theoretical/ computational in nature.
4. There should be minimum 360 hrs. of engagement from the student in the Project work in Honours programme as well as in Honours with Research programme.
5. There should be minimum 13 hrs./week of engagement (the hours corresponding to the three core courses in Major in semester 8)from the teacher in the guidance of the Project(s) in Honours programme and Honours with Research programme.
6. The various steps in project works are the following:

- Wide review of a topic.
- Investigation on a problem in systematic way using appropriate techniques.
- Systematic recording of the work.
- Reporting the results with interpretation in a standard documented form.
- Presenting the results before the examiners.

7. During the Project the students should make regular and detailed entries in to a personal log book through the period of investigation. The log book will be a record of the progress of the Project and the time spent on the work, and it will be useful in writing the final report. It may contain experimental conditions and results, ideas, mathematical expressions, rough work and calculation, computer file names etc. All entries should be dated. The Project supervisor should periodically examine and countersign the log book.
8. The log book and the typed report must be submitted at the end of the Project. A copy of the report should be kept for reference at the department. A soft copy of the report too should be submitted, to be sent to the external examiner in advance.
9. It is desirable, but not mandatory, to publish the results of the Project in a peer reviewed journal.
10. The project report shall have an undertaking from the student and a certificate from the research supervisor for originality of the work, stating that there is no plagiarism, and that the work has not been submitted for the award of any other degree/ diploma in the same institution or any other institution.
11. The project proposal, institution at which the project is being carried out, and the project supervisor should be prior-approved by the Department Council of the college where the student has enrolled for the UG Honours programme.

3.4. EVALUATION OF PROJECT

- The evaluation of Project will be conducted at the end of the eighth semester by both internal and external modes.
- The Project in Honours programme as well as that in Honours with Research programme will be evaluated for 300 marks. Out of this, 90 marks is from internal evaluation and 210 marks, from external evaluation.
- The internal evaluation of the Project work shall be done through continuous assessment mode by a committee internally constituted by the Department Council of the college where the student has enrolled for the UG Honours programme. 30% of the weightage shall be given through this mode.
- The remaining 70% shall be awarded by the external examiner appointed by the University.

The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be given as follows:

Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)	Weightage
Continuous evaluation of project work through interim presentations and reports by the committee internally constituted by the Department Council	90	30%
End-semester viva-voce examination to be conducted by the external examiner appointed by the university	150	50%
Evaluation of the day-to-day records and project report submitted for the end-semester viva–voce examination conducted by the external examiner	60	20%
Total Marks	300	

INTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research)
1	Skill in doing project work	30
2	Interim Presentation and Viva-Voce	20
3	Punctuality and Log book	20
4	Scheme/ Organization of Project Report	20
Total Marks		90

EXTERNAL EVALUATION OF PROJECT

Sl. No	Components of Evaluation of Project	Marks for the Project (Honours/ Honours with Research) 12 credits
1	Content and relevance of the Project, Methodology, Quality of analysis, and Innovations of Research	50
2	Presentation of the Project	50
3	Project Report (typed copy), Log Book and References	60
4	Viva-Voce	50
Total Marks		210

4. GENERAL FOUNDATION COURSES

- All the General Foundation Courses (3-credits) in Zoology are with only theory component.

4.1. INTERNAL EVALUATION

Sl. No.	Components of Internal Evaluation of a General Foundation Course in Zoology	Internal Marks of a General Foundation Course of 3-credits in Zoology	
		4 Theory Modules	Open-ended Module
1	Test paper/ Mid-semester Exam	10	2
2	Seminar/ Viva/ Quiz	6	2
3	Assignment	4	1
Total		20	5
		25	

4.2. EXTERNAL EVALUATION

External evaluation carries about 70% marks. Examinations will be conducted at the end of each semester. Individual questions are evaluated in marks and the total marks are converted into grades by the University based on 10-point grading system (refer section 5).

PATTERN OF QUESTION PAPER FOR GENERAL FOUNDATION COURSES

Duration	Type	Total No. of Questions	No. of Questions to be Answered	Marks for Each Question	Ceiling of Marks
1.5 Hours	Short Answer	10	8 – 10	2	16
	Paragraph/ Problem	5	4 – 5	6	24
	Essay	2	1	10	10
Total Marks					50

5. LETTER GRADES AND GRADE POINTS

- Mark system is followed for evaluating each question.
- For each course in the semester letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below.
- The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester.
- The Cumulative GPA (CGPA) is based on the grades in all courses taken after joining the programme of study.
- Only the weighted grade point based on marks obtained shall be displayed on the grade card issued to the students.

LETTER GRADES AND GRADE POINTS

Sl. No.	Percentage of Marks (Internal & External Put Together)	Description	Letter Grade	Grade Point	Range of Grade Points	Class
1	95% and above	Outstanding	O	10	9.50 – 10	First Class with Distinction
2	Above 85% and below 95%	Excellent	A+	9	8.50 – 9. 49	
3	75% to below 85%	Very Good	A	8	7.50 – 8.49	
4	65% to below 75%	Good	B+	7	6.50 – 7.49	First Class
5	55% to below 65%	Above Average	B	6	5.50 – 6.49	
6	45% to below 55%	Average	C	5	4.50 – 5.49	Second Class
7	35% to below 45% aggregate (internal and external put together) with a minimum of 30% in external valuation	Pass	P	4	3.50 – 4.49	Third Class
8	Below an aggregate of 35% or below 30% in external evaluation	Fail	F	0	0 – 3.49	Fail
9	Not attending the examination	Absent	Ab	0	0	Fail

- When students take audit courses, they will be given Pass (P) or Fail (F) grade without any credits.
- The successful completion of all the courses and capstone components prescribed for the three-year or four-year programme with 'P' grade shall be the minimum requirement for the award of UG Degree or UG Degree Honours or UG Degree Honours with Research, as the case may be.

5.1. COMPUTATION OF SGPA AND CGPA

- The following method shall be used to compute the Semester Grade Point Average (SGPA): The SGPA equals the product of the number of credits (Ci) with the grade points (Gi) scored by a student in each course in a semester, summed over all the courses taken by a student in the semester, and then divided by the total number of credits of all the courses taken by the student in the semester,

  i.e. SGPA (Si) = Σi (Ci x Gi) / Σi (Ci)

  where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th}course in the given semester. Credit Point of a course is the value obtained by multiplying the credit (Ci) of the course by the grade point (Gi) of the course.

$$SGPA = \frac{\sum of\ the\ credit\ points\ of\ all\ the\ courses\ of\ a\ semester}{Total\ credits\ of\ that\ semester}$$

ILLUSTRATION – COMPUTATION OF SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	Course 1	3	A	8	3 x 8 = 24
I	Course 2	4	B+	7	4 x 7 = 28
I	Course 3	3	B	6	3 x 6 = 18
I	Course 4	3	O	10	3 x 10 = 30
I	Course 5	3	C	5	3 x 5 = 15
I	Course 6	4	B	6	4 x 6 = 24
	Total	20			139
	SGPA				139/20 = 6.950

- The Cumulative Grade Point Average (CGPA) of the student shall be calculated at the end of a programme. The CGPA of a student determines the overall academic level of the student in a programme and is the criterion for ranking the students.
  CGPA for the three-year programme in CUFYUGP shall be calculated by the following formula.

$$CGPA = \frac{\sum of\ the\ credit\ points\ of all\ the\ courses\ of\ six\ semesters}{Total\ credits\ of\ six\ semesters(133)}$$

  CGPA for the four-year programme in CUFYUGP shall be calculated by the following formula.

$$CGPA = \frac{\sum of\ the\ credit\ points\ of\ all\ the\ courses\ of\ eight\ semesters}{Total\ credits\ of\ eights\ emesters\ (177)}$$

- The SGPA and CGPA shall be rounded off to three decimal points and reported in the transcripts.
- Based on the above letter grades, grade points, SGPA and CGPA, the University shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

UNIVERSITY OF CALICUT

B.Sc. ZOOLOGY HONOURS

MAJOR

DISCIPLINE SPECIFIC CORE COURSES

AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or the following online courses 1. https://www.coursera.org/learn/physiology 2. https://learn.utoronto.ca/programs-courses/courses/2159-basic-human-physiology 3. https://www.classcentral.com/classroom/youtube-anatomy-physiology-45834 4. https://www.ivyroses.com/Revise/AnatomyPhysiology/index.php 5. https://www.medicalnewstoday.com/articles/organs-in-the-body#organ-systems 6. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/physiologypti.pdf				
Course objectives	The student develops understanding in the organization and functioning of human physiological systems and will be able to perform simple experiments related to it.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the structural and functional organization of human body	U	F&C	Short answer, Paragraph type questions
CO2	Explain the mechanism of transport and exchange of respiratory gases and its control	U	F&C	Paragraph, Essay type questions
CO3	Identify and describe different components of blood and various blood groups; cardio-vascular problems	U	F	Short answer, Paragraph type questions
CO4	Compare the different types of neurons; Explain mechanism of nerve impulse transmission; the ultrastructure of skeletal muscles and biochemical events and energetics involved in muscle contraction, the need of physical exercise in good physical and physiological condition	U	F&C	Short answer, Paragraph, Essay type questions

CO5	Acquire skill in estimating and enumerating blood parameters; calculating BMI, measuring the respiratory volumes, etc.	Ap	C&P	Practical lab exams, Viva- voce
CO6	Explain the mechanism of excretion and its hormonal control; enumerate common renal disorders in man.	U	F&C	Short answer, Paragraph type questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Unit 1: Introduction to human physiology :(3 hrs) (Out of 70: 7marks)

Unit 1. Branches of human physiology, Components of body system, Human body systems and functions, vital and non vital organs, Levels of physiological regulation: Intracellular, local and extrinsic regulation. Homeostasis, Anthropometry, BMI and its significance.

Module 2: Physiology of Respiration & Circulation (18 hrs) (22marks)

Unit 1: Respiration (8 hrs) : Measures of lung volume : Vital capacity, tidal volume, residual volume etc., Structure, types and functions of hemoglobin, Transport of oxygen and carbon dioxide in blood, factors influencing transport of gases, Oxygen dissociation curves and the factors influencing it; Carbon monoxide poisoning; Nervous and chemical control of respiration, Respiratory problems in new born babies and old age, COVID associated problems, COPD, Problems and adaptations at high altitude.

Unit 2: Circulation (10 hrs)

Pace maker and conducting system, Components of blood and their functions; Haemostasis, Biochemical pathway of Blood coagulation: Clotting factors, Disorders of blood clotting, Haemopoiesis; ESR, Haemoglobinopathies, Blood groups: Rh factor, ABO and MN; Blood transfusion and agglutination, Apherisis, ECG, Cardiovascular problems: Hyper and hypotension, Artheriosclerosis, Bradycardia and tachycardia, Myocardial infarction, Angina pectoris, Cardiac arrest.

Module 3: Physiology of Excitation (12 hrs) (22marks)

Unit 1: Nervous system (5 hrs): Structure and types of neurons, Propagation of nerve impulse, myelinated and non-myelinated nerve fibers, Types of synapse and synaptic transmissions; Saltatory conduction, Neurotransmitters, synaptic delay, synaptic fatigue, numbness, tingling, tickling.

Unit 2: Muscular system (7 hrs) : Types of muscles; Ultra structure of skeletal muscle; Physiology and biochemistry of muscle contraction:- Sliding filament theory, physiological changes, Muscular relaxation, Energy for muscular contraction, Neuromuscular junction; muscle twitch; summation, tetanus and Rigor mortis. Sports Physiology - Aims and its benifits, Effect of sports on physical health, Benefits of exercise, Physical ergonomics.

Module:4 -Physiology of Digestion and Excretion (12 hrs) (19 marks)

Unit 1. Digestion (6 hrs): Structural organization and functions of gastrointestinal tract and associated glands; Hormonal control of digestion. Nutrition in pregnancy. Nutritional disorders: Cachexia, Bulmia Nervosa, Anorexia nervosa, obesity, flatulence, Peptic ulcer; physiological causes of vomiting and hiccups

Unit 2. Excretion (6 hrs): Ornithine cycle, Juxta glomerulus apparatus, Urine formation and Counter current mechanism, Hormonal and enzymatic control of urine formation. Role of kidney in osmoregulation, Abnormal constituents of human urine and its significance: Glycosuria, Albuminuria, Heamaturia, Ketonuria, Haemoglobinuria, Uraemia, Pyuria. Dialysis.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1. Determination of ABO Blood group
2. Detection of Abnormal constituents of urine (Glucose, Protein, Ketone bodies)
3. Determination of Lung volume, tidal volume etc. by using Spirometer
4. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum, liver, trachea, lung, kidney, Types of Muscles, (Virtual Model/Slide)

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5. Estimation of haemoglobin using Sahli's haemoglobinometer
6. Preparation of haemin crystals
7. Calculation of BMI
8. Recording of blood pressure using a sphygmomanometer
9. Demonstration of Blood clotting time
10. Demonstration enzymatic activity of Amylase, Protease and lipase
11. Recording of simple muscle twitch

Field study: A) Visit to Anatomy Museum B) Visit to Diagonestic centres, and submission of detailed field study report at the time of semester end practical examination.

Virtual Labs (Suggestive sites)

https://www.vlab.co.in
https://zoologysan.blogspot.com
www.vlab.iitb.ac.in/vlab
www.onlinelabs.in
www.powershow.com
https://vlab.amrita.edu
https://sites.dartmouth.edu
https://faculty.uobasrah.edu.iq/uploads/teaching/1645858465.pdf

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- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills
- Chatterjee, C.C (2016): Human Physiology, 11th Edition, ISBN-10 8123928726 Medical Allied Agency.
- Arthur Vander, James Sherman and Dorothy Luciano (1998) Human Physiology: The Mechanisms of Body Function, ISBN-10: 9780070670655, William C. Brown Pub., 818 pages
- Sembulingam, K and Sembulingam, P (2016): Essentials of medical physiology, 7th Edition, ISBN-10: 9789385999116, Jaypee Brothers Medical Publ, 1067p.
- Tortora, G.J. &Grabowski, S. (2006): Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

ONLINE SOURCES

1. https://study.com/learn/anatomy-and-physiology.html

2. https://alvernia.libguides.com/oer/anatomy
3. https://www.udemy.com/course/human-physiology-notes-powerpoint-slides-practice-exams/
4. https://www.physiology.org/career/teaching-learning-resources/student-resources/what-is-physiology?SSO=Y
5. https://www.getbodysmart.com/
6. https://byjus.com/biology/human-body-anatomy/

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3	3						3						
CO 4		3					3						
CO 5				3					3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	I1				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student develops understanding in the organization and functioning of ecosystems, the concept of population, population interactions, biogeochemical cycle, behavioural patterns of animals, their social organisation, etc.				

Course outcome

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the various components of ecosystem along with their interactions and flow of energy in ecosystem and the importance of productivity of ecosystem, food chain and food web, and types of biogeochemical cycles and their importance.	U	F&C	Short answer, Paragraph, Essay type questions
CO2	Identify the terms related to population, biotic community, types of community interactions; the concepts of k and r species and Keystone species, characteristics of habitat and its types, policies and laws for environmental protection..	R	F	Short answer, Paragraph type questions
CO3	Describe innate behaviour and its components, concept of FAP, learned behaviour and its various types and examples, the concept of animal communication; the types of animal communication, emphasizing the relation between animal communication and social behaviour of animals.	U	F&C	Short answer, Paragraph type questions
CO4	Describe sociobiology of different animals, the concept of social organisation in animals, and the concept of proximate factors.	U	F&C	Short answer, Paragraph , Essay type questions
CO5	Acquire skill in estimating ecological parameters like dissolved Oxygen, Carbon dioxide, pH etc. .	Ap	C&P	Practical lab exams, Viva- voce

CO6	Compare the characteristics of different types of ecosystems, pattern of flow of materials and energy in ecosystem, etc.	U	F&C	Short answer, Paragraph type questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Ecosystem (12hrs) (Out of 70: 18marks)

Unit 1: Introduction, Ecosystem & Energetics. (02 hrs) Fundamentals of Environmental Sciences. Scope of Environmental Science. Ecology as an inter-disciplinary science, Sub division of Ecology- Autecology, Synecology, Scope of Ecology.

Unit 2: Ecosystem-Concept, Structure and functions*:*(08 hrs) Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems & law of thermodynamics, energy flow modelsenergy transfer & transformations.

Productivity of ecosystem- primary (GPP, NPP, NCP), secondary productivity, standing crop, material removed and production rate. Ecological efficiencies. Trophic structures and ecological pyramids.Trophic levels, food chains and food webs.

Unit 3: Biogeochemical cycles(02hrs*)* -Concept and Basic types. Gaseous cycle -carbon & nitrogen cycles, Sedimentary cycle- phosphorus cycle. Decomposition and transformation.

Module 2: Ecosystem classification and Habitat Ecology (11hrs) (13marks)

Unit 1: Basics of Ecosystem classification(05 hrs): *Types of Ecosystem*: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), *Oceanic Biomes:* Concept, classification and distribution. Characteristics of different biomes (mention): Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chaparral, Savanna, Tropical Rain forest.

Unit 2: Habitat ecology: (06hrs)

Terrestrial ecology -Tropical wet evergreen, tropical dry deciduous forests- its characteristics. Faunal characteristics & adaptations.

Freshwater ecology- Lentic &lotic habitats- its characteristics. Faunal characteristics & adaptations.

Marine ecology- Biotic divisions and its characteristics. Pelagic realm-Planktonic& nektonic adaptations. Benthic realm-littoral & Abyssal adaptations. Adaptations of animals on sandy, muddy & rocky seashore.

Module 3: Population, Community and Habitat (10 hrs) (17marks)

Unit 1: Population Ecology- (05hrs) Characteristics of population, - Biotic potential, concept of carrying capacity, population growth (S and J shaped curves) and regulations. Population fluctuations, dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species.

Unit 2: Community ecology: **(03 hrs)**Biotic community: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy.

Unit 3: Overview of Environmental Laws in India(02hrs)

National Water Policy, 2012; National Environmental Policy, 2006; The Plastic Waste Management Rules, 2016; The Solid Waste Management Rules, 2016; The e-waste (Management) Rules 2016.

Module 4: Animal Behaviour (12hrs) (22 marks)

Unit 1: Foundations of Ethology (02hrs*)*-Introduction and historical development of ethology, Key figures in ethological approach, its scope and relation with other branches of biology.

Unit 2: Innate/Stereotyped behaviour (02hrs)- orientation -taxes, kinesis, simple reflexes, instincts, Fixed action patterns (FAPs) and releaser stimuli. Examples of instinctive behaviours in different species.

Unit 3: Acquired behaviour/Learned behaviour (02hrs): Habituation, Conditioned reflex, latent learning, Imprinting, Habituation and Trial and error and learning with suitable example.
Unit 4.: Types of communication (03 hrs)1. Visual 2.Auditory3.Tactile 4.Chemical with suitable examples.
Unit 5: Sociobiology (03hrs) Social organization in Animals: Termites and Elephants.
Proximate factors.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1. Estimation of dissolved oxygen in water sample using Winklers method (Pond water, well-water, Tap water). Discuss the ecological significance of dissolved oxygen in water.
2. Identify soil micro-organisms in soil samples collected from different localities-by floatation process & Berlese funnel method. Discuss the ecological significance of soil characteristics.
3. Demonstration of Phototaxis by earthworm
4. Demonstration of alarm pheromones in ants

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5. Estimation of dissolved CO2 in water sample (Pond water, well-water, Tap water). Discuss the ecological significance of dissolved CO2 in water.
6. Estimation of PH of water (Pond water, well-water, Tap water) Discuss the ecological significance of PH characteristics.
7. Locomotory behavior of dipteran larvae on different types of substrata
8. Determination of salinity of water
9. Determination of moisture content in different types of soil (sand, clay, laterite, etc.)
10. Estimation of water holding capacity of different types of soil.(sand, clay, laterite, etc.)

Field study: A). Conduct a field trip to assess the biodiversity of a chosen ecosystem- by preparation of food chains and food web. Add a note on its significance, B) A visit to natural habitat of wild animals or birds, or zoo, aviary etc, and observation of behaviour patterns of those animals; and submit a detailed field study report at the time of semester end practical examination.

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- Molles. M. 2015 - Ecology: Concepts and Applications McGraw-Hill Education 592pp
- Townsend, C. R. Begon, M. and Harpe, J. L. 2008 Essentials of Ecology John Willey & Sons 532pp.
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ANIMAL BEHAVIOUR

- Dugatkin, L. A. 2020 Principles of Animal Behavior 4th Ed. - University of Chicago Press 576pp

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- Mathur, R. 2022 Animal Behaviour -Visionias 676pp
- Alcock, J. 2005 Animal Behavior - SP Oxford University Press 556pp

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2	3						3						
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO 6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course is designed to develop an understanding in principles of Systematics, theories, evidences, and trends of evolution, process of speciation, various zoogeographical realms and their characteristics.				

Course outcomes

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the concept of taxonomy and systematics and their importance, the basic trends in taxonomy, the concept of ICZN, different systems of nomenclature; and the principles and techniques of molecular systematics,	U	F&C	Short answer, Paragraph, Essay type questions
CO2	Explain the concept of organic evolution and various theories associated with it and the origin of life, the Major events in evolutionary timescale and the reason for Mass extinction and its consequences	U	F&C	Short answer, Paragraph, Essay type questions
CO3	Describe the various theories on evolution, the concept of species and speciation; and the factors leading to speciation	U	F&C	Short answer, Paragraph type questions
CO4	Identify and describe major zoogeographical realms, understanding the factors contributing to their delineation, the principles of island biogeography, including the effects of island size, distance, and isolation on species diversity	R&U	F&C	Short answer, Paragraph type questions
CO5	Present seminars and debates on Evolutionary principles,	Ap	C&P	Seminars, assignments& debates,

CO6	Differentiate between the evolutionary principles and the mythological features and stories, identify the pseudoscience elements in general belief.	Ap	C&M	Short answer, Paragraph type questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Systematics (10hrs) (Out of 70: 16marks)

Unit 1: Taxonomy(6hrs) - Historical account natural and classical. Taxonomy and Systematics, Taxonomic hierarchy. Obligatory categories of classification. Species concept. Modern trends in Systematics. Modern Taxonomic Trends: Chemotaxonomy, Cytotaxonomy, Molecular taxonomy, Cladistics, Numerical taxonomy, Bar coding techniques.

Unit 2: Classification and Nomenclature (4hrs) -Two and Five kingdom classification, merits and demerits. Cavalier-Smith's Eight kingdom classification; International Code of Zoological Nomenclature. - Binomial, Trinomial Nomenclature, merits and demerits, ethics.

Module 2: Principles of Evolution (14hrs) (20marks)

Unit 1: Introduction (2hrs) -Concept of evolution, Evolution as the process of change, history of evolutionary thought - Lamarck, Darwin, and Wallace.

Unit 2: Theories on origin of life (3hrs)- concept of organic evolution, Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments. Evolution of Prokaryotes- origin of eukaryotic cells-

Unit 3: Geological Timescale (2hrs) - Major events in evolutionary timescale, Anthropocene. Mass extinction and its consequences.

Unit 4: Evidences of evolution (5hrs)- comparative morphology and anatomy, homologous organs, divergent evolution and adaptive radiation, analogous organs, convergent evolution and parallel evolution, vestigial organs, atavism, connecting links. Evidences from comparative physiology and biochemistry, embryological evidences, Von Baer's rule, Biogenetic law, paleontological evidence,

Unit 5: Animal Evolution(2hrs) Evolution of horse, Archaeopteryx.: features and significance

Module 3: Theories of evolution & speciation (14hrs) (17marks)

Unit 1: Theories on Evolution(6hrs)- Lamarck's theory- postulates, with examples. criticism, Neo-Lamarckism, present status:

Darwin's theory -postulates, with examples, criticism, neo-Darwinism. Supplementary theories of Darwin-Sexual selection, Artificial selection.

Mutation theory of De Vries: Weizmann's theory of germplasm. The synthetic theory of evolution.

Unit 2: Species concept(3hrs)- Phylogenetic & Biological species concept. General characteristics and subdivisions-subspecies, semi species, sibling species, cline and deme.

Unit 3: Speciation(5hrs) —Phyletic, quantum and Gradual speciation. Methods of natural speciation. Allopatric, parapatric and sympatric. Isolation & Isolating mechanisms- Geographic and Reproductive isolations; genetic drift, Hardy-Weinberg equilibrium.

Module IV Zoogeography (10hrs) (17marks)

Unit 1: Introduction (1hr)- Concept of Zoogeography, historical events of Zoogeography; Factors controlling distribution of animals.

Unit 2: Animal distribution (3hrs) – Geographical distribution- Cosmopolitan, discontinuous, isolated, Bipolar- with examples. Methods of animal distribution. Barriers to animal distribution.

Unit 3: Zoogeographical realms (4hrs) - -Physical features, sub-regions of realms, Faunal characteristics of the realm. Palaearctic, Nearctic, Neotropical, Ethiopian, Oriental & Australian. Mention Wallace line, Webers line &Wallacea.
Unit 4: Biogeographical zones of India (1hr)-Trans-Himalayan, Himalayan, North-Eastern Zone, semi-arid zone, desert zone, Gangetic plain, Deccan plateau zone, Western ghats, Coastal zone, Island Zone.
Unit 5: Insular fauna (1hr) - concept- faunal characteristics; Continental islands - British-isles, Sri Lanka: Oceanic islands-Galapagoes islands-: Ancient Islands- Madagascar

Module 5: Open ended (12hrs)
The teacher can design student activities like assignments, seminars, debates collection of notes/reference materials related to the topics of module 2&3, trace human evolution, organizing mass education programmes on evolutionary principles by the students for the school students and general public of their locality through offline or online modes etc.

References

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- Introduction to Zoogeography. Illies, J. Macmillan.
- International Commission for Zoological Nomenclature (ICZN): 1999 International Codeof Zoological Nomenclature. (available online free: www.iczn.org).
- Theory and Practice of Animal Taxonomy, Kapoor, V.C.
- Principles of Systematics Zoology. Mayer, E
- Principles of Animal Taxonomy, Simpson, G.C
- Readings in Indian Zoogeography (Vol.1) Tiwari, S.
- Principles of Evolution, Peter R. Grant and B. Rosemary Grant
- Evolutionary Biology, Eli C. Minkoff
- The Selfish Gene, Richard Dawkins

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4	3	3					3						
CO 5				3	3			3					
CO6					3						3		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05		✓		✓
CO6	✓			✓

PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or the following online courses 1. https://onlinecourses.swayam2.ac.in/cec20_ge23/preview 2. https://asutoshcollege.in/new-web/six-months-certificate-course-in-api-culture-and-sericulture.html				
Course objectives	The course is designed to develop an understanding in overall aspects of Sericulture, Apiculture, Dairy and Poultry Science and enable the student to do simple experiments regarding these.				

Course outcomes

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the process of Apiculture; different species of Honey Bees; the importance of health and hygiene in Beekeeping; the economic importance of Apiculture	U	F&C	Short answer, Paragraph, Essay type questions
CO2	Describe various stages of Sericulture; different species of Silk moths; the importance of health and hygiene in Sericulture; the economic importance of Sericulture	U	F&C	Short answer, Paragraph, Essay type questions
CO3	Enlist various traps and other physical means to control insect pests	U	F&C	Short answer, Paragraph type questions
CO4	Identify and describe different breeds of cattle and fowls for various purposes, different appliances and parts of cattle and poultry rearing houses	R& U	F& C	Short answer, Paragraph type questions
CO5	Acquire the skills to maintain Bee hives, Silk worm rearing houses and insect traps in a scientific way.	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Compare different species of honey bees and silkworms for their rearing characteristics	U	F&C	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Apiculture (12Hrs) (Out of 70: 18marks)
Unit 1: Introduction to Apiculture: (2hrs)-Brief history, Apiculture worldwide and in India and its Scope; Traditional, Modern and Urban or Backyard Beekeeping; species of Honey Bees used in Bee-keeping; Role of Central Honey Bee Research and Training Institute.
Unit 2: Biology of Honey bees (2 hrs)- Morphology, Life History and Social Behaviour of Honey Bees of Honey Bees.
Unit 3: Rearing of Honey Bees (5hrs) -: Standard tools used in Apiculture, types of bee hives; Basic requirements for Beekeeping. Honey Bee Enemies and Diseases, Management, Preventive and control measures of diseases.
Unit 4: Economy and Entrepreneurship(3hrs)- Bee products; Composition and uses of honey; Honey extraction and handling; Economic importance and marketing aspects of bee products; Role of Govt. and Non-Govt. agencies in promoting apiculture in Kerala; Present status and scope of apiculture in Kerala.

Module 2: Sericulture and Lac culture(14hrs) (20marks)
Unit 1: Introduction to Sericulture (2hrs) - Origin and history of Sericulture. Sericulture in India and other countries. Present status of sericulture. Scope of sericulture. Types of silkworms and their distribution. Mulberry and non-mulberry sericulture.
Unit 2: Silkworm Biology and Rearing (6hrs)- A brief introduction to mulberry cultivation and mulberry varieties. Commercial varieties of mulberry, Mulberry plantation establishment and cultivation practices. Life cycle of *Bombyx mori*. Structure of silk gland and secretion of silk. Rearing house and rearing appliances. Disinfectants. Silkworm rearing technology: Early age and Late age rearing. Types of mountages. Spinning, harvesting and storage of cocoons.
Unit 3: Diseases of silkworms (1hr)– Viral, Bacterial, Fungal and Protozoan; Control measures.
Unit 4: Entrepreneurship in Sericulture(2hrs)-: Prospects of Sericulture in Kerala, potential in mulberry and non-mulberry sericulture. Employment in Sericulture and Govt. Schemes for financial Assistance.
Unit 5 Lac culture (3hrs)- Morphology and life cycle of Lac insect lac host plants, different strains of lac insects, cultivation, inoculation, harvesting and propagation of lac, composition and uses of lac.; Enemies of lac insect and their control. Scope for cultivating lac in Kerala. Recent advances in lac culture research.

Module 3: Traps and other physical methods to control insect pests (6 hrs) (13marks)
Unit 1: Insect traps (5hrs) – Passive traps: Window flight trap, barrier trap, Malaise trap, cone trap, pan trap, bucket trap, Aquatic arthropod trap: Aquatic interception traps, Aquatic emergence trap; Aerial rotary and suction traps; coloured trap, USB based traps: Active traps: Light traps- different types, parts of a light trap, sticky traps, pheromone trap, bait traps.
Unit 2: Other methods(1hr): Sweeping : aerial nets, sweep nets; beating cards and sheets; netting sieving,

Module :4 Dairy Science and Poultry production(13hrs) (19marks)
Unit 1: Dairy cattle breeding (3hrs)- Different breeds of cattle grown for different purposes; Inbreeding, Outbreeding, Cross breeding, Grading up. Breeding systems suitable to enhance milk production in India (Cross breeding of cattle and Grading up of buffaloes). Multi-ovulation and Embryo transfer technique. Cloning and Transgenic animals

Unit 2: Dairy processing (3hrs)– Milk collection, transportation & Grading of milk – Standardization – Pasteurization – Homogenisation of milk - packaging of milk- Common adulterants in milk and their detection techniques- Nutritive value of milk ICMR recommendation of nutrients.

Unit 3: Current status of Indian poultry industry (3hrs)- avian biology and welfare; breeds and varieties of poultry, poultry breeding and genetics.
Unit 4: Physical requirements of incubation and hatchery management(4hrs)- summer and winter management of poultry; artificial insemination; Common poultry diseases and management; Management of hatchery and poultry waste; economics of poultry production.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1. To study the different species and castes of Honey Bees.
2. Familiarise Bee keeping instruments and Bee hives.
3. Familiarise Silkworm rearing appliances.
4. Construction of any two types of insect traps: light trap/ sticky trap/ pan trap/ malaise trap

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5. Identification of different species of Silkworms and their life cycles.
6. To test the quality of milk
7. Structure of Honey comb – Different types of cells for Queen, Workers and Drones.
8. Morphological peculiarities of Worker bees – Honey and pollen storage structures.
9. Construction of mini egg incubators using suitable materials.
10. Construction of bee hives (if original hive making is not possible, make miniature models using cardboards or other suitable materials)

Field Study: a) Visit to an apiary to study the bee keeping methods /b) Visit to Silk worm rearing centers to find the silk worm rearing/ c) Visit to Dairy and Poultry farms/.d) Visit to insect pest control device – making units or industries. Prepare a detailed report based on the field visit, which is to be submitted at the time of end semester exam.

Virtual Labs (Suggestive sites)

1. https://agritech.tnau.ac.in/farm_enterprises/fe_api_castesofhoney-bee.html#:~:text=Queen%20is%20a%20fertile%2C%20functional,drone%20is%20a%20male%20insect.&text=Queen%20and%20worker%20develop%20from,the%20queen%20or%20worker%20larvae.
2. https://agritech.tnau.ac.in/farm_enterprises/fe_api_beekeepingaccessories.html
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4. https://agritech.tnau.ac.in/sericulture/seri_silkworm1_rearing%20house.html
5. https://www.beemaniacs.com/2015/04/18/cells-cells-and-cells/
6. https://ir.library.oregonstate.edu/downloads/m613n331f
7. https://agritech.tnau.ac.in/farm_enterprises/fe_api_typesofhoneybee.html#:~:text=The%20Indian%20hive%20bee%2C%20Apis,%2C%20Melipona%20irridipennis%20(Meliporidae).
8. https://pureshmilk.com/blog/2019/06/21/simple-tests-at-home-to-check-the-purity-of-the-milk-you-consume/

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3. https://agritech.tnau.ac.in/animal_husbandry/animhus_index.html
4. https://vetstudy.journeywithasr.com/p/bvsc-and-ah-1st-year-notes_2.html
5. https://www.vedantu.com/biology/poultry-farming
6. https://www.drprofessionals.in/2021/05/livestock-production-management.html#google_vignette

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
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CO 3		3					3						
CO 4	3						3						
CO 5				3					3				
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Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

ANIMAL DIVERSITY-I- NON-CHORDATA

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student develops understanding of the diversity, structural organization, complexity, characteristic features, economic and evolutionary importance of non-chordates of various animal phyla and will be able to perform simple dissections in order to study its characteristic features.				

Course outcome (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the importance of the diversity of non-chordates living in varied habits and habitats.	U	F&C	Short answer, Paragraph questions
CO2	Understand evolutionary history and relationships of different non-chordates	U	F&C	Short answer, Paragraph, Essay type questions
CO3	Outline the classification and compare the specified protists, acoelomates, pseudocoelomates and coelomates non-chordate phyla.	U	F&C	Short answer, Paragraph type questions
CO4	Critically analyze the organization, complexity and characteristic features of non-chordates of various animal phyla.	An	F&C	Short answer, Paragraph, Essay type questions
CO5	Explain the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.	U	F&C	Short answer, Paragraph type questions
CO6	Perform the mounting of specialized organs of selected non-chordates and dissections of selected specimens by standard laboratory protocols and prepare report on field study	Ap	C&P	Practical lab exams, Viva- voce, report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Protists to Animals (10 hrs) (Out of 70: 15marks)

Unit 1: Five Kingdom Classification of Living Organisms (1 hr)

Brief description of Five kingdom classification. Mention Cavalier-Smith's eight kingdom classification also.

Unit 2: Concept of Classification of Animals (2 hrs)
Classification based on number of cells, tissue or organ system level of organization, and development of germ layers. Evolution of symmetry, and segmentation, homology and analogy of organs and their origin, Acoelomate, Pseudocoelomate, and Coelomates; Protostomia and Deuterostomia.
Unit 3: Classification of Kingdom Protista (3 hrs)
General characteristics features and classification of Kingdom Protista down to phyla.[*Salient features of the major groups of protists given below with short notes on theexamples cited*]

Phylum Rhizopoda: *Entamoeba*
Phylum Dinoflagellata: *Noctiluca*
Phylum Apicomplexa: *Plasmodium*
Phylum Parabasilia: *Trichomympha*, and
Phylum Ciliophora: *Vorticella*.

Unit 4: Type: *Paramecium*(4 hrs)
Morphologyand structural organization [as revealed by compound microscopy], Nutrition, Locomotion and Reproduction; Conjugation in detail.

Module II: Kingdom Animalia: Non-chordata-Acoelomates and Pseudocoelomates (10hrs) (18marks)

Salient features and Classification down to classes of major phyla (Porifera, Cnidaria, Ctenophora, Platyhelminthes and Nematoda). [*Habits, habitat, morphology, functional anatomy and life history of representative types (wherever specified) and classification of each phylum down to classes, except otherwise mentioned, and listed examples. Study of animal diversity with typical examples from each class, with emphasis on ecological– and adaptive features, economic importance and such other points of biological interest expected. Only very brief account of each example is to be studied.*]
Unit 1: Phylum Porifera (2 hrs)
Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) of each class.

Class Calcarea (=Calcispongiae)
Class Demospongiae
Class Hexactinellida (=Hyalospongiae).
Eg. *Leucosolenia* from Calcarea (Brief description only).

Mention Amphiblastula, Parenchymula, and gemmule.
Give an account on canal system (Asconoid, Syconoid, Leuconoid and Rhagonoid).
Unit 2: Phylum Cnidaria (4 hrs)
Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) of each class.

. Class Anthozoa
Class Hydrozoa
Class Scyphozoa.
Egs. *Physalia* from Hydrozoa and *Madrepora* from Anthozoa (Brief description only).

Type: *Obelia* - Morphology and metagenesis.
Polymorphism in Cnidaria with special reference to siphonophores.
Unit 3: Phylum Ctenophora (1hr)
Unique features of the Phylum
eg. *Pleurobrachia* (Brief description only).
Mention cydippid larva
Unit 4: Phylum Platyhelminthes (1 hr)
Salient features of the Phylum, Classification down to classes and Diagnostic features (any three) of the following classes

Class Turbellaria

Class Trematoda
Class Cestoda
Eg. *Dugesia* from Class Turbellaria (Brief description only)

Unit 5: Super-phylum Aschelminthes (1 hr)

Phylum Nematoda

Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) offollowing classes

Classes Enoplia
Class Chromadorea
Eg. *Ascaris* from Class Chromadorea

Unit 6: Pseudocoelomate Minor Phyla (1 hr)

Salient features of the following pseudocoelomate minor phyla:
Phylum Gastrotricha (eg. *Chaetonotus)*
Phylum Rotifera(*eg. Brachionus)*.

Module III: Kingdom: Animalia: Non-chordata- Coelomates (15 hours) (22marks)

General characteristics and Classification down to classes of the coelomate phyla of non-chordates (Annelida, Onychophora, Arthropoda, Mollusca, Echinodermata and Hemichordata). [*Habits, habitat, morphology, functional anatomy and life history of representative types (wherever specified) and classification of each phylum down to classes, except otherwise mentioned, and listed examples. Study of animal diversity with typical examples from each class, with emphasis on ecological and adaptive features, economic importance and such other points of biological interest expected. Only very brief account of each example is to be studied.*]

Unit 1: Phylum Annelida (2 hrs)

Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) of following class.

Class Polychaeta
Class Oligochaeta
Class Hirudinea.

Egs. *Neanthes* (Life cycle and development, Heteronereis) from Class Polychaeta; *Megascolex*fromClass Oligochaeta (Brief description only) and *Hirudinaria* fromClass Hirudinea (brief description with parasitic adaptations).

Unit 2: Phylum Onychophora (1 hr)

Distribution, peculiarities and affinities of *Peripatus.*

Unit 3: Phylum Arthropoda (6 hrs)

Salient features of the Phylum, Classification down to classes and Distinguishing /identifying/Diagnostic features (any three) of following classes.

Class Trilobita
Class Merostomata
Class Crustacea
Class Insecta
Class Arachnida
ClassChilopoda
Class Diplopoda.

Egs. Class Merostomata – *Limulus*; Class Arachnida – *Heterometrus (=Palamnaeus), Heteropoda*, mention ticks and mites*;* Class Crustacea –*Sacculina, and Eupagurus;* Class Chilopoda – *Scolopendra;* Class Diplopoda – *Spirostreptus;* Class Insecta – *Lepisma, Mantis, Troides minos* (Southern Birdwing butterfly), *Papilio buddha* (Malabar Banded Peacock), Mosquitoes (*Culex, Anopheles, Aedes*), *Apis* [Brief description only].

Type: *Penaeus* - Morphology, digestive system, excretory system, nervous system, sense organs (statocyst, compound eye in detail), reproductive system and development (details of larval stages not expected).

Unit 4: Phylum Mollusca (2 hrs)

Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) of following classes.

ClassAplacophora
Class Polyplacophora (=Amphineura)
ClassMonoplacophora
ClassGastropoda
Class Bivalvia (=Pelecypoda)
Class Scaphopoda
Class Cephalopoda (=Siphonopoda)
Egs. (Brief descriptions only) Class Polyplacophora – *Chiton;* Class Gastropoda – *Turbinella;* Class Bivalvia – *Perna;* Class Cephalopoda – *Sepia*.

Unit 5: Phylum Echinodermata (2 hrs)

Salient features of the Phylum, Classification down to classes and Distinguishing features (any three) of following classes.

Class Crinoidea
Class Asteroidea
Class Ophiuroidea
Class Holothuroidea
ClassEchinoidea.
Egs. *Holothuria* from Class Holothuroidea (Brief description only); Mention Evisceration.
Echinus from Class Echinoidea (Brief description only). Mention Aristotle's lantern.

Water vascular system of Starfish in detail.

Unit 6: Phylum Hemichordata (1 hr)

Balanoglossus: Salient features

Unit 7: Coelomate minor phyla (1hr)

Salient features of the following Coelomate minor phyla

Echiura(eg. *Bonellia)*
Phoronida (eg. *Phoronis)*

Module IV: Economic, Ecological and evolutionary importance of non-chordates (10 hrs). (15marks)

Unit 1. Evolutionarily significant Non-chordates (2 hrs)

Larval forms Mention Cydippid, Trochophore, Nauplius, Zoea, Megalopa, Glochidium, Veliger, Bipinnaria, Brachiolaria, Echinopluteus, Ophiopluteus and Tornaria. (Structural details not expected). [Emphasis on adaptations, distribution and survival as well as phylogenetic significance]

Living fossils – *Limulus, Nautilus*; Extinct forms - Trilobites.

Unit 2. Economically important Non-chordates (5 hrs)

Pollination by insects (especially honeybees)
Vermiculture (Role of earthworms in nutrient recycling and vermiculture**)**
Pearl formation in bivalves
Spider silk and web formation
Edible molluscs
Harmful forms – *Teredo*, Any one Insect pest

Unit 3. Ecological indicators and adaptations (3 Hrs)

Coral reefs (Coral reef ecosystems, bleaching and sustainable reef management)
Mention ecological indicators -*Tubifex, Chironomus*
Parasitic adaptions in helminthes

Module V: Practicals - Non chordata [1 Credit; 30 Hours]

[Students are expected to make sketches/photographs with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches/photographs/copy of printed figures with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches.]

MANDATORY EXPERIMENTS

1. Study of the following specimens:
   - *a. Protists: Noctiluca, Entamoeba, Trichonympha, Paramecium [any 2]*
   - *b. Poriferans: Leucosolenia / Scypha / Spongilla*
   - *c.Cnidarians: Sedentary hydrozoans: Obeliacolony / Obelia medusa*
     - *Pelagic hydrozoans: Physalia*
     - *Pelagic scyphozoan: Aurelia/ Rhizostoma*
     - *Common anthozoans: Adamsia, Madrepora, Fungia, Tubipora, Gorgonia [any 2]*
   - *d.Helminths: Platyhelminths: Free living flat worm: Bipalium / Dugesia*
     - *Parasitic flat worms: Fasciola/Taenia solium*
     - *Aschelminths: Parasitic round worms: Ascaris/Ancylostoma*
   - *e. Annelids: Polychaetes: Neanthes, Aphrodite, Chaetopterus, Arenicola [any 1]*
     - *Common earthworm: Megascolex / Pheretima*
     - *Leech: Hirudinaria, Heamadipsa, [any 1]*
   - *f. Arthropods: Items of evolutionary / taxonomic importance - Limulus / Streptocephalus*
     - *Common fouling barnacle – Lepas / Balanus*
     - *Parasitic crustaceans– Sacculina / Cymathoa*
     - *Crustacean of the sandy shore– Emerita / Albunea*
     - *Symbiotic crustacean - Eupagurus*
     - *Economically important crustacean - Penaeus*
     - *Vectors – Cyclops, Aedes, Musca, Xenopsylla [any 2]*
     - *Insect pests – Lepisma, termite queen, Pest of paddy, Pest of coconut, Pest of mango, pest of stored grains [any 4]*
     - *Aquatic insects – Belostoma / Nepa / Ranatra*
     - *Predatory insect - Dragonfly / Ant-lion / Mantis*
     - *Insect which camouflages - Carausius / Phyllium*
     - *Common myriapods – Scolopendra / Scutigera / Julus / Spirostreptus*
     - *Common arachnids – Palamnaeus / Buthus / Spider / tick / mite [any 2]*
   - *g. Molluscs: Inter tidal molluscs – Chiton, Patella, Haliotis, Aplysia [any 1]*
     - *Ornamental gastropods – Cypraea, Murex, Turbinella [any 1]*
     - *Poisonous gastropod – Conus*
     - *Pelecypods of economic importance – Perna, Pinctada, Teredo [any 2]*
     - *Scaphopod - Dentalium*
     - *Cephalopods of economic/evolutionary importance - Sepia, Loligo, Octopus, Nautilus [any 2]*
   - *h. Echinoderms: Antedon, Asterias, Ophiothrix, Cucumaria, Echinus [any 2]*
   - *i. Hemichordate: Balanoglossus*
   - *j. Onychophora: Peripatus*
   - *k.* Minor phyla: *Phoronis / Bonellia / Chateonotus / any other specimen*
2. Mounting of Earthworm setae in situ
3. Mounting of Prawn appendages

4. Dissection of Prawn to display Nervous system

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5. Honeybee: mounting of Mouth parts
6. Dissection of Earthworm: Alimentary canal
7. Cockroach: Salivary apparatus
8. Cockroach: Nervous system
9. Examination of pond water collected from different places for diversity in Protista.
10. Metamorphosis in Insects (rearing of an insect [*Drosophila* / Mosquito] to view the various life stages).
11. Plant bug: Mounting of Mouth parts
12. Mosquito: Mounting of Mouth parts

Field Study: Visit to any **field/ecosystem** in the local body (within Panchayat/Corporation) to create awareness of local biodiversity richness of non-chordates and prepare a local biodiversity register with geo-tagged photographs of minimum 20 specimens belonging to any 3 or more non-chordate phyla studied.

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4					3						3		
CO 5		3					3						
CO6				3	2	3		2	3				3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05	✓	✓		✓
CO6	✓		✓	✓

CELL BIOLOGY & GENETICS

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course develops an understanding in the cellular organization, gene concept and hereditary principle, etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Illustrate the life cycle of cells, aging of cells, apoptosis and its deregulation in diseases such as cancer.	U	F&C	Short answer, Paragraph, questions
CO2	Describe the ultrastructure and important functions of plasma membrane as well as membraned and non-membraned cell organelles	U	F&C	Short answer, Paragraph, Essay type questions
CO3	Explain chromosomal inheritance, Mendel's contributions, allelic and non-allelic interactions, structure & classification of human chromosomes	U	F&C	Short answer, Paragraph, Essay type questions
CO4	Distinguish genes; gene types, gene bank, gene cloning, gene mapping, genome sequencing and different modes of inheritance	U	F&C	Short answer, Paragraphtype questions
CO5	Perform experiments like, staining of epithelial cells, blood cells, chromosomes of onion and drosophila.	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Conduct surveying to find out the intensity of occurrence of various genetic traits in local population.	Ap	C&P	Viva – Vove, report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Cell - life cycle (12 Hrs) (Out of 70: 15marks)

Unit 1: Cell theory and cell cycle: (4 Hrs)-. Cell Theory. Phases of cell cycle - G1, S, G2 and M phases – Check points; G0 phase. Cell division: Mention different types of divisions such as Amitosis, Mitosis and Meiosis and Cleavage.

Unit 2: Interphase nucleus (3 Hrs) - General structure; mention nucleo-cytoplasmic index; ultrastructure of nuclear pore complex (NPC); Nucleoplasm - Composition and function; Nucleolus - Structure, composition, nucleolar organizer, nucleolar cycle and functions of nucleolus.

Unit 3: Chromosomes (2 Hrs) -A typical chromosome structure, Euchromatin and heterochromatin. Human Karyotype.; Nucleosome organization and higher order structures; Endomitosis; Giant chromosomes - (Polytene chromosomes, Lamp brush chromosomes) structure and significance.;
Unit 4: Ageing, Apoptosis and Cancer (3 Hrs) -. Theories of Ageing. Mechanism of apoptosis and its significance. Characteristics of cancer cells; causes of transformation. Types of cancer.

Module 2:. Cell organelles (11 Hrs) (22marks)
Unit 1: Plasma membrane (3 Hrs) - Chemical composition and structure (unit membrane concept and fluid mosaic model).; Modifications of the plasma membrane – microvilli, desmosomes, nexuses, tight junction and gap junction.
Functions: trans-membrane transport mechanisms – diffusion, osmosis, active transport, ion transport (channels), co-transport, bulk trans-membrane transport – exocytosis, endocytosis.
Unit 2: Mitochondria (1 Hrs) - Ultra-structure and Functions of mitochondria; Biogenesis and dynamic nature of mitochondria.
Unit 3: Lysosomes and GERL (2 Hrs) - Lysosomes - Structure and function; polymorphism in lysosomes, lysosomal enzymes.; GERL- Golgi body – Endoplasmic Reticulum – Lysosome complex
Unit 4: Centrosome and Cytoskeleton (2 Hrs) - Location, ultrastructure, biochemical composition and functions of microfilaments, intermediate filaments and microtubules. Centrosome cycle.
Unit 5: Ribosomes (1 Hrs) - Ultra structure and functioning
Unit 6: Cytoskeleton. Microtubules, Microfilaments and Intermediate filaments (2 Hrs)

Module. 3 Factors of Inheritance (12 Hrs) (16marks)
Unit 1: Introduction to inheritance (2 Hrs)- Nature vs nurture. Mendelian inheritance and Non-Mendelian inheritance (in brief)
Unit 2: Concept of gene (4 Hrs) - Gene structure; Pseudogenes; Modifying genes; Housekeeping genes and luxury genes, Complementary genes, Polymeric genes and Duplicate genes with examples. Gene mapping and genomic sequencing. Genbank, gene cloning. Expression and penetrance. Pleiotropy.

Unit 3: Mutations (3 Hrs) - Chromosome mutations: numerical (euploidy and aneuploidy) and structural changes (deletion, duplication, insertion, inversion, translocation).
Gene mutations: types. Point mutation and frameshift mutations. Mutagenesis- Natural and artificial mutagenesis, Mutagenic agents: a) UV radiation and ionizing radiation b) Base analogues, alkylating and intercalating agents.

Unit 2: Alleles, isoalleles and pseudoalleles (3 Hrs) -Allelic interactions: codominance and incomplete dominance with example. Non-allelic interactions: Epistasis: dominant and recessive epistasis Multiple alleles (ABO blood group system and coat colour in rabbits)
.
Module. 4 Linkage, Recombination and modes of Inheritance (10 Hrs) (17marks)
Unit 1: Linkage and Recombination (6 Hrs) - Definition and characteristics of linkage groups, Morgan's work on Drosophila. Types of linkage: complete and incomplete with examples; Crossing over and recombination; Linkage map and Map Distance (brief).
Sex-Linked Characteristics: Types of sex-linkage - X linked characters - Colour blindness and haemophila in humans, holandric genes – hypertrichosis.
Sex-Influenced and Sex-Limited Characteristics with examples
Unit 2: Modes of inheritance (4 Hrs)
Autosomal dominant inheritance, autosomal recessive inheritance and X-linked inheritance. Multifactorial inheritance (in brief).

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1. To study the effect of isotonic, hypotonic and hypertonic solutions on RBCs.
2. Mitosis: Identify stages in onion (*Allium cepa*) root meristem by squash preparation.
3. Study of inheritance of human traits using pedigree charts.Widow's peak, attached ear lobe, dimple in chin, hypertrichosis, Blood groups, Eye colour
4. Study through photographs of Karyotype (Human, Drosophila) and sex linked inheritance - Haemophilia and Colour blindness (Ishihara Chart).

From the remaining 6, four experiments can be selected by the teacher; Two more experiments (not included in the list) are to be designed by the teacher

5. Study of the polytene chromosome of *Drosophila melanogaster* using salivary gland cells of 3rd instar larva (Demonstration).
6. Cytochemically demonstrate presence of DNA in cheek cells or onion peel using Feulgen reagent.
7. Study of diversity of eukaryotic cells. Methylene blue staining of buccal epithelium, striated muscle cells.
8. Genetic problems on Monohybrid, dihybrid crosses; blood groups; sex-linked inheritance. incomplete dominance (One problems each).
9. Observation of Barr body in buccal epithelial cells or drumstick in WBC
10. Study of different stages of meiosis in grass hopper testes

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Online Sources

1.https://onlinecourses.swayam2.ac.in/cec24_bt04 (Cell biology 5 credits)
2.https://onlinecourses.nptel.ac.in/noc24_bt18 (Cell biology 2 credits)
3. https://onlinecourses.swayam2.ac.in/cec24_bt12 (Genetics 4 credits)

Mapping of COs with PSOs and POs :

	PSO 1	PS O2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5				3	3				3				
CO6						3		2	2			2	3

Correlation Levels:

Level	Correlation
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Exam
Project/Practical
Final Exam

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	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6		✓	✓	✓

BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTICES

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or the following online courses 1. https://onlinecourses.swayam2.ac.in/cec21_bt01/preview 2. https://elearning.fao.org/course/view.php?id=579 3. https://www.classcentral.com/classroom/youtube-aquaculture-types-of-culture-systems-179652 4. https://fisheries.tamu.edu/training-online-courses/				
Course objectives	The student develops understanding and knowledge about different aquatic culture species, culture methods and aquaculture systems. Student develops skill in developing aquaculture systems				

Course Outcomes (COs)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify and describe major commercially important aquaculture species of India and the basic principles of aquaculture and culture methodologies of fishes and shellfishes.	U	F&C	Short answer, Paragraph, questions
CO2	Describe the concepts of pond culture, pen culture, cage culture and other advanced culture systems	U	F&C	Short answer, Paragraph, questions
CO3	Explain different types of tools used in fishing and resource utilization.	U	F&C	Short answer, Paragraph questions
CO4	Manage induced breeding of fish and hatchery technology; fish disease diagnosis	Ap	C&P	Short answer, Paragraph, Essay questions
CO5	Develop expertise in setting up and maintenance of different types of aquaculture systems in commercial level.	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Prepare field reports on visiting aquaculture systems, fish processing centers and fish landing centers	C	M&P	Viva- voce, report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Unit 1: Introduction to Aquaculture (6hrs) (Out of 70: 6marks)
Unit 1. Aquaculture – Definition. Criteria for selection of species for aquaculture. Commercially important aquaculture species in India. Freshwater, Brackish and Marine finfish and shellfish species. Brief account of classification of aquaculture based on: Environment – Freshwater, brackish water and mariculture.

Module 2: Culture Techniques and breeding(12hrs) (20marks)
Unit 1: Culture techniques (3 hrs): pond aquaculture, cage culture, pen culture, raft culture, pole culture, rack culture and long line culture. Number of species – Mono culture and poly culture.
Unit 2: Type of culture and breeding (9 hrs): Brief account on prawn culture, shrimp culture, edible oyster culture, lobster culture, mussel culture, pearl culture, pisciculture etc. Important cultivable species in India, seed collection, spawning and larval rearing, induced breeding. Mudbanks of Kerala coast.

Module 3: Aquaculture systems(17hrs) (22marks)
Unit 1: Aquaculture (8 hrs): Principles of Aquaculture, Site selection, Surveying, Pond preparation-Layout of a farm. Weed eradication, Water quality requirements, Selection of candidate species (indigenous/exotic). Live feed culture, Feed formulation.
Unit 2: Culture and breeding of finfishes (9 hrs): Carps, Air breathing fishes, Catfishes, Tilapia, Etroplus. Broodstock management, seed production, larval rearing, growout technology, types of hatcheries, design; feed management, harvesting and marketing.

Module4: Fishing resources and management (10hrs) (22marks)
Unit 1: Fishing crafts and gears (4 hrs): Mention Catamaran, Canoes and dug-out-canoes. Gillnet/drift gillnet, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing. Prohibited fishing practices, trawl ban, impacts of trawling.
Unit 2: Fish diseases, spoilage and preservation (6 hrs): Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting and smoking. Fish and Shell fish diseases (Bacterial, fungal, viral). Cryopreservation of fish germplasm, semen bank and preservation media.

Module 5: Practicals – 30 hrs; 2hrs per week; Credit – 1
Experiments1-4 are mandatory; from the remaining 6, four experiments can be selected by the teacher; Two more experiments (not included in the list) are to be designed by the teacher.

1. Identification of culturable species.
2. Identification of aquatic weeds, pests and predators.
3. Feed formulation and preparation for cyprinids, catfishes, prawns, etc.
4. Preparation of field study report after visiting, hatchery and farm/ fish processing plants,/ice plant and fish landing centre/ institutes like CMFRI/ CIFNET/ KUFOS (Maximum **TWO** days)
5. Collection and preservation of crustaceans, molluscs, fishes and other aquatic organisms
6. Identification of fishing crafts(models, charts, pictures can also be used)
7. Making of culture devices: rafts for mussel culture, happa for fish culture etc. (models can be made)
8. Water quality analysis of aquaculture systems (pH, salinity, dissolved Oxygen, BOD etc.,)
9. Culturing of any commonly available culture fishes in synthetic tanks, ponds etc.
10. .Identification of Fish and shell fish diseases

Virtual lab:
1. https://blue-cloud.d4science.org/web/aquacultureatlasgeneration
2. https://www.aquaexcel2020.eu/virtual-laboratory

3. https://www.aquafeed.com/regions/europe/new-virtual-fish-laboratory-open-for-use/

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Online Sources

1. https://www.tandfonline.com/journals/brfs21
2. https://www.fisheries.noaa.gov/topic/aquaculture/science-&-technology

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3					3						
CO 2		3					3						
CO 3		3					3						
CO 4				3	3				3				3
CO 5				3	3						3		
CO6					3-	3							3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

ANIMAL DIVERSITY-II-CHORDATA

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses: 1. https://www.acsebooks.com/product-ungulate-animals-pdf-ebook-6155.aspx 2. https://www.su.se/english/search-courses-and-programmes/bl7034-1.413080#:~:text=Animal%20Diversity%20%E2%80%94%20Vertebrates%20is%20an,main%20points%20of%20the%20course 3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/225/ANIMAL DIVERSITY 22				
Course objectives	The student develops understanding of the general characteristics and classification of Phylum Chordata, analyze the salient features of ***Hoplobatrachus tigerinus*** (Indian Bullfrog) with emphasis on selected systems, create awareness in the significance of conservation of chordates and will be able to perform simple dissections in order to study its characteristic features.				

Course Outcomes (COs)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Enumerate the salient features and examples of Phylum Chordata	U	F & C	Oral exams, Quizzes, Written exams
CO2	Describe the classification principles vertebrates within Phylum Chordata, with emphasis on Pisces, Amphibia, Reptilia, Aves, and Mammalia	U	F & C	Oral exams, Written exams
CO3	Analyze the anatomical and physiological adaptations of various vertebrate groups to their environments	An	F & C	Assignments, Written exams
CO4	Explain identification keys for distinguishing between venomous and non-venomous snakes	U	F C & P	Assignments, Practicals, Written exams
CO5	Appreciate the biodiversity of vertebrates, with a focus on indigenous species and their conservation	E	F C& P	Practical sessions, Case studies, Field trips
CO6	Conduct field study and prepare report; contribute towards the preparation of Local Biodiversity register	C	F C P &M	Field study report,Oral presentations

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

MODULE I. Protochordates to Tetrapods (11 hours) (Out of 70: 15marks)

Unit 1. Introduction to Chordata (1 hour)

Chordate characters (fundamental, general and advanced); chordates versus non-chordates; Outline the classification of Phylum Chordata down to classes.

Unit 2. Subphylum Cephalochordata and Subphylum Urochordata (3 hours)

General characteristics and classification of sub-phylum Cephalochordata up to Classes

Class Leptocardiie.g. *Branchiostoma*

General characteristics and classification of sub-phylum Urochordata up to Classes Ascidiacea, Thaliacea and Larvacea

Class Ascidiaceae.g. *Ascidia*– Retrogressive Metamorphosis, Mention neoteny and paedogenesis

Class Thaliaceae.g. *Salpa*

Unit 3. Subphylum Vertebrata Division I – Agnatha (1 hour)

Characteristics and classification down to classes eg. *Petromyzon,*mention Ammocoetes larva

Unit 4. Subphylum Vertebrata Division II – Gnathostomata Superclass Pisces (6 hours)

Classification of fishes down to subclasses, Salient features of the following extant groups

Class Chondrichthyes

Subclass Selachii e.g. *Scoliodon,* mention Mermaid's Purses

Subclass Holocephali e.g. *Chimaera*

Class Osteichthyes

Subclass Sarcopterygii e.g. *Latimeria*

Subclass Actinopterygii e.g. *Sardinella*, *Etroplus suratensis*

MODULE II. Subphylum Vertebrata – Superclass Tetrapoda – I (11 hours) (18 marks)

Unit. 1. Class Amphibia (4 hours)

Type: ***Hoplobatrachus tigerinus*** (Indian Bullfrog)

Morphology, skeletal system (exclude skull bones), digestive system, respiratory system, circulatory system, excretory system and reproductive system

Unit 2. Classification of Amphibia (3 hours) Classification down to orders, Characteristic features of the following extant examples

Order Gymnophiona e.g., *Ichthyophis*

Order Caudata (=Urodela) e.g, *Andrias davidianus* (Chinese Giant Salamander), Mention the three Indian species of *Tylototriton (T. verrucosus,T.himalayanus and T.* zaimeng), *Ambystoma*, mention Axolotl larva

Order Anura e.g., *Rhacophorus*

Unit. 3. Class Reptilia (4 hours)

Classification of class Reptilia down to orders and salient features of thefollowingorders (onlyextant forms)

Subclass Anapsida

Order Testudines e.g., *Geochelone elegans*

Subclass Diapsida

Order Rhynchocephalia e.g., *Sphenodon*

Order Squamata Suborder Lacertilia e.g., *Chamaeleozeylanicus*

Suborder Ophidia e.g., *Hydrophis, Lycodonaulicus*

Order Crocodilia e.g., *Gavialis gangeticus*

Mention Arribada.Mention Polyvalent Snake Antivenoms.

MODULE III. Subphylum Vertebrata – Superclass Tetrapoda – II (10 hours) (15marks)

Unit 1. Class Aves (2 hours)

Classification of class Aves down to orders and salient features of thefollowingorders (onlyextant forms)

Subclass Archaeornithes

Order Archaeopterygiformes e.g., *Archaeopteryx*

Subclass Neornithes

Super order Palaeognathae

Orders Casuariiformes, Dinornithiformes, Rheiformes, and Struthioniformes

Order Struthioniformes e.g., *Struthio* and

Order Dinornithiformes e.g., *Apteryx*

Unit 2. Super order Neognathae (3 hours)

Order Galliformes e.g., *Pavo cristatus*
Order Coraciiformes e.g., *Merops orientalis*
Order Bucerotiformes e.g., *Ocyceros griseus*
Order Cuculiformes e.g., *Eudynamysscolopaceus*
Order Psittaciformes e.g., *Psittaculakrameri*
Order Columbiformes e.g., *Columba livia*
Order Falconiformes e.g., *Falco peregrinus*
Order Accipitriformes e.g., *Accipiter badius*
Order Strigiformes e.g., *Tyto alba*
Order Passeriformes e.g., *Pycnonotus jocosus*
Order Charadriiformes e.g., *Tringa*
Order Sphenisciformes e.g., *Aptenodytes*

Unit 3. Class Mammalia (5 hours)

Classification of class Mammalia down to orders and salient features of theorders cited with specified examples

Subclass Prototheria

Order Monotremata e.g. *Ornithorhynchus, Tachyglossus*

Subclass Theria

Order Marsupialia e.g. *Macropus*
Order Edentata e.g. *Myrmecophaga*
Order Pholidota e.g., *Manis*
Order Lagomorpha e.g. *Lepus nigricollis.* Mention dentition in rabbit.
Order Rodentia e.g. *Funambulus*
Order Chrysochloridea e.g., Golden mole of Africa
Order Dermoptera e.g., *Cynocephalus*
Order Soricimorpha e.g. *Crocidura.* Mention discovery of *C. narcondamica*
Order Erinaceomorpha e.g., *Paraechinusnudiventris*
Order Chiroptera e.g. *Pteropus giganteus, Latidenssalimalii*

Order Primates	e.g. *Hylobates*
Order Carnivora	e.g., *Vivericula indica*
Order Cetacea	e.g. *Balaenoptera*
Order Artiodactyla	e.g. *Bos gaurus, Sus scrofa cristatus*
Order Perissodactyla	e.g., *Rhinoceros*
Order Sirenia	e.g. *Dugong*
Order Proboscidia	e.g. *Elephus maximus indicus.* Mention *Loxodonta.*
Order Pholidota	e.g., *Manis*
Order Hyracoidea	e.g., *Dendrohyrax* (Tree hyrax)
Order Tubulidentata	e.g., *Orycteropus* (Aardvark)

MODULE IV. Ecologically, Economically and Evolutionarily significant chordates (13 hours) (22marks)

Unit 1. Ecologically important chordates from Kerala

Sub-terranean fishes from Kerala:

Mention *Pangiopathala, Kryptoglanisshajii, Horaglanis populi, Monopterus, Rakthamichthys indicus, Aenigmachannagollum*

Endangered and Threatened Amphibians

Diversity of bush frogs, dancing frogs and night frogs in Western Ghats

Mention the Indian sanctuaries with Amphibians as flagship species -- Jore Pokhri Wildlife Sanctuary –*Tylototritonverrucosus (*Himalayan Newt); Mathikettan Shola National Park – *Melanobatrachus indicus* (Galaxy Frog)

Reptilia from Kerala

Contributions of Padmashree Rhomulus Whitaker in Reptile Conservation

Common venomous and non-venomous snakes of Kerala: a] *Python molurus*b] *Ptyas mucosa*] *Gongylophis* (= *Eryx*) *conicus*d] *Indotyphlopsbraminus*e] *Bungarus caeruleus* f] *Naja naja*g] *Daboia russellii*h] *Ophiophagus hannah*

Identification key for venomous and non-venomous snakes

Endemic birds of the Western Ghats

Myophonushorsfieldii (Malabar Whistlingthrush), *Leptocoma minima* (Crimson-backed Sunbird), *Anthusnilghiriensis* (Nilgiri Pipit), *Chrysocolaptes socialis* (Malabar Flameback)

Endemic/Endangered Mammals from Kerala *Macaca silenus* (Lion-tailed macaque), *Niligiritragus hylocrius* (Nilgiri Tahr), *Martes gwatkinsii* (Niligiri marten)

Unit 2. Economically important chordates

Ornamental fishes from Kerala ---Denison's barb/ Miss Kerala --*Sahyadriadenisonii,* Rosy barb–*Pethiaconchonius*, Honey gourami -*Trichogasterchuna*, Indian glassy fish—*Parambassisranga,* Yoyo loach–*Botiaalmorhae*

Dolphin echolocation and biosonar technology

Unit 3. Evolutionarily significant chordates

Affinities and systematic position of Cephalochordata

Neoceratodus, Protopterus, Lepidosiren

Nasikabatrachussahyadrensis

Mention the extinct subclasses Euryapsida, Parapsida and Synapsida (mammal- like reptiles) and mention the origin of mammals from synapsids

Rediscovery of *Rhinoptilusbitorquatus* (Jerdon's Courser) and *Athene blewitti* (Forest owlet)

Recent Extinctions: Passenger Pigeon [*Ectopistesmigratorius*), Dodo [*Raphus cucullatus*], Pink-headed Duck [*Rhodonessacaryophyllacea*], Elephant Bird [*Aepyornis*].

MODULE V. Practicals- Chordata[1 Credit; 30 Hours]

[Students are expected to make sketches/photographs with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches/photographs/copy of printed figures with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches.]

MANDATORY EXPERIMENTS

1. **Study of the following specimens:**

(Students are expected to identify the specimens by their generic names, respective phyla /classes/ orders)

a. **Cephalochordates:** *Branchiostoma*
b. **Urochordates:** *Ascidia*, *Salpa* (any 1)
c. **Agnathans:** *Petromyzon*, Ammocoetes larva [any 1]
d. **Fishes:**
i) Common elasmobranchs - *Chiloscyllium, Stegostoma, Sphyrna, Pristis, Trygon, Narcine, Astrapes* [any 2]
ii) Common edible fishes (marine) - *Sardinella, Rastrelliger, Cynoglossus, Parastromateus, Trichiurus, Cybium, Thunnus* [any 2]

iii) Common edible fishes (Inland) - *Etroplus, Mugil, Wallagonia, Tilapia, Catla, Cirrhina, Labeo, Cyprinus* [any 3]

iv) Fishes with special adaptive features - *Hippocampus, Belone, Exocoetus, Tetrodon, Pterois, Ostracion, Heteropneustes, Clarias, Anabas, Channa, Echeneis, Antennarius, Anguilla* [any 3]

e. **Amphibians:** Common amphibians - *Duttaphrynus, Euphlyctis, Rhacophorus, Hyla, Ambystoma*, Axolotl larva, *Ichthyophis*/*Uraeotyphlus* [any 3 – one from each order]

f. **Reptiles** :

i) Common lizard - *Hemidactylus, Calotes, Mabuya (Eutropis)* [any 1]
ii) Lizards with special adaptations - *Draco, Chamaeleo, Phrynosoma* [any 2]
iii) Non venomous snakes - *Ptyas, Gongylophis, Lycodon, Indotyphlops*[any 2]
iv) Venomous snakes - *Naja, Daboia, Bungarus, Echis* [any 3]
v) Water snake – *Hydrophis / Enhydris*/ *Xenochrophis*
vi) Arboreal snake – *Dendrelaphis / Python / Ahaetulla*
g. **Birds**:

i) Fossil bird - *Archaeopteryx*
ii) Flightless bird - *Rhea, Struthio* [any 1]
iii) Wetland birds - Waterhen, Duck, Egret, Heron, Ibis, Stork [any 2]
iv) Shore birds – Gulls, Plovers, Terns [any 1]
v) Migratory birds - Pelican, Crane, Flamingo [any 1]
vi) Birds of Prey – Falcon, Eagle, Kite, Shikra, Owl [any 2]
h. **Mammals**:
i) Common insectivore – *Suncus*, Hedgehog [any 1]

ii) Common rodent – *Rattus, Bandicoota, Funambulus* [any 1]
iii) Common bat of Kerala – *Pteropus, Megaderma, Pipistrellus* [any 1]
iv) Small Carnivore – Jungle Cat, *Herpestes*, Civet [any 1]
v) Primate – *Loris* or any other species
2. **Osteology**
a. Frog: Pectoral & Pelvic girdles
b. Rabbit: Skull showing dentition
3. Mounting of Placoid scales of Shark
4. Dissect and display the alimentary canal of Sardine/Mullet
Of the remaining experiments any 4 can be selected by the teacher from the following list. Two experiments other than the listed should be identified by the Supervising teacher and introduced to the students.
5. Mounting of cycloid scales of Sardine/ctenoid scales of Mullet
6. Osteology: Frog: Typical, 8^{th} and 9^{th} Vertebrae
7. Histology: *Branchiostoma* - T. S. through pharyngeal region
8. Key for identification of venomous and non-venomous snakes.
9. Features and adaptations of: duck, parrot, king fisher, owl, kite and wood pecker [sketches/photographs/copy of printed figures of the beaks and feet of 4 birds)

10.Locate the distribution of following animals in the worldmap: Lungfishes, *Sphenodon*, monotremes, marsupials
11. Study on different types of Feather, Structure and Adaptations
12. Morphometric measurements of fishes
13. **Local Biodiversity Record:** Observe birds of the locality in their natural habitat and prepare a field note.

Field Study: Visit to any Hatchery/aquarium, Zoo/Virtual Zoo, Wild life Sanctuary/National park in Kerala to create awareness of biodiversity richness of chordates and prepare a field study report with geo-tagged photographs of minimum 20 specimens belonging to any 2 or more Classes of Phylum Chordata studied.
Suggested Activities

- Awareness on software application SARPA and Snakepedia
- Awareness on software application 'Merlin', 'Kili','Indian birds' and its installation

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Online resources

Sardinella digestive system
https://www.youtube.com/watch?v=r_pSMuE25rw

Virtual tour
https://www.360virtualtour.co/portfolio/google-street-view-of-london-zoo-virtual-tour/

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3					3		3						
CO 4		3					3						
CO 5					3				3		2		
CO6		3					3						2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓	✓		✓

BIOSTATISTICS AND BIOTECHNIQUES

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop an understanding in the procedures of data collection, analysis, centrifugation, electrophoresis, chromatography, DNA extraction, histochemical tissue preparation etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various data collection and presentation methods	U	F&C	Short answer, Paragraph, type questions
CO2	Perform various data analysis procedure using the given data	Ap	C&P	Short answer, Paragraph and Essay type questions
CO3	Describe the procedures for centrifugation, electrophoresis, chromatography etc.	U	F&C	Short answer, Paragraph, Essay type questions
CO4	Explain DNA extraction and purification and histochemical tissue preparation methods	U	F&C	Short answer, Paragraph type questions
CO5	Perform experiments related to biostatistics and tissue processing techniques	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Compare the merits and demerits of different techniques for molecular, cytological and histological studies	U	F&C	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1 Data – Collection and Presentation (9Hrs) (Out of 70: 12marks)

Unit 1: Introduction (1hr) - Definition; Applications; Terminology, variables. Limitations of statistical methods.

Unit 2: . Methods of Collection (2hrs)- a) census method, Advantages, disadvantages b) Sampling methods: Random Advantages, Disadvantages Types: Non random Advantages, Disadvantages Types Sample size Collection and processing of data, Classification of data.

Unit 3: Presentation of data (6hrs) - a) Tabular: class intervals, preparation of class intervals, tally marks b) Graphical : Line graph, histogram, frequency polygon and frequency curve: types, kurtosis, cumulative frequency curves (ogive), scatter or dot diagram c) Diagrammatic: bar diagram: simple, multiple, component, percentage and pie diagram).

MODULE 2 Data Analysis (13 Hrs) (20marks)

Unit 1: Measures of central tendency and Dispersion (8hrs)-: (raw data, discrete series data, continuous series data- problems are to be discussed) i) Mean, ii) Median and iii) Mode. Measures of Dispersion: (raw data, discrete series data, continuous series data - problems to be discussed) i) Range, ii) Mean deviation, iii) Standard deviation, iv) Standard error (problems are to be discussed)

Unit 2: Hypothesis testing and Interpretation of results(5hrs)-: a) i)'t' test, ii) F-test (ANOVA) (problems are to be discussed) b) Statistics-based acceptance or rejection of hypothesis.

MODULE 3 (12 Hrs) (19 marks)

Unit 1: Basic Methods to study Biomolecules(9hrs) - Basic principle, procedure and application of Cell fractionation; Centrifugation-Differential, Density Gradient and Ultracentrifugation; Electrophoresis- Agarose Gel Electrophoresis and SDS-PAGE (Mention 2D-PAGE); Chromatography: Paper and Thin Layer Chromatography (Other types of Chromatography Mention only); Blotting techniques: Northern, Southern, Western Blots; DotBlots (Breif)

Unit 2: Colourimetry, Spectroscopy and spectrometry(3hrs)-: Working and application (Mention the application of Mass spectrometry, LC-MS, GC-MS also). Autoradiography.

MODULE 4 (11 Hrs) (19 marks)

Unit 1: DNA Extraction and Purification(6hrs)- Basic methods for isolating and purifying DNA. Polymerase Chain Reaction (PCR): Basic principle and working of PCR, Mention Different types of PCR; Application. Overview of DNA microarray. Emerging Trends in Biotechnology - Overview of CRISPR-Cas9 technology and synthetic biology (Breif note only).

Unit 2: Biotechniques to study tissues and organs(5hrs) - Basic procedure and application of Histology and Histochemical Techniques- Introduction, whole mount, serial section, microtomy, basic steps in histology -Fixation, Dehydration, Embedding, sectioning, staining and mounting Karyotyping: Procedure and Application.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1. Calculate the mean, median and mode (raw data, discrete series & continuous series) for the given data
2. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.
3. Demonstration of Paper Chromtography/Centrifugation- Pipetting and dilution technique
4. Staining any tissue sample (serial sectioning) and whole mount preparation

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students

5. Measure the size of given shells / any sample of data and represent it in a graphical form and interpret it.
6. Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical form. Compare by t-test.
7. Construct a frequency curve and frequency polygon with mean ± SD using suitable data.

8. Draw a bar diagram with mean ± SD employing suitable data. Construct a histogram with mean ± SD utilizing suitable data.
9. Draw a pie diagram using suitable data.
10. Demonstration of PCR set up and optimization
11. Demonstration of any one type of Electrophoresis
12. Karyotyping of the given sample.

Field study: A) Visit to Molecular Biology/ Biotechnology Laboratory, and submission of detailed field study report at the time of semester end practical examination.

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Basic Concepts in Clinical Biochemistry: A Practical Guide Vijay Kumar & Gill, K.D. Springer Nature 2018

Dubey, R.C. A Text Book of Biotechnology. New Delhi: S.Chand publication.

Lohar, Prakash S. Biotechnology. India: MJP, 2005.

Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology Hofmann, A. &Clokie, S , Cambridge University Press, 2018

McCabe,L.L. and E.R.B. McCabe. DNA: Promise & Peril. USA: University of California Press,2010.

Mcgiffen, Steven P. Biotechnology. USA: Pluto Press, 2005.

Mahesh, S. Biotechnology IV. India: New Age International, 2006.

Nicholl, Desmond, S.T.: An Introduction to Genetic Engineering. UK: Cambridge University Press, 2002.

Sathyanarayana, U. Biotechnology. Books and Allied, 2008..

Young, Lisa. Biotechnology and Genetic Engineering. Facts on Files, 2004

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2				3	3				3				
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO6		3				3	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

FOUNDATIONS OF MOLECULAR BIOLOGY & BIOINFORMATICS

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or the following online courses https://onlinecourses.swayam2.ac.in/nou24_bt05 https://onlinecourses.nptel.ac.in/noc24_bt03 https://onlinecourses.nptel.ac.in/noc24_bt07				
Course objectives	The course aims to develop an understanding in basic concepts about genome, and its organization, DNA replication, regulation of gene expression, genomic and metabolic databases, search engines etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Comprehend the fundamentals of genomics, including central dogma, genome organization and the intricacies of DNA replication.	U	F&C	Short answer, Paragraph questions
CO2	Describe transcription, translation and protein targeting mechanisms in prokaryotes and eukaryotes.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe gene regulation and diverse regulatory mechanisms in prokaryotes and eukaryotes.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Analyze major biological databases, demonstrate proficiency in sequence analysis, and utilize search engines for effective data retrieval and submission.	An	F&C	Short answer, Paragraph questions
CO5	Apply genomics and proteomics tools for comprehensive molecular analysis and drug discovery in bioinformatics and comprehend molecular phylogenetics.	Ap	C&P	Viva- voce, report writing
CO6	Identify appropriate model organisms, genetic engineering technique and bioinformatic tools for advanced research and biotechnological applications.	An	C&M	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: GENOME ORGANIZATION (10 Hrs) (Out of 70: 14marks)
Unit 1: Basic Concepts of genome (2 hrs): Nucleic acid as the genetic material (Griffith'sexperiment and Hershey-Chase experiment), Importance of Molecular Biology, Central Dogma of Molecular Biology
Unit 2: Structure of Nucleic acids(4hrs): Nucleosides and nucleotides, purines and pyrimidines, biologicaly important nucleotides. Nucleic acids, Watson and Crick model of DNA structure, A, B &Z forms of DNA, Structure of tRNA and types of RNA (mRNA, tRNA, r RNA) Supercoiled and relaxed DNA,
Unit 3: Genome and its organization (4Hrs): Concept of gene, cistron, muton, recon, split gene, overlapping gene, pseudogenes, transposons, coding sequence, regulatory sequence, intron, exon. Nucleosome structure and packaging of DNA into higher order structures. Brief idea of chloroplast DNA and Mitochondrial DNA)
Module 2: DNA REPLICATION AND GENE EXPRESSION (14Hrs) (21 marks)
Unit 1: Replication of DNA (3Hrs): An overview of DNA Replication, DNA replication in prokaryotes and eukaryotes, semiconservative nature of DNA replication, Uni-directional and bidirectional DNA replication.
Unit 2: Gene expression(8Hrs): Mechanism of Transcription in prokaryotes and eukaryotes: RNApolymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains; Genetic code, properties of genetic code, Wobble hypothesis; Components of Protein synthetic machinery: Messenger RNA, tRNA function, Charging of tRNA, aminoacyl tRNA synthetases, ribosome structure and assembly, Mechanism of protein synthesis in prokaryotes and eukaryotes: initiation, elongation and termination; Post translational modification of the peptide chain (breif account only)
Unit 3: Gene expression regulation (3Hrs): Concept of operon, inducible and repressible operons, Regulation of gene expression in bacteria: trp operon concept; RNA mediated gene silencing(si RNA, mi RNA and RNAi)

Module 3: INTRODUCTION TO BIOINFORMATICS (14hrs) (21marks)
Unit 1: General Introduction (8 Hrs) Introduction to bioinformatics and its relationship with molecular biology. Definition of Bioinformatics. Scope and application of Bioinformatics. General Introduction of Biological Databases; Overview of major biological Databases: Nucleic acid databases (EMBL, DDBJ, Genbank); Protein databases (Primary-Swiss Prot, PIR, and Secondary-PROSITE, PRINTS); Metabolite databases (KEGG, EcoCyc) Specialized Genome databases: (VirGen, GOLD, TIGR). Structure databases (PDB, NDB) Special databases – CATH, OWL, PubMed.
Unit 2 : Database Search Engines (2Hrs): Entrez at NCBI of USA, SRS at EBI of England, STAG at DDBJ of Japan. Data retrieval with Entrez and SRS.Sequence submission to NCBI.

Unit 3:Sequence Alignments and Analysis tools (4 Hrs): Introduction to Sequences, types of alignments and Sequence similarity search-Local alignment and Global alignment, Pairwise alignment tools (BLAST and FASTA Algorithm) and multiple sequence alignment tools (Clustal W and Clustal X)

Module 4: -OMICS in Bioinformatics and its application (10hrs) (14marks)
Unit 1: Genomics (4Hrs): Basics of Genomics, Genome sequencing technologies; A brief description of Sanger sequencing and next-generation sequencing (NGS). A brief mention of Single molecule sequencing, Whole genome sequence assembly, SAGE and ESTs. Brief account of Transcriptomics, Metabolomics, Metagenomics and cheminformatics
Unit 2: Proteomics (3 Hrs): Basics of Proteomics. Brief account on proteomics technologies-2D-electrophoresis, iso-electric focusing, LC/MS-MS, MALDI-TOF, mass spectrometry. Introduce Machine learning in Bioinformatics

Unit 3: Molecular Phylogenetics (3Hrs): Basics of Phylogenetics; molecular evolution and molecular phylogenetics, cladistics and ontology. Phylogenetic tree construction methods and programmes. Forms of Tree representation

Module 5: Open Ended Module: (12Hrs)

Design student activities like assignments, seminars, collection of notes/reference materials related to the course. Model organisms in molecular biology research (Example, *Escherichia coli* (*E. coli*)/*Saccharomyces cerevisiae* (Baker's yeast)/ *Caenorhabditis elegans* (*C. elegans*)/ *Drosophila melanogaste*r (Fruit fly)/ *Mus musculus* (House mouse)/*Danio rerio* (Zebrafish). Various bioinformatic techniques (Example Molecular docking/Protein-proten docking). Introduce widely used software such as Pymol and VMD. Mention Modern AI techniques in biology (Example Support vector machines/Neural networks/deep learning).

REFERENCES

- Bioinformatics: Sequence and Genome Analysis by David W. Mount. 2013. Cold Spring Harbor Laboratory Press.
- Bioinformatics For Dummies by Jean-Michel Claverie and Cedric Notredame. 2007. Wiley.
- Molecular Evolution and Phylogenetics by Masatoshi Nei. 2013. Oxford University Press
- Bioinformatics: Sequence and Genome Analysis by David W. Mount. 2016. Cold SpringHarbor Laboratory Press.
- Bioinformatics: An Introduction by Jeremy Ramsden. 2019. CRC Press
- Molecular Biology of the Gene by James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2019 (8th Edition) Pearson
- Genes IX by Benjamin Lewin. 2007 (9th Edition) Jones & Bartlett Learning.
- Molecular Cell Biology By Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger,AnthonyBretscher, HiddePloegh, Angelika Amon, and Kelsey C. Martin. 2016 (8th Edition). W. H. Freeman and Company.
- Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. 2017 (7thEdition). W. H. Freeman and Company.

ONLINE SOURCES

1. https://study.com/learn/anatomy-and-physiology.html
2. https://alvernia.libguides.com/oer/anatomy
3. https://www.udemy.com/course/human-physiology-notes-powerpoint-slides-practice-exams/
4. https://www.physiology.org/career/teaching-learning-resources/student-resources/what-is-physiology?SSO=Y
5. https://www.getbodysmart.com/
6. https://byjus.com/biology/human-body-anatomy/

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3		3	3		3		3				
CO 3		3					3						
CO 4					3		3						
CO 5					3				3				
CO6					3		2				3		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓			✓
CO6	✓			✓

DISCIPLINE SPECIFIC ELECTIVE COURSES

ENTOMOLOGY I: STRUCTURE, ADAPTATIONS AND CLASSIFICATION OF INSECTS

Programme	B. Sc Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course imparts knowledge in insect diversity, morphology, adaptations and insect classification				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the insect diversity, basic morphology and recognize the causes of the success of insects.	R & U	F & C	Short answer, Paragraph, questions
CO2	Analyse the morphological adaptations of insects and assess the role of these adaptations.	R, U & An	F, C & P	Short answer, Paragraph, Essay questions
CO3	Describe the insect classification, taxonomic tools and curation techniques for insects.	R, U	F, C	Short answer, Paragraph questions
CO4	Critically assess the morphology and biology of five hyper-diverse orders namely Coleoptera, Hemiptera, Hymenoptera, Lepidoptera and Diptera.	R & U	F & C	Short answer, Paragraph, Essay questions
CO5	Collect and preserve insect specimens, present seminars on the insect diversity etc.	Ap	C&P	Assignments, seminars, presentation of collection
CO6	Describe various types of taxonomic keys used in insect classification	R & U	F & C	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1. Introduction to Insect Morphology (10hrs) (Out of 70: 17marks)

Unit 1. Insect Diversity and Abundance (4hrs) - Specialties of insects and the causes of the success of insects over other creatures.

Unit 2. Overview of insect body plan and morphology (6hrs)- Insect body regions-head, thorax, and abdomen, Insect cuticle, sclerites, and external processes

Module 2: Insect Adaptations(11hrs) (18marks)

Unit 1. Head (2hrs) : Segmentation, structure, modifications

Unit 2: (2hrs) Insect mouth parts and their modifications
Unit 3: (2hrs) Insect antennae and their modifications.
Unit 4: (1hr) : Photoreceptors (compound and simple eyes)
Unit 5: Thorax (3hrs) Segmentation, structure, legs, and their modifications, wings and their modifications; wing venation.
Unit 6: Abdomen(1hr): Segmentation, structure and their modifications.

Module 3:Insect Orders, Curation and Insect Morphs (9hrs) (15marks)
Unit 1: **(**Collection, processing and curation of insects for taxonomic study. (2hrs)
Unit 2: Taxonomic tools: Keys (types; dichotomous; pictoral; bracketed) (2hrs)
Unit 3: Types of larva and pupa with examples. (2hrs)
Unit 4: The History of Insect Classification; Introduction to insect orders, their characteristics, classification of Class Insecta up to Orders (3hrs)

Module 4: Hyper-diverse Orders of Insects (18hrs) (20marks)
Unit 1: Bugs (4hrs): Hemiptera - Classification and characteristics of economically important families (Belostomatidae, Pentatomidae, Cicadidae, Coccidae, Aphididae)
Unit 2: Beetles (5hrs): Coleoptera - Classification and characteristics of economically important families (Carabidae, Chrysomelidae, Curculionidae, Scarabaeidae, Cerambycidae)
Unit 3: Moths and Butterflies (5hrs): Lepidoptera - Classification and characteristics of economically important families (Papilionidae, Nymphalidae, Noctuidae, Saturniidae, Pyralidae)
Unit 4: Flies (4hrs): Diptera - Classification and characteristics of economically important families (Tachinidae, Asilidae, Oestridae, Culicidae, Chironomidae).

Module 5:Open Ended (12hrs)
Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 4, Encourage collection of insects representing each family and their preservation.

References

- Charles A Triplehorn; Norman F Johnson; Donald J Borror. 2005. Borror and DeLong's introduction to the study of insects. Thompson Brooks/Cole. ISBN:9780030968358. 864 pages.
- R. F. Chapman, Stephen J. Simpson, Angela E. Douglas. 2013. The Insects: Structure and Function -5th Edition. Cambridge University Press. ISBN: 9780521113892
- P. J. Gullan, P. S. Cranston. 2021. The Insects: An Outline of Entomology, 5th Edition. Wiley-Blackwell. ISBN: 978-1-118-84615-5. 624 Pages
- David Grimaldi& Michael S. Engel. 2005. Evolution of the insects. Cambridge University Press. ISBN:9780521821490. 755 pages.
- Dunston P. Ambrose. 2015. Insects: Structure, Function and Biodiversity. Kalyani Publishers. ISBN:9789327251746. 626 pages.
- O.W. Richards. 2012. IMMS' General Textbook of Entomology.Springer Netherlands. ISBN:9789401165143. 418 pages.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

ENTOMOLOGY II: AGRICULTURAL ENTOMOLOGY

Programme	B.Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or the following online courses https://www.coursera.org/learn/bugs-101 https://www.entsoc.org/resources/education/online-courses https://onlinecourses.swayam2.ac.in/cec20_bt02/preview https://www.careers360.com/university/university-of-mysore-mysore/applied-entomology-certification-course https://ecourses.icar.gov.in/ https://onlineentomology.ifas.ufl.edu/programs/courses/ https://online-distance.ncsu.edu/program/university-undergratuate-certificate-in-fundamentals-of-entomology/ https://www.aau.in/agricultural-entomology-1 http://ecoursesonline.iasri.res.in/course/view.php?id=142				
Course objectives	The student gains knowledge of the anatomy, physiology, life cycles, and behavior of insect pests and beneficial insects relevant to agriculture and develops skills in identifying and classifying common insect pests and their damage symptoms on crops.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify and understand current research trends and challenges in Agricultural Entomology.	U	F&C	Short answer, Paragraph questions
CO2	Analyze and describe the various insect habitats in agricultural landscapes.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Analyze factors influencing insect population dynamics, including abiotic and biotic factors.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Recognize the symptoms and explain the nature of pest damage on crops.	U & Ap	F & C	Short answer, Paragraph questions
CO5	Identify the major insect pests affecting crops and comprehensively understand and apply the knowledge of management strategies related to insect pests affecting agricultural and horticultural crops.	Ap	C&P	Quizes, seminars, case study analysis etc.
CO6	Describe the features of major vegetable pests, and the damages caused by them	U	F&C	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Agricultural Entomology(12hrs) (Out of 70: 14 marks)

Unit 1: Introduction to Agriculture Entomology:(2 hrs)

Definition and scope of agriculture entomology, Historical development and significance, Careers and research opportunities in agriculture entomology.

Unit 2: Pests in agroecosystem (8hrs) - definition – classification into insects and non-insects with examples, categories of pests – based on occurrence - based on level of infestation - based on percentage of crop loss the cause with examples.

Unit 3: pest outbreak(2hrs)- definition-reasons, Impact of global warming on pest status. Pest surveillance and pest forecasting.

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Module 2: Insect pests affecting crops of Kerala - I (16hrs) (21marks)

Diagnostic features, biology, nature and symptoms of damage and management strategies of insect pests

Pests of Paddy 1. *Nilaparvata lugens*2. *Leptocorisa acuta* 3. *Spodoptera mauritia*
Pests of Pulses 1. *Helicoverpa armigera* 2. *Exelastisa tomosa*
Pests of Coconut 1. *Oryctes rhinoceros* 2. *Opisina arenosella* 3. *Rhynchophorus ferrugineus.* Mention damage caused by *Aceria guerironis*
Pests of Gingelly 1. *Antigastraca talaunali* 2. *Asphondylia sesami*
Pest of Rubber 1. *Saissetia nigra* 2. *Aetherastis circulata*
Pest of Arecanut 1. *Tirathaba mundella* 2. *Leucopholis coneophora*
Pest of Tapioca 1. *Aleurodicus dispersus* 2. *Bemisia tabaci*
Pest of Cashew 1. *Neoplocaederus ferrugineus* 2. *Lamida moncusalis*
Pest of Coffee 1. *Xylotrechus quadripes* 2. *Coccus viridis*
Pest of Tea 1. *Helopeltis antonii* 2. *Toxoptera aurantii*

.

Module 3: Insect Pests Affecting Crops of Kerala – II (11hrs) (21marks)

Diagnostic features, biology, nature and symptoms of damage and management strategies of insect pests

Unit 1: Pests of Spices and Condiments

Pest of Ginger & Turmeric 1. *Formosina flavipes* 2. *Chalcidomyia atricornis*
Pest of Cardamom 1. *Sciothrips cardamomi* 2. *Euptero tecanarica*
Pest of Pepper 1. *Lanka ramakrishnai 2. Laspeyresiahemidoxa*

Unit 2: Pests of Fruit-Trees

Pest of Mango 1. *Batocera rufomaculata* 2. *Orthaga exvinacea*3. *Sternochetus mangiferae*
Pest of Banana 1. *Odoiporus longicollis* 2. *Pentalonia nigronervosa*

Unit 3: Pests of vegetables:

Pest of Lady's finger 1. *Sylepta derogata* 2. *Earias vitella*
Pest of Brinjal 1. *Leucino desorbonalis* 2. *Henosepilachna vigintioctopunctata*
Pest of Cucurbits 1. *Bactrocera cucurbitae* 2. *Raphidopalpa foveicollis*

Module: 4 : Insect Pests Affecting Crops of Kerala – III (9 Hours) (14marks)

Diagnostic features, biology, nature and symptoms of damage and management strategies of insect pests

Unit 1: Pest of stored products

1. *Tribolium castaneum*2. *Callasobruchus chinensis* 3. *Lasioderma serricorne*

Unit 2: Pests of Forest Trees:

Pest of Teak – 1. *Hyblaea purea* 2. *Eutectona macheralis*
Pest of Castor – *Achaea janata*
Pest of Oak – *Lymantria* sp.

Pest of Sandal – *Aristobia octofasciculata*
Unit 3: Polyphagous Pests- Locust, Termites

Module 5: Open Ended (12hrs): Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 4,

Virtual Labs (Suggestive sites)
http://entoweb.okstate.edu/4H-FFA/Neuroptera.htm
https://entomology.tamu.edu/tamu-insect-collection/
https://insectcollectionlab.nmsu.edu/
https://site.caes.uga.edu/mchughlab/research/the-virtual-roach/
https://ag.purdue.edu/department/entm/extension/field-crops-ipm/

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Haq, M. A. and Ramani, N. 1992. Mites and Environment. Anjengo Publications, Kerala. 171p.
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Prakash, I and Mathur, R. P. 1987. Management of Rodent Pests. Indian Council of Agricultural Research, New Delhi 133 p.

Online sources
1. https://www.entsoc.org/publications/common-names
2. https://i5k.nal.usda.gov/

3.https://www.entsoc.org/
4.https://libguides.utk.edu/entomology/online
5.https://entomology.unl.edu/agroecosystems

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓			✓
CO6	✓			✓

FISHERY SCIENCE I: FUNDAMENTALS OF FISHERY SCIENCE

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	To understand the critical role of fisheries in national development and gain knowledge about diverse aspects of fisheries, including fishery organisms and their habitats.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the importance of fisheries in national development and the role of research institutions and identify job opportunities in fishery sector	R & U	F & C	Short answer, Paragraph, Essay questions
CO2	Compare and classify common fishery organisms by taxonomic groups and species	R, U & An	F, C & P	Short answer, Paragraph, Essay questions
CO3	Describe different activities in fish landing sites; identify fishing crafts, gears and its accessories	R, U	F, C	Short answer, Paragraph questions
CO4	Analyze various unsustainable fishing practices and its consequences	An	F & C	Short answer, Paragraph questions
CO5	Identity and explain the fundamentals of fish genetics	R, U	F & C	Short answer, Paragraph questions
CO6	Prepare field study report of visit to ferries or fish landing sites	C	C &P	Viva- voce, report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
#-Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Introduction to Fisheries (14hrs) (Out of 70: 20marks)

Unit 1: Significance of Fisheries (4hrs Definition of fisheries; Evolution of fisheries; Significance: Role of fisheries in maintaining aquatic biodiversity; Contribution of fisheries to global economy; fisheries as a source of employment; Role in food security; International trade in fish and fish products; Role of fisheries in cultural heritage; Importance of Fisheries to national development: Income generation, Employment, Foreign exchange

Unit 2: Scope of Fisheries: (3hrs): Major fisheries research institutes in India: CIFT, CMFRI, CIRNET, NIO, FSI, CIBA, FIA, MPEDA: Fisheries extension and education in India. Fishery as a tool for

rural development and employment potentiality. Different fisheries development plan/schemes in India. Role of Government, NGOs, fisheries co-operatives and other agencies in fisheries sector.

Unit 3: Types of Fisheries (4hrs): Types of Fisheries: Finfish fishery and Shell fish fishery; Capture and culture fishery; marine and inland fishery, freshwater, brackish water and reservoir fishery; Subsistence Fisheries, Artisanal Fisheries, Commercial Fisheries and Industrial Fisheries. Commercially important fishery organisms with their morphological characteristics: Fresh water organisms: Anabas, Catla, Catfish; Brackish water organisms: Tilapia, Grey mullet, Shrimps, crabs; Marine organisms: Sardinella, Mackerel, tuna, Anchovy, Ray, Shark, Shrimp, Crab, lobsters, Cuttle fish/squid. Brief account on thrash fishes.

Unit 4: Government policies and laws on fisheries (3Hrs): Organizational set up of fisheries administration at the Centre and state levels. Recent policies in fisheries sector. Functions and powers of functionaries of department of fisheries, corporations and cooperatives. Role of Central and State Government in the regulatory activities of fisheries. Fisheries legislation: Overview of fisheries and aquaculture legislations in India. Indian Fisheries Act, 1897. Laws relating to conservation and management of fishery resources in marine and inland sectors. Marine fisheries policy, Laws relating to fish products and marketing. International Law of the Seas and international commissions on fisheries and their impact.

Module 2: Limnology and Oceanography(13hrs) (15marks)

Unit 1: Introduction to limnology:(4hrs) inland water types, their characteristics and distribution; zonation. ponds and lakes; streams and rivers; physical and chemical characteristics of a lentic ecosystem; classification of lakes based on productivity; indices of productivity of lakes. Lotic environments: running waters in general; physical conditions; classification of lotic environments, biological conditions; productivity of lotic environments.

Unit 2: Introduction to Oceanography: (5hrs) Classification; zonation in oceans; Ocean Waves: definition and Difference between different waves; Tsunamis, Ocean Tides: Definition; types of tides, tidal bores, tide prediction. Ocean Currents: Definitions and features; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; El-Nino. Physical properties of sea water: Salinity and chlorinity; temperature; Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolved gases in sea water

Unit 3: Aquatic environment, Flora and fauna:(4hrs) Components of aquatic systems, Aquatic productivity, nutrient cycles, energy flow, food chain. Animal associations: Symbiosis, commensalisms, parasitism. Ecological niches – lagoons, estuaries, mangroves, coral reefs, coastal wet lands, Threats to biodiversity- habitat destination, introduction of exotic species, Conservation of habitats, marine parks and sanctuaries.

Module 3: Disaster mangement in Fisheries (12hrs) (21marks)

Unit 1: Understanding Disasters in Fisheries: (4hrs) Introduction to Disasters in Fisheries: Definition and types of disasters (natural and man-made) affecting fisheries, Historical overview of major disasters in the fisheries sector. Natural Disasters: Impact of cyclones, tsunamis, and storm surges. Floods and droughts: Effects on freshwater and marine ecosystems. Climate change and its impact on fisheries. Man-Made Disasters: Oil spills, chemical contamination, and industrial pollution, Overfishing and habitat destruction, Infrastructure failures (e.g., dam breaks, aquaculture facility collapses).

Unit 2: Disaster Preparedness and Risk Mitigation: (4hrs) Risk Assessment and Vulnerability Analysis: Identifying vulnerable regions and communities, Assessing risks to marine and freshwater fisheries. Tools and methodologies for risk assessment; Disaster Preparedness, Early warning systems and communication networks, Community preparedness and awareness programs, Emergency planning and response strategies. Mitigation Strategies: Structural measures: Building resilient

infrastructure, Non-structural measures: Policy, regulation, and education, Conservation and sustainable management practices.

Unit 3: Disaster Response and Recovery: (4hrs) Emergency Response: Immediate actions and coordination during a disaster; Role of government, NGOs, and community organizations; Providing relief and support to affected fishing communities. Rehabilitation and Recovery: Assessing damage and loss, Strategies for rebuilding fisheries and aquaculture; Psychological and social support for affected communities.

Module 4: Fishery Economics: (9hrs) (14marks)

Unit 1: Introduction to fisheries economics (3hrs): Wealth, welfare and scarcity: definition- Basic economic terminologies: micro and macro-economics, positive and normative economics, environmental economics; Brief account on resource scarcity and production; significance and scope of economics with respect to fishery sector.

Unit 2:Fish marketing: (6hrs):concepts and scope, Classification of markets, Indian marketing environment; rural marketing; Demand and Supply, Fishery & aquaculture marketing system; wholesale and retailing, consumer behaviour; buying process, Demand and supply models; market regulation: price stabilization measures and policies; market integration; Problems in marketing of fish and fishery products; government interventions in fish marketing including regulations, co-operative marketing etc.; marketing of inputs.

Module 5 (12 hrs) Open Ended

Field visit to boatyard/drydock, fish landing sites for students to observe some of the common fishing vessels and their accessories; common fishery organisms etc.

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1. Cambell. (1998). An introduction to marine sciences. John Wiley & Sons.
2. Day F. (1994). The fishes of India: Vol. I &II.Jagmohan Book Agency,NewDelhi.
3. Jayaram K.C. (1981). The freshwater fishes of India, Pakistan, Bangladesh, Burma and Srilank- A Handbook – ZSI.
4. Jayaram K.C. (1991). The freshwater fishes of the Indian region, NPH, Delhi.
5. Jayaram K.C. (2002). Fundamentals of fish taxonomy, NPH, Delhi.
6. Jhingran V. G. (1975). Fish and fisheries of India. HPC, Delhi.
7. Kurian C. V. and Sebastian V.O.(1982). Prawns and prawn fisheries of Kerala. HPC, Delhi.
8. Kyle H.M.(1993). The Biology of fishes. DPH, Delhi.
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20.Lutz CG. 2003. Practical Genetics for Aquaculture. Wiley-Blackwell.
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23 Snustad DP & Simmons MJ. 1999. Principles of Genetics. 2nd Ed. John Wiley & Sons.
24 Stansfield WD. 1991. Theory and Problems of Genetics. McGraw-Hill.
25 Tave D. 1993. Genetics for Fish Hatchery Managers. 2nd Ed. Chapman & Hall.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

FISHERY SCIENCE II: FISH TAXONOMY, FISH BIOLOGY AND FISH PHYSIOLOGY

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	To provide students with a comprehensive understanding of fish taxonomy, biology, and physiology, including the classification of fish species, their anatomical and physiological adaptations to aquatic environments, and the fundamental principles governing their behavior, growth, reproduction, and metabolism.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the fundamentals of fish taxonomy, including the classification of fin fishes up to the family level, distinguishing key characteristics, and identifying common or economically important examples within each family.	R & U	F & C	Short answer, Paragraph , Essay questions
CO2	Compare and classify gross external anatomy of fishes, including the integumentary system, scales, and coloration mechanisms, as well as the types, structures, functions, and modifications of fins. Additionally, participants will gain insight into the diverse body forms and adaptations of fishes, including those found in deep-sea environments, caves, hill streams, among venomous species, and among air-breathing fishes.	R, U & An	F, C & P	Short answer, Paragraph, Essay questions
CO3	Differentiate the fundamental physiological processes in fish, including digestion, excretion, osmoregulation, circulation, and respiration, and how these processes are adapted to the aquatic environment.	R, U	F, C	Short answer, Paragraph questions
CO4	Analyze the reproductive strategies and behaviors exhibited by fish species, including the processes of sexuality, gonadal development, maturity phases, fecundity, reproductive behavior, and parental care and evaluate how these adaptations contribute to the survival and reproductive success of fish populations	An	F & C	Short answer, Paragraph questions

CO5	Identify and explain the role of endocrine glands in fish physiology, including their structure, function, and regulation of secretion, and assess how endocrine processes influence various aspects of fish reproductive physiology and behavior	R , U	F & C	Short answer, Paragraph questions
CO6	Explain the causeandeffect relationship of various types of fin structure	U, Ap	F&C	Short answer, Paragraph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Fish Taxonomy (15 hrs) (Out of 70: 20 marks)

Unit 1: Fundamentals of fish taxonomy (4hrs): Basic principles of biological classification. Hierarchical levels of classification: Kingdom, Phylum, Class, Order, Family, Genus, Species., Morphological, morphometric and meristic characteristics of finfishes of taxonomic significance, Study of external morphology and meristic characteristics of crustacea and mollusca; Brief overview on the general anatomy of finfishes and shell fishes, Brief account on taxonomic keys of finfishes and shell fishes.

Unit 2 Classification of fin fishes upto family (8hrs) [referring to their orders] distinguishing characters with common or economically important examples: Hemiscyllidae, Carcharhinidae, Sphyrnidae, Notopteridae, Anquillidae, Clupeidae, Chanidae, Cyprinidae, Bagridae, Siluridae, Claridae, Heteropnuestidae, Ariidae, Salmonidae, Harpodontidae, Hemiramphidae, Belonidae, Aplocheilidae, Poecilidae, Syngnathidae, Platycephalidae, Ambassidae, Carangidae, Teraponidae, Leiognathidae, Gerreidae, Nandidae, Cichlidae, Mugilidae, Trichiuridae, Channidae, Cyanoglossidae and Tetraodontidae.

Unit 3: Modern Taxonomic Tools: (3hrs) Taxonomic keys: Types; Dichotomous keys: Structure and use, Steps in constructing a dichotomous key., Criteria for selecting distinguishing characteristics, Use of morphological, anatomical, and genetic traits, polyclave (multiple-access) keys, Interactive and digital taxonomic keys; Molecular taxonomy: DNA barcoding and genetic markers.Morphometrics and meristics: Quantitative analysis of form and structure. Bioinformatics tools and databases: FishBase;Barcoding in Fish taxonomy (brief account only)

Module 2: Functional Morphology of Fishes (13hrs) (21marks)

Unit 1 The Gross external anatomy of fishes (3hrs) -Integument-Exoskeleton: Skin- structure and function, scales- types of scales; Colouration- types Chromatophores and its biological significance.

Unit 2: **Types, Structure, function and modification of fins: (3hrs)** Overview of different fin types: Paired Fins: Pectoral and Pelvic fins, Unpaired Fins: Dorsal, Caudal, and Anal fins, Special Fins: Adipose fin, Finlets; Anatomy of Fin Structures: Fin rays and spines, Soft rays and hard spines, Basal and radial pterygiophores; Differences in fin structure among various fish species; Role of fins in swimming, Role in stability, maneuvering and steering, fin modifications in different fish species, Adaptations of fins for different habitats; Specialized Fins: Lure fins, gliding fins, and walking fins.

Unit 3: Body form diversity (3hrs): Brief account on the evolution of Super class Pisces; Importance of studying fish morphology; Body Forms and Adaptations: Fusiform; Compressed; Depressed; Elongate; Globiform ; Unique forms; Locomotion and swimming styles; Habitat-specific adaptations in deep-sea fishes and coral reef fishes (Brief account only); Role of natural selection in shaping fish body forms; Adaptive radiation in fishes

Unit 4 Adaptation of Fishes (4 hrs): Anatomical Adaptations: Body shapes: streamlined bodies, flattened bodies, feeding adaptations: Mouth and teeth adaptations in surface feeders, bottom feeders and predators; Respiratory adaptations; Sensory adaptations: lateral line system, electroreception, enhanced vision. Physiological Adaptations: Osmoregulation, Thermoregulation, Buoyancy regulation, Metabolic adaptations. Behavioral Adaptations: Migration patterns (anadromous and catadromous species), Territoriality and breeding behaviors, Feeding strategies and predator avoidance Adaptations in Deep-sea fishes and Coral reef fishes, Cave dwelling fishes, Hill stream fishes, Venomous fishes, Air breathing fishes (Brief Account)

Module 3: Fish Physiology (12Hrs) (15 marks)

Unit 1 Digestive physiology (3 hrs) Basic anatomy of digestive system of a cartilaginous and a bony fish, Food and feeding, Feeding behavior, Feeding mechanism, Digestive enzymes, Absorption.

Unit 2Excretory and Osmoregulatory physiology (3 hrs) Excretory organs, structure and function; Osmoregulation in marine, brackish water and fresh water fishes

Unit 3 Circulatory and respiratory physiology (3 hrs) Heart, Blood, blood cells, blood pigments and functions of blood, Circulation; Gills and Accessory respiratory organs, Gas transport

Unit 4 Reproductive Physiology and Endocrinology: Reproduction in fishes (3hrs): Sexuality, Gonads, Phases of Maturity, Gonadosomatic index, Fecundity; Reproductive Behaviour, Oviparity, Ovoviviparity, Sexual dimorphism, courtship, parental care, nest building; **Endocrine physiology:** Endocrine glands- structure and function, Regulation of endocrine secretion.

Module 4: Fish Cytogenetics (8hrs) (14 marks)

Unit 1: Fish Cytogenetics (5hrs): Cytogenetics and Evolution, Karyotyping and banding. Genetic basis of sex determination in fishes. Chromosome manipulation in fishes: Ploidy induction, sex reversal, gynogenesis and androgenesis; Genes, Genetic crossings, phenotype, genotype. Inheritance of external characters in fishes. Transgenesis in fishes; Development of super male tilapia; Genetically Improved Farmed Tilapia (GIFT).

Unit 2: Application of Genetics (3hrs): Application of genetics for fish resource conservation, preservation of gametes; Fish as genetic model; Bioinformatics in fish genetics and breeding.

Module 5: (12 hrs) Open Ended

Teacher can organize student activites like seminars, assignments, etc., related to module 4

References

1. Bone Q., Marshall N. B. and Boxter J.H.S. (1996). Biology of fishes. Chapman and Hart, London.
2. Cambell. (1998). An introduction to marine sciences. John Wiley & Sons.
3. Day F. (1994). The fishes of India: Vol. I & II.Jagmohan Book Agency,NewDelhi.
4. Jayaram K.C. (1981). The freshwater fishes of India, Pakistan, Bangladesh, Burma and Srilanka-A Handbook – ZSI.
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16. Kamaleswar Pandey and Sukla J. P. (2005). Fish and Fisheries. Rastogi Publications, Meerut.
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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2			3				3						
CO 3		3					3						
CO 4			3				3						
CO 5	2	3					3						
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓			✓
CO6	✓			✓

HUMAN GENETICS I: INTRODUCTION TO HUMAN GENETICS

Programme	B.Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://onlinecourses.swayam2.ac.in/cec24_bt12 (4 Credit) 2. https://onlinecourses.swayam2.ac.in/cec24_bt07 (4 Credit) 3. https://onlinecourses.nptel.ac.in/noc21_bt02 (1 credit)				
Course objectives	The course is aimed to impart knowledge in basic ideas in human genetics, like chromosome structure and abnormalities, andother disorders, and genetic aspects of Reproduction and development.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyze chromosomal abnormalities linking genetic variations to clinical outcomes.	An	F&C	Short answer, Paragraph, Essay questions
CO2	Explain human chromosome classification and nondisjunction events with diagnostic skills in cytogenetics.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Comprehend autosomal disorders and X-linked disorders including genetic control of diseases.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe the basic genetics of reproduction, development and multifactorial inheritance	U	F&C	Short answer, Paragraph questions
CO5	Describe the effects of consanguineous marriages and conduct surveys on it	U, C	C &P	Short answer, Paragraph questions, report writing
CO6	Conduct seminars, surveys etc, and prepare reports	Ap	C&P	Report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1. Human chromosomes (7 hrs) (Out of 70: 13 marks)

Unit 1: History of human genetics (3 hrs): Mention the three great milestones in genetics (1. The rules of inheritance by Mendel; 2. The structure of DNA by Watson and Crick and 3. The human genome project). Applications of Genetics to human endeavors.

Unit 2: Classification and nomenclature of Human Chromosomes (4 hrs): History of classification and nomenclature of human chromosomes – various conferences and their contributions: Denver, Chicago, Paris and Stockholm Conferences. Characteristics of A to G groups of chromosomes.

Module II: Chromosome Abnormalities and Clinical Phenotypes (14 hrs) (21 marks)
Unit 1: Abnormalities of Chromosome Number (7 hrs): Polyploidy (triploidy and tetraploidy) and aneuploidy (monosomy, trisomy & tetrasomy). Factors causing aneuploidy-Non-disjunction of Chromosomes (Meiotic non-disjunction, mitotic non-disjunction, non-disjunction of autosomes, non-disjunction of sex chromosomes and mosaicism). Autosomal aneuploid syndromes- trisomy 21, trisomy 18, trisomy 13. Sex chromosome aneuploid syndromes- Turner, Klinefelter, Triple X, XYY and X - inactivation.
Unit 2: Abnormalities of Chromosome Structure (7 Hrs): Duplication, deletion, translocation, reciprocal translocation, Robertsonian translocation, microdeletion, inversion and insertion. Ring chromosome, isochromosome, Philadelphia chromosome, Cri-du-chat syndrome (5p-syndrome) Prader willi syndrome, Fragile X- Syndrome (Martin Bell syndrome) and Burkitt's lymphoma (14q+ syndrome).

Module III: Dominant and Recessive Genetic disorders (14 hrs) (21 marks)
Unit 1: **Autosomal dominant disorders (6 hrs):** Familial hyper cholesterolemia, metabolic and genetic control of cholesterol, Huntington's disease, Marfan's syndrome (Arachnodactyly), Acondroplasia, Neurofibromatosis and Ehlers-Danlos Syndrome (Rubber man or the Elastic Woman).
Unit 2: **Autosomal recessive disorders (2 hrs)**
Cystic fibrosis - CF gene and protein, Detection of CF homozygotes and carriers, hereditary microcephaly.
Unit 3: **X-linked dominant and recessive disorders (2 hrs)**
Duchenne muscular dystrophy, identification of the DMD gene, carriers and hemizygotes, X–SCID.
Unit 4: Multifactorial Inheritance (2 hrs)
Congenital heart diseases (ASD and VSD), Alzheimer's disease, Schizophrenia, Intelligence
Unit 5: Human Pedigree (2 hrs)
Gathering family history, Symbols of Pedigree, construction of pedigrees, Pedigrees of Sex-linked and Autosomal (dominant and recessive), X-linked dominant and recessive gene mutation disorders. Presentation of molecular genetic data in pedigrees.

Module IV: Genetics of Reproduction and Development (13 hrs) (15 marks)
Unit I: Prenatal development (9hrs): genes and hormones. Errors in sexual development: Defects of androgen target cells-deficiency of 5-alpha reductase, congenital adrenal hyperplasia (CAH) and sex reversal. Maternal effect genes, Segmentation and pattern formation genes, Adhesion molecules and genes, Genomic imprinting, Inbreeding in isolates. Consanguinous marriages, twin studies, biology of twinning, analysis of twin data.
Unit II: Epigenetics(4hrs) Definition; Molecular Processes leading to Epigenetic changes-DNA methylation, Histone modifications, Epigenetic effects of RNA molecules; Epigenetic processes affecting development-Epigenetic changes associated with cell differentiation, Transgenerational effect through paramutation, X inactivation; Behavioural Epigenetics; Epigenetic effects of environmental chemicals).

MODULE V: Open ended (12hrs)
Teachers should design student activities related to Module III, like seminars, assignments, and conduct surveys on genetic disorders etc.

REFERENCES

Emery, A.E.H. and Rimoin, D.L. Principles and Practices of Medical Genetics Vol I, II & III. Churchill Livingstone.
Andrew P. Read and Tom Strachan (2003): Human Molecular Genetics, Third Edition; ISBN-10: 0815341822, Garland Science, 696 pages
Anne Gardner, Rodney T. Howell and Teresa Davies (2000): Human Genetics; ISBN-0340763744, Arnold, London, 206 pages
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Bruce R. Korf and Mira B. Irons (2012): Human Genetics and Genomics;4th Edition,ASIN: B00B9L1JHM, Wiley-Blackwell, 280 pages
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Julia E. Richards and R. Scott Hawley (2004): Human Genome: A User's Guide; ASIN: B002B54ISW, ELSEVIER
Max Levitan and Ashley Montagu (1998): Text Book of Human Genetics 3rd Edition; ISBN-10: 0195049357, Oxford University Press
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Ricki. Lewis (2010): Human Genetics: The Basics; 1St Edition, ISBN-10: 415579864, Routledge, 200 pages
Ricki. Lewis (2017): Human Genetics: Concepts and Applications: 12th Edition, ISBN- 10: 1259700933, Mc Graw Hill Education
Robert Nussbaum, Roderick McInnes and Huntington Willard (2015) Genetics in Medicine ,8thEdition, ISBN: 9781437706963,, Elsevier, 560 pages.
Snustad and Simmons (2012). Principles of Genetics, 6th Edition, John Wiley and Sons.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5		2			3				3				
CO6		2				3	3			3			

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓	✓		✓

HUMAN GENETICS II: HUMAN CYTOGENETICS

Programme	B.Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://onlinecourses.swayam2.ac.in/cec24_bt12(3 credit) 2. https://onlinecourses.swayam2.ac.in/cec24_bt07(2 credit) 3. https://onlinecourses.nptel.ac.in/noc21_bt02(2 credit)				
Course objectives	The course aims to develop understanding on chromosome banding techniques, cell cycle, apoptosis, genetic basis of cancer, and various cytogenetic techniques.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand different chromosome banding techniques	U	F&C	Short answer, Paragraph , questions
CO2	Describe different stages of cell cycle, its regulation.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain apoptosis and its significance, genetic basis of cancer and various genes involved.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Explain various cytogenetic techniques like FISH, CGH, CMA, MLPA.	U	F&C	Short answer, Paragraph questions
CO5	Analyze the principle and procedure of DNA finger printing.	An	C	Short answer, Paragraph questions
CO6	Describe the principle and mechanism of chromosome mapping.	U	F&C	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Preparation of Chromosomes (12hrs) (Out of 70: 15 marks)
Unit 1: Cell culture (4 hrs): Sterilizing techniques, Growth media, Variables affecting cell growth, Contamination in tissue culture and Preservation of cells.
Unit 2: Sample Collection and Handling (3 hrs): Peripheral blood, Bone marrow, Amniotic fluid and Solid tissues. Culture initiation. Harvesting, Hypotonic treatment and Slide preparation.
Unit 3: Chromosome staining and banding (3 hrs): Various staining and banding techniques - G-banding, Q-banding, R-banding, C-banding, Y-banding, NOR banding.
Unit 4: Karyotyping (2 hrs): Ideogram, Metaphase spread, Counting of chromosomes.

Module II: Cell Cycle and Apoptosis (12hrs) (20 marks)
Unit 1: Cell Cycle and its regulation (8 hrs): Over view of eukaryotic cell cycle- Four phases (G_1, S, G_2 and M). Mention G_0 Phase. Cell cycle control system- Role of Cyclins and Cyclin dependent

kinases; Cell Cycle check points and its molecular basis. Genetic regulation of cell cycle in *Saccharomyces cerevisiae*.
Unit 2: Apoptosis (4 hrs): Definition, Characteristic features of an apoptotic cell, Pathways- Intrinsic and extrinsic, Role of Caspases, Genes involved in apoptosis, Significance of Apoptosis.

Module III: Cancer Cytogenetics (12hrs) (20 marks)
Unit 1: Introduction (2 hrs): Cancer- definition, Characteristics of cancer cells, genetic predisposition of cancer, Types of Cancer.
Unit 2: Genes and Cancer (5 hrs): Proto-oncogenes, Oncogenes, Tumor suppressor gene, anti- apoptotic genes, pro- apoptotic genes and DNA repair genes. Activation of proto-oncogenes. Role of p53 gene as guardian of genome. bcr-abl gene fusion, PML- RARA gene fusion.
Unit 3: Metastasis and Tumour Angiogenesis (4 hrs): Different events in metastasis. Significance of tumour angiogenesis. Difference between normal and tumour blood vessels.
Unit 4: Telomeres and Telomerases (1hr): Introduction and function of telomeres and Telomerases.

Module IV: Molecular Cytogenetics (12Hrs) (15 marks)
Unit 1: Gene sequencing Probes (10 hrs): Preparation and classification, in-situ hybridization, FISH, mFISH, fiber FISH, Principle and application of FISH. Principle and applications of Multiplex ligation-dependent probe amplification (MLPA), Comparative genomic hybridization (CGH), Cytogenomic microarray (CMA); Marker chromosomes; Human artificial chromosomes SKY, Micro array, Microchips, Comet assay.
Unit 2: DNA finger printing (2 hrs): Principle, procedure and applications

Module V: Open Ended ((12hrs):
Teacher can develop the topics related to Module I, and introduce Chromosome mapping to students. (Hints: Physical mapping, gene mapping, linkage analysis, recombination frequencies, LOD score, linkage equilibrium, linkage disequilibrium)

REFERENCES
Emery, A.E.H. and Rimoin, D.L. Principles and Practices of Medical Genetics Vol I, II & III. Churchill Livingstone.
Andrew P. Read and Tom Strachan (2003): Human Molecular Genetics, Third Edition; ISBN-10: 0815341822, Garland Science, 696 pages
Anne Gardner, Rodney T. Howell and Teresa Davies (2000): Human Genetics; ISBN-0340763744, Arnold, London, 206 pages
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10: 0195049357, Oxford University Press
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CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5		3					3						
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5	✓	✓		✓
CO6	✓			✓

WILDLIFE BIOLOGY I : BIODIVERSITY & BIOTA

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop an understanding in various aspects of biodiversity, ecological roles of insects and other invertebrates, their diversity in Kerala, Major groups of fishes and crocodilians in India, threats and conservation efforts of fish diversity, endemic amphibians and lizards of Western Ghats and poisonous and non-poisonous snakes of India				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various biodiversity indices, concepts like species richness, abundance, variation of biodiversity according to climatic zones, Major biodiversity areas of India,	U	F&C	Short answer, Paragraph questions
CO2	Explain the ecological role of invertebrates, describe the diversity of nematodes, annelids, molluscs, insects, forest tree pests, pollinators and predators, control of forest pests etc.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the major fish groups of India, endangered and endemic amphibians of Western Ghats, and their threats and conservation efforts.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Explain the diversity of turtles, tortoises and crocodilians of India, endemic lizards of Western Ghats, and their threats and conservation efforts.	U	F&C	Quizes, Short answer, Paragraph questions
CO5	Make floral, insect and soil fauna diversity register of the locality, explain the major plant families found in the Indian forests.	Ap, C	C&P	Quizes, assignments, report writing, Viva - voce
CO6	Describe the importance of biodiversity, need to conserve it,	U	F&C	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Biodiversity (7hrs) (Out of 70: 20 marks)

Unit 1. Introduction (2hrs): Definition, Kinds of biodiversity; α, β, γ; species richness, species abundance; biodiversity as natural resource

Unit 2. Climatic Zones and Biodiversity(5hrs): Vegetational Zones, Zones of faunal distribution, Major Biodiversity areas of the world, Mention the global biodiversity hotspots, Hot spots in India.

Module 2: Invertebrates and Entomology(16hrs) (15marks)
Unit 1. Ecological roles of invertebrates(6hrs): Invertebrates of of Kerala- Nematodes, annelids, Molluscs.
Unit 2. Introduction to Entomology (10hrs): Insects as indicator for biodiversity monitoring, insect plant interaction; Harmful Insects and their role in forest economy: Insect pests of important trees of India -Teak, Sal and Bamboo; Beneficial Insects and their role in forest economy: Scavenger insects dung beetles; Pollinators, Predatory insects, and parasitic insects on insect pests; control of forest insects.

Module 3: Ichthyology &Batrachology (12hrs) (20 marks)
Unit 1. Ichthyology (6hrs): Major groups of fishes in India. Threats and conservation perspectives of fish biodiversity in India, Endangered and Endemic Fishes of Western Ghats (Brief account with threat their survival).
Unit 2. Batrachology (6hrs): Classification of amphibians; Endangered and Endemic Amphibians of Western Ghats (Brief account of their threat and survival.

Module IV: Herpetology(12hrs) (15 marks)
Unit 1. Reptiles of India (6hrs): Turtles and Tortoises of India; Crocodilians of India, endemic lizards of Western Ghats, An Overview of conservation problems and issues of herpeto-fauna of Indian subcontinent.
Unit 2. Snakes (6hrs): Poisonous and non-poisonous snakes of India. Endangered and Endemic snakes of Western Ghats.

Module V: Open ended (13hrs)
Teacher can design a module on classification, distribution and characteristics of major plant families with emphasis on forest plants.

References
1. Aaron, N.M. (1973): Wildlife ecology. W.H. Freeman Co. San Francisco, USA.
2. Alfred, J.R.S., Das, A.K. and Sanyal, A. K. (1998): Faunal diversity in India, ZSI Calcutta
3. Bird life International Red Data Book for Asia (1995), SACON, Coimbatore.
4. Daneil, J.C.(2002). The book of Indian Reptiles and Amphibians, Oxford publ.
5. Grzimek‟s Animal life Encyclopedia (1972): Vol. 1-13, Van Nostrand Reinhold Company
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7. IUCN, WRI and UNEP (1992): Global biodiversity Strategy.
8. Kratiger, A. F. *et al.*(1993) - Global Biodiversity strategy
9. Mc Neely, J. A. *et al.*, (1990): Conserving the world‟s biological diversity, IUCN. Gland
10. Negi, S.S. (1993). Biodiversity and its conservation in India. Indus Publishing Co., New Delhi.
11. Prater, S.H.(1939). The Book of Indian Animals. BNHS/Oxford Uniersity Press.
12. Salim Ali (2002). The book of Indian Birds, revised edn. BNHS & Oxford University Press, New Delhi.
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14. Sharma, B.D. (1999). Indian wildlife resources: Ecology and development. Daya publishing House, Delhi.
15. Singh, Samar (1987): Conserving India‟s Natural Heritage. Nataraj Pulblication.
16. Sukumar, R. (1989): Asian Elephant. Cambridge University Press.
17. Trothy, J.B. Boyle and Boontawee.(1995). Measuring and monitoring Biodiversity in Tropical and

Temperate Forest. Centre for International forestry Research, Bogor, Indonesia.

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		✓
CO6	✓			✓

WILDLIFE BIOLOGY II : ORNITHOLOGY & MAMMALOGY

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	Develops understanding in habitat ecology, feeding, nesting territorial behaviours of birds, their reproduction, migration etc.; Classification, biology and conservation status of mammals				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the various aspects of habitat and feeding ecology of Indian birds, their territoriality, defensive and nesting behaviour etc.	U	F&C	Short answer, Paragraph questions
CO2	Describe and analyse the reproductive and migratory behaviour of birds. Their economic values, threats and endemism in birds of India.	U & An	F&M	Short answer, Paragraph, essay type questions
CO3	Describe the classification schemes of Indian Mammals, territorial behaviour and communication patterns of mammals	U	F&C	Short answer, Paragraph, questions
CO4	Describe the detailed biology and conservation strategies of major mammals of India.	U	F&C	Short answer, Paragraph, questions
CO5	Prepare reports biodiversity on social behaviour of animals and birds of the locality	U &An	C&M	Assignment, Report submission
CO6	Prepare reports on the habitat quality parameters	C&Ap	C&M	Short answer, Paragraph, essay type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: General information on Birds(14hrs) (Out of 70: 20 marks)

Unit 1. Habitat ecology of Indian birds (8hrs) water birds, Birds of high altitude and deserts, forest and non-forest birds. Distribution of birds in India. Feeding ecology- Insectivores, Frugivores, Nectarivores, Graminivores, Carnivores and Scavengers.

Unit 2. Territoriality(6hrs); functions and types of territorialities, sizes and shapes of territory, Defense and site fidelity. Songs and calls; Functions of voice, birds vocabularies, nature of song, non vocal songs. Nesting; Functions, choice of nest sites, colonial nesting, forms of nests, nest materials and nest building and multiple nests.

Module II: Reproduction & Migration (13hrs) (20marks)
Unit 1. Reproduction(6hrs); Breeding seasons, Factors influencing breeding seasons, seasonal reproductive cycles, photo periodism, courtship and pair selection, pair bond, sexual dimorphism, mating systems, polyandry, polygyny, promiscuity, co-operative breeding, brood parasites. Egg laying- Timing of egg laying, clutch size, incubation patterns, hatching. Parental care- Feeding, nest sanitation.
Unit 2. Bird Migration(3hrs): Factors influencing migration, Bird Navigation, significance of Bird migration.
Unit 3. Economic values of birds(1hr): beneficial and harmful role
Unit 4. Major threats to bird populations (3hrs): Threatened, endangered and extinct birds (Indian Scenario), Endemic Indian birds and important endemic bird areas.

Module III: General aspects on Mammals (9hrs) (15 marks)
Unit 1. Classification of Indian mammals (2hrs): based on Skin and its derivatives; Diet and feeding behavior.
Unit 2. Territories and communication (3hrs): Territorial marking, Importance of territorial behaviour; Communication patterns among mammals.
Unit 3. Endemic mammals of Western Ghat(4hrs): Nilgiri tahr, Lion tailrd Macaque, Nilgiri langur, Nilgiri marten

Module IV: Biology, distribution, feeding and breeding habits, population status, major threats to their survival and conservation of the following animals (Any one from each group) (12hrs) (15 marks)
Unit 1. Monkeys (2hrs): Bonnet Macaques, Lion tailed Macaques, Nilgiri Langur,
Unit 2. Carnivores (2hrs): Tiger, Lion, Leopard, Indian Wild dog,
Unit 3. Grazing animals (2hrs): Sambar, One Horned Rhinoceros,
Unit 4. Small mammals (2hrs): Indian Pangolin, Hedgehog, Porcupine,
Unit 5. Volant mammals (2hrs): Grizzled giant squirrel, Indian flying fox,
Unit 6. Aquatic mammals (2hrs): Gangetic dolphin, sperm whale

Module V: Open ended (12hrs)
Teacher can design a module on sociobiology and conservation status of mammals with special emphasis on Western Ghats, Prepare a registry of birds of selected locality.

References
1. Aaron, N.M. (1973): Wildlife ecology. W.H. Freeman Co. San Francisco, USA.
2. Alfred, J.R.S., Das, A.K. and Sanyal, A. K. (1998): Faunal diversity in India, ZSI Calcutta
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15. Singh, Samar (1987): Conserving India's Natural Heritage. Nataraj Publication.
16. Sukumar, R. (1989): Asian Elephant. Cambridge University Press.
17. Trothy, J.B. Boyle and Boontawee. (1995). Measuring and monitoring Biodiversity in Tropical and Temperate Forest. Centre for International forestry Research, Bogor, Indonesia.

Online Sources

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Mapping of COs with PSOs and POs :

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CO 1		3					3						
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CO 3		3					3						
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CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

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CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

DISCIPLINE SPECIFIC CORE COURSES

FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course helps the students to comprehend the fundamental principles of chemistry that govern complex biological systems; to enable a student acquire sound knowledge of biochemistry and its practicable applicability; to make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the properties of various bio-molecules	U	F&C	Short answer, Para-graph, questions
CO2	Describe metabolic pathways of carbo-hydrates, lipids and proteins	U	F&C	Short answer, Para-graph, Essay ques-tions
CO3	Describe the microbial diversity in envi-ronment, methods of microbial prepara-tion, the structure of typical bacterium.	Ap	C&P	Short answer, Para-graph questions
CO4	Understand the common useful and harmful microbes existing and their im-pacts.	U	F&C	Short answer, Para-graph, Essay ques-tions
CO5	Get exposed to various biochemical pro-cesses used in industries and gain skills in techniques of chromatography and spectroscopy, and the various techniques for handling microbes in the laboratory	U	F&C	Practical lab exams, Viva- voce, report writing
CO6	Explain biosynthesis of nucleic acids and Purine and Pyrimidine catabolism	U	F& C	Short answer, Para-graph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Biomolecules in relation to animals(14hrs) (Out of 70: 20 marks)

Unit 1: Micromolecules (2hrs): macromolecules, water, buffer systems and importance, bonds stabilizing biomolecules – covalent and non-covalent bonds – electrostatic, hydrogen, hydrophobic interaction, Vander wall`s interaction

Unit 2: Carbohydrates(3hrs) -structure, classification (monosaccharides, disaccharides, polysaccharides and Glycoconjugates) and biological importance: with emphasis on aldose, ketose, glycosidic linkage; Reducing and non-reducing sugars.

Unit 3: Structure, Classification and biological functions of lipids (3hrs) - simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins)
Unit 4: Proteins (4hrs)- Amino acids: Basic structure, Classification and General properties of amino acids; physiological importance of essential and non-essential - amino acids, classification of proteins, Structure of proteins - Primary, Secondary, tertiary and quaternary structures, Denaturation
Unit 5: Structure of purines and pyrimidines (2hrs) Nucleosides, Nucleotides, Nucleic acids, Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA, Complementarity of DNA.

Module 2. Metabolism of Biomolecules (13hrs) (20 marks)
Unit 1: Carbohydrate metabolism (7hrs)- Glycolysis, Kreb`s cycle, ETS, oxidative phosphorylation, Glycogenesis. Glycogenolysis, Gluconeogenesis, HMP Shunt Pathway
Unit 2: Lipid metabolism (2hrs)-Fatty Acid Synthesis, Fatty Acid Oxidation
Unit 3: Protein metabolism (1hrs)- Deamination, Transamination, Trans-deamination, Decarboxylation
Unit 4: Biosynthesis and degradation of Purines and Pyrimidines (3hrs): Nucleotide biosynthesis-de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanism of Purine and Pyrimidine catabolism.

Module 3: Introduction & Methods in Microbiology (10hrs) (15 marks)
Unit 1: Microbial Diversity (2hrs)- Archaebacteria, Eubacteria, Prochlorophyta, Viruses, Viroids, Prions, Mycoplasma and Rickettsias;

Unit 2: Microbial preparations (5hrs)- Sterilization: Common methods of sterilization used in laboratories: Dry and Moist Heat, Radiation, Disinfection, Sanitization, Antiseptics, and Fumigation. Preparation of culture media: General purpose, Selective, Enrichment and Differential media. Plating techniques (Pour and spread plate) and Isolation of pure colonies by quadrant streaking. Staining: Simple staining, Negative staining and Gram's staining. Culture preservation techniques: Refrigeration, Deep freezing, Freezing under liquid Nitrogen and Lyophilisation

Unit 3. Bacteria (3hrs): Structure of a typical Bacterium, Bacterial growth: Growth phases.

Module 4: Medical Microbiology (8hrs) (15 marks)
Unit 1: Normal microflora of the human body (1hr): skin, throat, gastrointestinal tract and urinogenital tract.
Unit 2: Microbial diseases (6hrs): (with reference to causative agent, symptoms, mode of transmission and treatment). a) Bacteria: anthrax, tuberculosis, typhoid, whooping cough, pneumonia, cholera, gonorrhea, and syphilis. b) Viruses: polio, chicken pox, herpes, hepatitis, rabies, dengue, AIDS and chikungunya. c) Protozoa: malaria, kala-azar and toxoplasmosis. d) Fungi: dermatomycoses and opportunistic mycoses.
Unit 3: Primary & Secondary metabolites from Microbes(1hr) – Enzymes, Antibiotics, Acids

Module 5: <u>Practicals (1 Credit, 30hrs)</u>

<u>MANDATORY EXPERIMENTS</u>

1.Detection of organic constituents, proteins and lipids only) from sample solutions
1. Carbohydrates : Detection of carbohydrate: Molisch`s Test; Detection of reducing sugar: Glucose/ Fructose [Fehling's test, Benedict's test].; Detection of non-reducing sugars: Sucrose [Hydrolysis test].; Detection of polysaccharides: Starch [Lugol's iodine test, confirmatory heating & cooling test]

2. Proteins: Detection of proteins:[Biuret test, Nitric acid test, Xanthoproteic test].
3. Gram staining for the identification of Gram-positive and Gram-negative bacteria (*Lactobacilius* and *Rhizobium)*(Major).
4. Methylene blue reduction test for assessing the quality of raw milk

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students

5. Detection of lipids: [Sudan III or IV test, Spot test].
6. Separation of amino acids (or any other compounds) from a mixture by using paper chromatography
7. Determination of concentration of unknown solutions using Photo-electric colorimeter (Demonstration).
8. Mannitol Motility Test-for microbial motility (Demonstration).
9. Preparation of culture media for bacteria (Synthetic Media, Natural Media, Simple Media, Differential Media and Selective Media).
10. Preparation of a fungal smear–Lactophenol cotton blue staining & mounting

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

BASICS OF BIOTECHNOLOGY AND IMMUNOLOGY

Programme	B.Sc. Zoology				
Type of Course	Major				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student develops an understanding in the principles, procedures and applications of genetic engineering and other biotechnological practices, different components and functioning of immune system, and its disorders.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe genetic engineering and Appreciation in various biotechnological methods and its applications	U	F&C	Short answer, Paragraph questions
CO2	Explain the methods of transfection, transgenic animals and applied aspects of molecular techniques in unique gene pattern identification	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the components and functioning of human Immune system.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe immunological disorders - Autoimmune diseases primary and secondary immunodeficiency diseases, immunology of tumor and organ transplantation	U	F&C	Short answer, Paragraph questions
CO5	Practice the procedures involved in PCR, Electrophoresis, Western blotting ELISA etc, by direct observation either laboratory demonstration/ by visiting diagnostic or biotechnological laboratories	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Describe the basis of human blood groups and histology and functioning of organs of immune system	U	F&C	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Section A: BIOTECHNOLOGY (22 hours)

MODULE 1 -INTRODUCTION, GENETIC ENGINEERING AND ITS APPLICATIONS (14 hrs) (Out of 70: 21 marks)

Unit 1. Introduction (1 hr): Concept and scope of biotechnology – Mention various branches of biotechnology

Unit 2. Genetic Engineering, Vectors and Enzymes(6hrs): Introduction to the concept of Recombinant DNA Technology: Cloning vectors (Plasmid, pBR322, Phages, Cosmids, Virus. vectors, YAC vector and Bac vector); Enzymes: Type II Restriction endonucleases, polynucleotide kinase, exonuclease, terminal transferase, reverse transcriptase and DNA ligase; Construction of Recombinant DNA: Preparation of vector and donor DNA, Joining of vector DNA with the donor DNA, Introduction of recombinant DNA into the host cell and selection of transformants (brief account).
Unit 3. Techniques in Biotechnology (2 Hrs): Polymerase Chain Reaction, Blotting techniques: (a) Southern blotting (b) Northern blotting(c)Western blotting; Mention dot blots and slot blots; DNA finger printing and DNA foot printing (Brief)
Unit 4. Animal Cell Culture (2 hrs): Cell culture media (Natural and Defined), Preparation and Sterilization, Primary cell culture, Cell Lines, Pluripotent Stem Cells, Cryopreservation of cultures. Somatic cell fusion and HAT selection of hybrid clones – production of monoclonal antibodies.
Unit 5. Transgenic Organisms and methods of Transfection (3hrs): Transfection Methods: (Chemical treatment, Electroporation, Lipofection, Microinjection, Retroviral vector method, Embryonic stem cell method and Shot Gun Method). Brief account on various transgenic animals; Fish, Pig, Sheep, Rabbit, Mice, Goat and Insects), Knock Out Mice. Human Cloning and Ethical Issues of transgenic Animals.

MODULE 2: APPLICATIONS OF BIOTECHNOLOGY AND HUMAN WELFARE (8 hrs) (14 marks)
Unit 1. Environmental Biotechnology(2hrs): Enzymes in detergents and leather industries, Heterologous protein production, Biofiltration, Bioremediation, Bioleaching, and Bioreactors.
Unit 2. Molecular markers (2hrs) : (brief account) RFLP, RAPD, VNTR, SNPs and their uses/applications agriculture, personalized medicines and in DNA Fingerprinting.
Unit 3. Biotechnology for human healthcare (4hrs): Disease diagnosis- (Cystic Fibrosis, Huntington's Disease and Sickle Cell Anemia). Recombinant DNA in Medicines and Molecular pharming (Recombinant Insulin and Human Growth Hormone). Vaccines and Therapeutic agents, Antenatal diagnosis, Reproductive cloning, Gene/stem cell therapy and therapeutic cloning (SCID), artificial skin and 3D organ printing, GM food, Organ banking, PND act, and Ethics and National Biotechnology policy of India (Protecting Human Subjects in Clinical Trials, Animal ethics, Privacy, Stem Cell Research etc).

Section B: IMMUNOLOGY (23 hours)

MODULE 3: CELLS AND ORGANS OF IMMUNE SYSTEM, ANTIGENS, IMMUNOGLOBULINS, IMMUNITY AND MHC (14 hrs) (21 marks)
Unit 1. Introduction (1 hr): Immunity: Natural and acquired, active and passive immunization, vaccines (Brief), mechanisms of innate immunity - barriers, inflammation, phagocytosis.
Unit 2. Cells and Organs of the immune system (4hrs): B- cells, T – cells, NK cells, monocytes, macrophages, neutrophils, basophils, eosinophils, mast cells, and dendritic cells (APCs). Lymphoid organs: Primary (thymus, bone marrow) and secondary (lymph nodes, spleen).
Unit 3. Antigens and Immunoglobulins (2hrs): Types, factors for immunogenecity, exogenous antigens, endogenous antigens, adjuvant, haptens, epitopes, antigen-antibody reaction - precipitation reaction and agglutination reaction.
Structure, classification and biological functions of Immunoglobulins.
Unit 4. Types of Immunity and Vaccines(3hrs): humoral and cell mediated immunity, primary and secondary response, generation of cytotoxic T- cells (CTLs), NK cell mediated cytotoxicity, ADCC and cytokines (brief). Brief account on different types of vaccines. (Whole organism vaccines. Recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines, Multivalent vaccines).
Unit 5. Major Histocompatability Complex (2 hrs)

MHC, HLA, Class I MHC, Class II MHC molecules and structure. Mention Class III MHC.
Unit 6. Techniques in Immunology (2 Hrs)
Principles and applications of Various Immuno assays, ELISA, RIA, and Flow cytometry (Brief Account)

MODULE 4: AUTOIMMUNE AND IMMUNODEFICIENCY DISEASES, TUMOR AND TRANSPLANTATION IMMUNOLOGY (9hrs) (14 marks)

Unit 1. Autoimmune diseases (2 hrs): Auto immune diseases: Systemic (SLE, multiple sclerosis and rheumatoid arthritis). Organ specific- (Hashimoto's thyroiditis, Grave's disease, Myasthenia gravis)
Unit 2. Immunodeficiency disease (3 hrs): Primary (Bruton's Disease, Di-George syndrome and SCID); Secondary (AIDS) – Clinical course of HIV – acute infection, seroconversion, window period, chronic latent phase - lymph adenopathy and crisis phase.
Unit 3. Tumor immunology (2 hrs): Malignant transformation of cells, tumor antigens, immune response to tumor antigens.
Unit 4. Transplantation Immunology (2 hr): Transplantation Antigens, Various organ transplantation and immunology of rejection (liver, Bone marrow and kidney transplantations -Brief account).

MODULE5: PRACTICALS [30 Hrs, 1 credit]

1.Preparation and demonstration of Agarose gel Electrophoresis of DNA
2. Separation of RNA from tissues
3. Quantitative estimation - OD DNA/RNA (spectroscopic method)
4. Study of any 3 transfection methods and Application (Visiting a biotech research laboratory)
5. Study of cells of immune system- Lymphocytes, NK cells, Monocytes, Macrophages, Neutrophils, Basophils, Eosinophils, Mast cells, and Dendritic cells (Slides/Photographs).
6. Histological study of spleen, thymus and lymph nodes through slides/photographs.
7.Microhaemagglutination: Ex. Identification of human blood groups (A B O and Rh).
8. Differential Leukocyte count
9. ELISA (methodology of detection of biomolecules using flowcharts/diagrams/by visiting a diagnostic Lab)
10.Study of the principle and applications. PCR and Southern blotting (Demonstration//by visiting a diagnostic Lab)
Teacher Designed experiments

11. One experiment related to Biotechnology other than the listed should be designed by the Faculty and introduced/demonstrated to the students (Eg. DNA /RNA/Plasmid extraction, DNA separation on Agarose gel, Transformation of bacteria etc.

12. One experiment related to Immunology other than the listed should be designed by the Faculty and introduced/demonstrated to the students (Eg. Phagocytosis on cavity slides, ELISA, Immuno electrophoresis etc).

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ONLINE SOURCES

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGYAND REPRODUCTIVE BIOLOGY

Programme	B. Sc. Zoology				
Type of Course	Major				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student develops insights to the organization and functioning of reproductive and endocrine systems in humans and better understanding of human development with necessary comparison with other animal groups wherever it needed.				

Course outcome (CO)

	CO statement	**Cognitive Level***	**Knowledge Category#**	**Evaluation Tools used**
CO1	Describe basic concepts like classification of hormones, major endocrine glands in human body and their secretions; neuro-endocrinology and mechanism of hormonal action at cellular and molecular level.	R & U	F & C	Short answer, Paragraph Essay questions
CO2	Explain basic embryological concepts like theories of development, eggs, cleavage and germ layers, compare development of various chordate groups from fertilization to formation of germ layers	R, U & An	F, C & P	Short answer, Paragraph, Essay questions
CO3	Describe parthenogenesis, analyze different experiments to understand various phenomena during embryo development, survey of different teratogenic agents that disrupt development	R, U & An	F, C & P	Short answer, Paragraph questions
CO4	Describe the basic concepts in reproductive biology, discuss the events in human reproduction from structure of organs to parturition & lactation, summarize technologies for infertility management and prenatal diagnosis	U	F & C	Short answer, Paragraph questions

CO5	Collect information and prepare notes on various human hormones, role of hormones in animal development, comparison and categorization of eggs of various animal groups, different teratogens and their effects and comparison of different fertility control methods	U, Ap, An & E	F, C & M	Assignment, seminar, Viva - voce
CO6	Describe various fertility control methods, and compare their merits and demerits	U	F&C	Short answer, Paragraph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

SECTION-A: ENDOCRINOLOGY (12 hours)

Module 1. Introduction, Neuro-endocrinology and Hormonal action (12 hours) (Out of 70: 18 marks)

Unit 1- Introduction (6 hours) : Definition & Classification of hormones: based on chemical nature- Amine, peptide and steroid hormones; prostaglandins as fatty acid derivatives with hormone like action (mention only); Endocrine, paracrine and autocrine modes of hormone delivery; Feedback mechanism.

Endocrine glands in man- central and peripheral (hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenal, thymus, pineal and gastro-intestinal): their structure, hormones and functions (brief account), Hormonal disorders.

Hormones of reproduction: Testes, ovaries and placenta- their hormones and physiological effects; role of hormones in female sexual cycle; hormone related female and male sexual dysfunctions.

Endocrinology of non-chordates and lower chordates- role of hormones in crustacean, insect and amphibian development (short account)

Unit 2- Neuro-endocrinology and Hormonal action (6 hours): Hypothalamo-hypophysial interactions- Hypothalamo-hypophysial axis, Hypothalamo-hypophysial portal system; hypothalamus releasing and inhibiting hormones and their roles, Neuro-hormonal integration, Neuro-endocrine pathways, Regulation of neuro-endocrine glands and their secretions, feedback mechanisms.

Hormonal action at cellular level: Hormone receptors; Mechanism of action of amine, peptide and steroid hormones- transduction and regulation at molecular level, molecular mediators; mode of action of insulin and thyroxine; positive and negative feedback regulation; genetic control

SECTION-B: DEVELOPMENTAL BIOLOGY (24 hours)

Module 2. Introduction and comparative chordate embryology (15 hours) (21 marks)

Unit 1- Introduction (4 hours)

Historical Perspective (brief account); Phases in development (mention only). Theories: preformation, epigenesis, recapitulation and germplasm theory (short account).

Types of eggs: Classification with examples based on- Amount of yolk (micro, meso & macrolecithal); Distribution of yolk (iso, centro and telolecithal); Presence or absence of shell (cleidoic & non cleidoic); Types of development (determinate and indeterminate) (short account for all); Egg membranes: primary, secondary and tertiary; functions of egg envelopes (brief account only).

Cleavage and cell lineage- Types of cleavage with examples based on: Plane of cleavage (Meridional, Vertical, Equatorial & Latitudinal); Amount of yolk (Holoblastic & Meroblastic); Types of development (Determinate & Indeterminate); Pattern of arrangement of blastomeres (Radial and Spiral).

Germ layers and derivatives; Cell lineage studies in Planocera (brief account only); Different types of blastula.

Unit 2- Comparative chordate embryology (11 hours)

Development of amphioxus, frog, chick and human: Early development of amphioxus- fertilization, cleavage, blastulation, gastrulation and neurulation; Development of frog- fertilization, cleavage, blastulation and fate map, gastrulation (morphogenetic movements- mention only) and formation of germ layers, neurulation and notochord formation, mesoderm and coelom formation; organogeny of brain and eye; Development of chick- structure of egg, fertilization, cleavage, blastulation, gastrulation and formation of germ layers, salient features of chick embryo at primitive streak stage, 24, 33 and 48 hours, development and functions of extra embryonic membranes; Development of man- cleavage and formation of morula, development of blastocyst, implantation, gastrulation up to the formation of germ layers, human placenta and its functions (brief account only for each category)

Module 3. Parthenogenesis, experimental embryology and teratology (9 hours) (14 marks)

Unit 1- Parthenogenesis (2 hours)

Definition and types- natural parthenogenesis: arrhenotoky, thelytoky, obligatory and facultative; artificial parthenogenesis; significance of parthenogenesis

Unit 2- Experimental embryology & Teratology (7 hours)

Experimental embryology- Construction of fate map, vital staining, marking with carbon particles and radioactive tracing; Spemann's constriction experiments on amphibian embryos, potency of nuclei and importance of grey crescent; organizers in amphibian development (primary, secondary & tertiary organizers); embryonic induction; gradient experiments in sea urchin eggs; cloning experiments in sheep.

Teratology- Environmental disruption in animal development: Teratogenic agents and their effects (alcohol, drugs, nicotine and other chemicals), infections (Herpes virus, Cytomegalovirus and Rubella virus), metabolic imbalance (malnutrition and autoimmunization) (brief account).

SECTION- C: REPRODUCTIVE BIOLOGY (12 hours)

Module 4. Introduction, Human reproduction & reproductive technologies (12 hours) (17 marks)

Unit 1- Introduction (1 hour)

Importance and scope; Reproductive strategies in invertebrates and vertebrates- semelparity and iteroparity; Sex patterns; Mention sex reversal with examples.

Unit 2- Human reproduction (5 hours)

Human reproductive system: Male reproductive system- structure of testis, semen production and composition; Female reproductive system- structure of ovary and graffian follicle, ovulation, mention corpus haemorrhagicum, corpus luteum & corpus albicans; Accessory reproductive organs; Gametogenesis- spermatogenesis and oogenesis; Secondary sexual characteristics; Menstrual cycle (brief account of oestrous cycle in mammals) and its hormonal control (mention only);Fertilization- Fertilizin and anti-fertilizin, capacitation, agglutination, sperm penetration, activation of egg and amphimixis, Physiological and biochemical changes during and after fertilization; Pregnancy; Gestation; Placentation; parturition and lactation (mention hormonal role)

Unit 3- Reproductive technologies (6 hours)

Infertility and its management: Semen collection, preservation & storage (brief account), artificial insemination, surrogacy; Cryopreservation & embryo transfer- Collection, care & preservation of embryos; In vitro fertilization and embryo transfer- major steps; Test tube babies;

Assisted Reproductive Techniques- GIFT, ZIFT, ICSI, oocyte donation & embryo donation.

Prenatal diagnosis: Different Prenatal Diagnostic techniques (invasive and non-invasive); Prevention of Female foeticide - ethical issues and laws (Mention–PNDT Act).

Fertility control: Natural methods, artificial methods, chemical methods, hormonal methods, surgical contraception, removal of gonads and uterus; abortion (brief account)

Module 5. Open ended (12 hours)

Teacher can design student activities like assignments, seminars, poster making and presentations, discussions related to the following topics in above modules- survey of various hormones in humans for their structure, source and functions, hormonal control of insect and amphibian metamorphosis, comparison of eggs of various animal groups and categorization of eggs with examples based on different criteria like amount and distribution of yolk, shell, development, etc., survey different teratogenic agents and their effects on development, compare different fertility control methods for their pros and cons

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- Sastry K. V. & Vineetha Shukla (2018): Developmental Biology,2nd Revised Edition, ISBN: 9789350781289372, Rastogi, 372 pages
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- Wolpert, L. (1994): Principles of Development, 3rd Edition, ASIN: B008WDHBB8, Oxford University Press.
- Scott F. Gilbert (2016) Developmental Biology 11th Edition, Sinauer Associates- imprint of Oxford University Press, ISBN-10: 9781605356044, 500 pages
- Jones, R. E. and Lopez, K. H. (2013) Human Reproductive Biology (3rd edition)

- Thomas W.S. (2014) Langman's Medical Embryology (13th edition) Lippincott, Williams & Wilkins, Baltimore.
- Gary C.S.; Steven B.B.; Philip R.B. and Philippa H.F. (2014) Larsen's Human Embryology (5th edition) Elsevier.

ONLINE SOURSES

1. https://courseware.cutm.ac.in/courses/developmental-biology/
2. https://www.biologyonline.com/tutorials/developmental-biology
3. https://ocw.mit.edu/courses/7-22-developmental-biology-fall-2005/
4. https://www.endocrine.org/
5. https://ocw.mit.edu/courses/hst-071-human-reproductive-biology-fall-2005/

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	✓
CO6	✓			✓

DISCIPLINE SPECIFIC ELECTIVE COURSES

ENTOMOLOGY III: INSECT ECOLOGY

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	Equip students with a comprehensive understanding of the fundamental principles, concepts, and applications related to the ecology of insects.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the fundamental principles of insect ecology, including the historical development of the field and its significance in the natural world.	R & U	F & C	Short answer, Paragraph, essay questions
CO2	Analyze the adaptations of insects to various environmental factors, both abiotic and biotic, and explain how these adaptations influence their distribution and survival.	An	F, C & P	Short answer, Paragraph, Essay questions
CO3	Evaluate the factors affecting insect population dynamics and describe the mechanisms that regulate insect populations.	E	F, C	Short answer, Paragraph-questions
CO4	Describe the role of insects in different ecological processes, such as pollination, nutrient cycling, and decomposition.	R & U	F & C	Short answer, Paragraph questions
CO5	Critically assess the insect interactions in the field, prepare reports of field visit.	An, C	F & C	Assignment, seminar, Viva - voce
CO6	Explain the significance of insects in human health, focusing on their role as vectors of disease and the methods for controlling their spread.	U	F & C	Short answer, Paragraph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Introduction to Insect Ecology (13hrs) (Out of 70: 19marks)

Unit 1. Introduction and History of Insect Ecology (1hrs): Definition and scope of insect ecology, Historical development of insect ecology and entomology

Unit 2. Diversity and Importance of Insects (12hrs): Insect diversity and its ecological significance, The insect adaptations for different environments- hot: desert and hotsprings; icey; Toxic chemicals, salty, aquatic- freshwater, marine, marshy; darkness; parasitic mode of life, gall forming, leaf mining

Module 2: Insect-Environment Interactions (10hrs) (15 marks)

Unit 1. Abiotic Factors and Insects (2hrs): Temperature, light, moisture, and wind as ecological factors.

Unit 2: Biotic Interactions and Insects (8hrs): Interspecific interactions: competition, predation, parasitism, and mutualism- pollination, dispersal agents; Intraspecific interactions: cooperation and competition.

Module 3: Population and Community Ecology of Insects(14hrs) (20 marks)

Unit 1. Population Dynamics and Regulation (6hrs): Factors affecting insect population growth and decline: Food availability and quality, Predation and parasitism, Climate and weather, Habitat quality and availability, Disease and pathogens, Human activities; ; Population regulation mechanisms: density dependence and independence; Positive density dependence, Negative density dependence Examples: Intraspecific competition, Predation, Disease; density-independent mechanisms example: Weather events, Climate change, Habitat destruction

Unit 2: Insect Communities and Ecosystem Services (8hrs): Assembly and structure of insect communities: Species composition, Habitat characteristics, Climate and weather, Evolutionary history; Insect communities, Food webs, Guilds, Assemblages, social insects: ants, termites, bees, wasps ; Species Interactions, Ecosystem services: Ecosystem engineering, trophic cascades, pollination, nutrient cycling, and decomposition.

Module 4: Applied Insect Ecology(11hrs) (16marks)

Unit 1. Insects as pests (3hrs): Pest adaptations: Morphological, physiological behavioural ; examples: insecticide resistance, host plant adaptation, dormancy, pest- host relationships: Facultative, obligate, accidental; example; co-evolution: adaptation and counter adaptation, specialization and generalizations, evolution of special traits.

Unit2: Insects and Human Health (8hrs): Insect-borne diseases and their transmission: : Malaria, Dengue fever, Yellow fever, Zika virus, Lyme disease, Chagas disease; Strategies for vector control and disease prevention: Integrated Pest Management (IPM), Vector surveillance, Larval control, Adult control, Personal protection, Vaccination, Public awareness and education, Collaboration and coordination; New and Emerging Strategies: Genetic modification, Biological control, Wolbachia, Gene drive, Artificial intelligence and machine learning.

Module 5: Open ended (12hrs)

Teacher can design assignments and seminars and other student activites; **Field study**: A) Visit to Entomology Museum B) Field visit to observe interactions of insects in an ecosystem, and preparation of detailed field study report.

REFERENCES

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- Christopher Fleming. 2016. Insect Ecology. ISBN: 978-1682860939. Syrawood Publishing House. 215p
- Price, P. W., R. F. Denno, M. D. Eubanks, D. L. Finke, and I. Kaplan. 2011. Insect Ecology: Behavior, Populations and Communities. Cambridge University Press, Cambridge.

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- The Insects: An Introduction by P. J. Gullan and P. Cranston (6th Edition) (2014). Wiley-Blackwell.
- Insect Pest Management and Ecological Strategies by Michael A. Alonso and Terry L. Erwin (2017). Springer International Publishing.

ONLINE SOURCES

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	3					3						
CO 2					3		3						
CO 3		3					3						
CO 4		3					3						
CO 5						3	2						3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		✓
CO6	✓			✓

ENTOMOLOGY IV: INSECT PEST MANAGEMENT

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://alison.com/course/pest-control-and-management				
Course objectives	The student develops understanding in overall aspects of Insect Pest Management and can apply in situations wherever necessary.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe historical and current pest control strategies.	R & U	F & C	Short answer, Paragraph questions
CO2	Identify and explain various Biological Pest control methods.	R & U	F& C	Short answer, Paragraph, Essay questions
CO3	Explain and apply various Chemical Pest control methods.	U & Ap	F, C	Short answer, Paragraph questions
CO4	Suggest effective pest control methods for different kinds of pests	U& Ap	F & C	Short answer, Paragraph, Essay questions
CO5	Improvise pest control devices after making visits to agricultural research centers.	C	M	Assignment, seminars
CO6	Report writing on the institutional vistis	C	M	Assignment, Report writing
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

MODULE 1: Control of Insect Pests (8 Hours) (Out of 70: 11marks)

Unit 1. **Historical aspects of pest control (2hrs) :** Ancient civilizations and pest control, Medieval period and pest control, development of modern pest control.

Unit 2. Ecology based pest control (6hrs); Natural: Predation, Parasitism, Disease, climate; Applied (Artificial): Chemical, Biological; Prophylactic and Curative Methods: Cultural, Mechanical, Legal methods.

MODULE 2: Biological Control (15 Hours) (20 marks)

Unit 1. Introduction (1hrs) History of Biological control**,** Ecological basis of biological control.

Unit 2. Natural enemies(4hrs): Parasites, Parasitoids, Predators, Feasibility of biocontrol.

Unit 3. Applied biological control(4hrs): Conservation and Enhancement, Importation and Colonization, Mass culture and release.

Unit 4. Feasibility of Biological control (2hrs): Importance of systematics, Advantages and disadvantages of biological control.
Unit 5. Case Studies (4hrs): Three Major Biological Control Projects in India, Merits and Demerits of Biological Control.

MODULE 3: Chemical Control (13 Hours) (20 marks)
Unit 1. Classification of Insecticides (1hrs): Mode of Entry and Mode of Action, Chemical Nature
Unit 2. Chemical pesticides (4hrs): Mode of action and examples: Organochlorines: DDT, Aldrin and Dieldrin, Endrin, Organophosphates: Malathion, Parathion, Diazinon: Carbamates: Carbaryl, Propoxur, Aldicarb,
Unit 3. Botanical Insecticides(4hrs): Pyrethrum, Neem, Rotenone, and Nicotine.
Unit 4. General aspects of insecticides (4hrs): Insecticide Residue, Resistance, and Resurgence Pesticide Appliances. Environmental Degradation of Pesticides

MODULE 4: Advanced Pest Control Methods (12 Hours) (19 marks)
Unit 1. Autocidal Control(3hrs): Process in autocidal control, Advantages and disadvantages, Pheromonal Control. Microbial Control.
Unit 2. Insect Traps (9hrs): Types, uses, working principle, Traps for Flying Insects: Simple nets (Aerial & Sweep Nets), Flight Interception Trap (Malaise Trap), Sticky Traps, Light Trap, Beating Tray, Pan Traps. Traps for Soil Insects: Berlesse-Tullgren Funnel, Baermann Funnel, Pitfall Trap, Aspirator or Suction tube, Soil Emergence Trap.
Trapping Stored product Insects: Bait Traps (Food Attractant Traps, Pheromone Traps).
Unit 3. Integrated Pest Management (IPM)(1hr): Features and advantages.

MODULE5: Open ended (12hrs)
Visits to local farms or agricultural research centres to observe pest control methods in practice.
Preparation of insect traps using locally available materials: Sweep Net, Light Trap, Sticky Traps, Pitfall Trap, Food Attractant Trap, Report writing.

References

- B.V. David& V.V. Ramamurthy. 2016. Elements of Economic Entomology 8th Edition. Brillion Publishing. ISBN: 9780994869104, 099486910X. 400 pages.
- David Dent, Richard Binks. 2020. Insect Pest Management, 3rd Edition. ISBN 978-1789241044. CABI Publishing. 378 pages.
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- Jack E. Rechcigl, Nancy A. Rechcigl. 1999. Insect Pest Management: Techniques for Environmental Protection. ISBN: 978-0367484224.
- I.M. Khan. 2019. Insect Pest Management. ISBN. 978-9387160255. Agrotech Press.
- Ramanuj Vishwakarma & Ranjeet Kumar. 2020. Management of Insect Pests in Vegetable Crops: Concepts and Approaches (Innovations in Horticultural Science). ISBN. 978-1771888592. Apple Academic Press. 344 pages.

Online Sources

1. https://www.classcentral.com/course/youtube-agriculture-integrated-pest-management-ipm-47912
2. https://www.cabi.org/products-and-services/academy/crop-pest-management-course/
3. https://www.cabi.org/publishing-products/crop-pest-management/

4. https://www.pestfree.co.in/pest-management-certificate-course-and-training/
5. https://bpca.org.uk/online-learning

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1		3					3						
CO 2		3					3						
CO 3				3			3						
CO 4				3			3						
CO 5				2	3				3				
CO6					3								3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6		✓		

FISHERY SCIENCE III: CAPTURE AND CULTURE TECHNIQUES

Programme	B. Sc Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	To understand, evaluate, and implement sustainable practices in both capture fisheries and aquaculture operations, emphasizing the importance of responsible resource management, conservation of biodiversity, and consideration of socio-economic factors				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Evaluate the significance of fisheries in both inland and marine ecosystems, distinguishing between capture fisheries and culture fisheries, and comprehend their roles in food security, economic development, and ecological sustainability.	U &E	F&C	Short answer, Paragraph questions
CO2	Describe the various types of inland capture fisheries, including riverine fisheries, reservoir fisheries, and estuarine fisheries, characteristics and management practices of marine fisheries, including offshore and deep-sea fisheries, as well as shellfish and finfish fisheries, and understand the ecological impacts of fishing activities on marine ecosystems and the measures taken for sustainable resource utilization and assess the challenges they face such as habitat alteration, pollution, and overexploitation, along with the management strategies employed to mitigate these issues.	U	F & C	Short answer, Paragraph, Essay questions
CO3	Explain aquaculture practices, including the historical context, current status, and future prospects, along with the classification of aquaculture methods, and apply this knowledge to critically evaluate and contribute to the sustainable development of aquaculture industries.	U & Ap	F&C	Short answer, Paragraph-questions

CO4	Demonstrate proficiency in various aquaculture practices, including integrated fish farming and monoculture systems, and apply this knowledge to design and manage sustainable aquaculture operations that optimize production efficiency and environmental sustainability	Ap & C	C&M	Short answer, Paragraph Essay questions
CO5	Demonstrate comprehensive knowledge of effective management strategies in fisheries, encompassing water quality management, grow-out management techniques, and control measures for weeds, pests, and predators, and apply this knowledge to optimize production efficiency and minimize environmental impacts in aquaculture operations	Ap & C	C&M	Assignment, seminars
CO6	Prepare field study reports on the visit to fishery and aquaculture sites and present it in seminars	Ap &C	C&M	Assignment, Report writing
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Inland Capture Fisheries (12hrs) (Out of 70: 15marks)

Unit 1: Introduction to inland fisheries(2hrs): Overview on inland fisheries, Scope and significance in local and global context.

Unit 2 Riverine Fisheries (4hrs): Major riverine systems and their fishery. Problems and management of riverine fishery - problems, construction of dams, river pollution; Management - regulation of populations and exploitation.

Unit 3: Reservoir Fisheries (3hrs): Types of Reservoirs - Major, Medium and Minor. Different reservoirs of river systems in India. Status of Reservoir Fisheries in Kerala.

Unit 4: Estuarine fisheries (3hrs): Major estuaries and their fishery- Definition of an estuary. Characteristics of estuarine waters. Origin and classification. Different estuaries in India with special reference to Kerala

Module 2: Marine fisheries (11hrs) (20 marks)

Unit 1: Introduction to Marine Fisheries(2hrs): Importance of marine fisheries in global and local economies; Overview of marine ecosystems (coastal, pelagic, and deep-sea); Population structure and dynamics: Growth, recruitment, and mortality, Factors affecting fish populations

Unit 2 Environmental and Economic Impacts of Marine Fisheries(4hrs): Environmental Impacts: Overfishing and its consequences; Bycatch and discards; Habitat destruction due to fishing activities; Impact of climate change on marine ecosystems; Ocean acidification and its effects on fish populations

Unit 3: Sustainable Practices and Emerging technologies(5hrs): Sustainable Fishing Practices: Ecosystem-based fisheries management (EBFM); Marine protected areas (MPAs) and their effectiveness; Certification and eco-labeling (e.g., MSC, ASC); Technological Innovations and Data Management: Use of technology in monitoring and managing fisheries, Role of data collection and analysis in fisheries management, Emerging technologies: remote sensing, AI in fisheries.

Module 3: Overview of Culture Fisheries (14hrs) (16marks)

Unit 1 Introduction (2hrs): History of aquaculture, scope and definition, importance of

aquaculture, present status of aquaculture in India and Kerala, future prospectus, Classification of aquaculture practices.

Unit 2: Design and construction of aqua farms and hatcheries (4hrs) Pond design and construction; Farm design and layout; Pond preparation; Cage farms; Pens and enclosures; Design and construction of hatcheries.

Unit 3: Nutrition and feeds (2 hrs)-Feeding habits and food utilization; Live feeds and Artificial feeds; Transportation and acclimatization; Fertilizers and chemicals in aquaculture

Unit 4: Aquaculture practices (6Hrs)

Integrated fish farming - paddy cum fish culture, duck cum fish culture, pig cum fish culture, Polyculture, Culture of shrimps, Culture of prawns, Culture of crabs, Culture of edible oysters, pearl oysters and mussels; Culture of fresh water fishes - Indian major carps and exotic carps; Culture of coldwater fishes - trout and mahaseer; Culture of brackish water fishes - mullets, milk fish and *Etroplus*; Culture of seaweeds

Module 4: Management and Disease Control in Fisheries (11hrs) (19 marks)

Unit 1: Water quality management (3hrs) Water quality parameters; Techniques for monitoring water quality; Strategies for monitoring water quality; bioremediation and waste water treatment technologies.

Unit 2: Grow-out Management (2hr) Stocking density, Feeding regime and growth optimization strategies; genetic engineering and transgenic aquaculture.

Unit 3: Control of weeds, pests and predators in aquaculture (2hrs)

Unit 4: Fish Pathology (4hrs) Major fish diseases - viral, bacterial, fungal, Protozoan infections; Control and treatment.

Module 5 (12 hrs) Open Ended

Teacher can design student activities like seminars, assignments, and conduct field visits to fishery and aquaculture fields, and ask to prepare reports on it.

References

1. T. V. R. Pillay.(1993). Aquaculture – Principles and practices. Fishing News Books.
2. T. V. R. Pillay [Ed.].(1972). Coastal Aquaculture in the Indo Pacific Region, FAO.
3. T. V. R. Pillay and Dill W. A. [Eds.](1979). Advances in aquaculture fishing. Fishing News Books.
4. Lucky Z. (1997). Methods for the diagnosis of fish diseases. APC Pvt. Ltd., New Delhi.
5. Vita I.D. [Ed.](1993). Fresh water pond culture and management. Scientific Publishers, Jodhpur.
6. Barg U.C.,(1997). Guidelines for the promotion of environmental management of coastal aquaculture development, DPH, Delhi.
7. Biswas K.P.(1992). Prevention and control of fish and prawn diseases. NPH, Delhi.
8. Amlacher, F.(1997). Text Book of fish Diseases. NPH, Delhi.
9. Stephen Blaber.(1997). Fish and Fisheries of Tropical Estuaries. Chapman and Hall.
10. Rick Parker(2007). Aquaculture Science. Delmar-Thomson Learning.

Online Sources

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Mapping of COs with PSOs and POs :

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4					3		3						
CO 5					3		3						2
CO6						3							3

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6		✓		

FISHERY SCIENCE IV: HARVESTING AND POST HARVESTING TECHNIQUES

Programme	B. Sc. Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	To acquire a thorough understanding of the principles, methods, and best practices involved in the efficient and sustainable extraction of aquatic resources, as well as the processing, preservation, and quality control measures essential for maintaining the freshness, safety, and marketability of seafood products.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various commercial fishing methods, including the historical context and materials used for constructing nets and ropes, identify and differentiate between indigenous fishing crafts and mechanized fishing crafts in India, and analyze the different types of fishing gears utilized in both sea and inland fishing, including traditional and conventional gear.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain the chemical composition of fish muscle, including the significance of proteins and lipids and the nutritive value of fish muscle; analyze post-mortem changes such as rigor mortis and spoilage in marine and freshwater fish, and demonstrate practical knowledge of handling fresh fish through techniques [P	U	F&C	Short answer, Paragraph, questions
CO3	Describe the requirements and regulations pertaining to fish processing plants and cold storage facilities, various methods of fish processing and preservation, and skilled in the processing techniques for crustaceans, cephalopods, and fish, including pre-processing, grading, and packing procedures.	U	F&C	Short answer, Paragraph, Essay questions

CO5	Analyse the merits and demerits of present fishing, fish food processing methods, prepare reports, and suggest improved methods,	An & C	C& M	Assignments, seminars, report writing.
CO6	Describe various aspects of fisheries management, from harvesting techniques and post-harvest technologies to processing methods and quality control measures for fishery byproducts, thereby preparing them for effective and sustainable participation in the fisheries industry.	U	F&C	Short answer, Paragraph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Harvesting (11hrs) (Out of 70: 20 marks)

Unit 1: Commercial fishing method(1hr): Brief history of commercial fishing; Common fishing methods: Fishing with nets, fishing with lines, Bait fishing; Harvesting shell fishes; Introduction to materials for construction of nets and ropes.

Unit 2: Fish Landing Sites and Facilities(4hrs): Fish landing sites - beaches, harbours, lagoons, river banks and lake shores. Facilities at fish landing sites: winch, cold store, ice plant, fuel station, slipway, dry dock, jetty, break-water, etc. and their uses; Activities at fish landing sites: unloading fish from vessels, fuelling vessels, loading ice into vessels, repair and maintenance of vessels/gear; Sanitation practices at fish landing sites: proper disposal of fish entrails.

Unit 3: Crafts for harvesting(3hrs): Traditional wooden boats, Indigenous fishing crafts of India- Catamaran, Musula boat, caraval boats, Dugout canoes, Dinghi, Plank built canoes, out trigger canoes; Mechanised Indian fishing crafts and its characteristics; Trawlers; Purse seiners; Longliners

Unit 4: Gears for harvesting(3hrs): Indigenous fishing gears in India - Traditional and conventional; gears for sea and inland fishing; Nets, Lines and Hooks, Traps and Pots, Dredges, Seines, trawls, Spears and Harpoons, Fishing rods and Reels; TED; Fish aggregating devices (FAD); Echo-sounder and sonar.

Module 2: Post Harvesting Technology (10hrs) (15 marks)

Unit 1 Chemical composition of fish (3 hrs) Biochemical composition of fish muscle; Significance of proteins and lipids, Nutritive value of fish muscle.

Unit 2 Post mortem changes (rigor mortis and spoilage) (4hrs) spoilage in marine fish, spoilage in freshwater fish (Microbial spoilage, Enzymatic spoilage, Biochemical spoilage); Physical and biochemical changes associated with the post mortem changes; Importance of post mortem changes in fish processing.

Unit 3: Handling of fresh fish (3 hrs) Icing and icing methods, Different types of ice - block ice, flake ice and dry ice; Handling - on board chilling and use of refrigerated sea water (RSW); Fish landing platforms; Hygienic handling of fish on board and on shore.

Module 3: Processing Techniques (17Hrs) (20 marks)

Unit 1: Fish processing plant and cold storage (3 hrs)

The pre-processing and processing plant, cold storage – general conditions relating to premises, building, equipment, general conditions of hygienic of plant and workers, conditions of storage of frozen products; Requirements for registration with MPEDA; approval of processing plant by FIA; allotment code

Unit 2 Methods (Techniques) of processing/preservation and their products (5hrs) Drying, Salting, Smoking, Freezing - plate freezers, blast freezers and individual quick freezing (IQF), Accelerated

freeze drying (AFD), Immersion freezing and cryogenic freezing, Canning, Irradiation, Assessment of capacity of plate, blast and IQF freezers

Unit 3 Processing of crustaceans (4 hrs) Pre-processing of commercially important prawns and shrimps of India - peeled and devined (PD), peeled and undevined (PUD), head-less (HI), head on (HON); Grades of shrimps; Cooked shrimps; IQF shrimp; Processing of lobsters - Pre-processing of commercially important lobsters of India; different varieties of lobster products; Grades of packing

Unit 4 Processing of cephalopods (3 hrs) Pre-processing of Commercially important cephalopods (squids and cuttlefish) of India; different varieties of cephalopod products**;** Grades of packing

Unit 5 Processing of fish (2hrs) Processing of Commercially important fishes of India**;** Grades for fish products

Module 4: Fishery byproducts (10hrs) (15 marks)

Unit 1 (6Hrs): Introduction to Fishery byproducts; Fish by-products-Fish Body oil, Fish liver oil, Fish sauces, Fish meal, Fish silage, Fish glue, Shark fins, fin rays, fish maws/isinglass, Fish silage, chitin and chitosan; Fish mince based products, Fish finger, fish cutlet, Surimi, IWP (individually wrapped product) products, Fish filleting etc; Battered and breaded products; Fermented fishery products

Unit 2 Quality Control (4Hrs): Fundamental aspects of quality; Major quality problems in sea foods Quality of water and ice-chlorination and use of UV rays; Microbial hazards of sea foods - *E. coli*, *Salmonella*, *V. cholerae*, *Staphylococcus*; Inspection systems; Brief introduction to the quality control concepts of HACCP, ISO and IQM (total quality management).

Module 5 Open Ended (12 hrs)

Teacher can design student activities like seminars, assignments, and conduct field visits to fishing sites, fish food manufacturing and processing units, promote improvisation in construction of fishing gears etc., and preparation of analytical notes on present fishing techniques, based on the visit to the sites.

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Online Sources

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3

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
CO 5						3							3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6	✓			✓

HUMAN GENETICS III: GENETIC DISEASES AND COUNSELLING

Programme	B.Sc. Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://onlinecourses.swayam2.ac.in/cec24_bt12 (4 Credit) 2. https://onlinecourses.swayam2.ac.in/cec24_bt07 (4 Credit) 3. https://onlinecourses.nptel.ac.in/noc21_bt02 (1 credit)				
Course objectives	The course aims to develop understanding in different hematological, skeletal, Neuromuscular, endocrine disorders, metabolic disorders, reproductive and developmental genetics, pre- natal diagnosis and genetic counselling.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the genetic basis and general features of different hematological, skeletal, Neuromuscular, endocrine disorders.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the genetic causes of metabolic disorders and their features	U	F&C	Short answer, Paragraph, questions
CO3	Explain the various morphological disorders during development and their genetic causes and assisted reproductive technologies.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe various pre-natal diagnostic techniques, its importance, genetic counselling.	U	F&C	Short answer, Paragraph, questions
CO5	Collect additional information regarding congenital disorders from additional sources and conduct surveying on the occurrence of the disorders in any selected locality and prepare reports	An & C	C&M	Assignments, seminars, report writing
CO6	Compare various assisted reproductive technologies and the suggest their suitability for different hypothetical and real life situations.	U&An	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module I: Exploring Hematological, Neuromuscular, and Endocrine Disorders (12hrs) (Out of 70: 18 marks)

Unit 1. Hematological disorders (3hrs)– Sickle cell anemia, Thalassemia, Haemophelia A &B.

Unit 2. Neurological disorders- (3hrs) - Spinal muscular atrophy, Neurofibromatosis, Parkinson's disorders.
Unit 3. Endocrine disorders- (6hrs) –Thyroid: Congenital hypothyroidism, Defects of Thyroxine binding globulin, Transthyretin defects, Pancreas: Type 1 insulin dependent diabetes mellitus (IDDM), Type 2 diabetes non-insulin dependent diabetes mellitus (NIDDM), Maturity onset diabetes mellitus (MODY), Pituitary: Acromegaly, Gigantism, Dwarfism, Gonads: Complete androgen insensitivity, True hermaphroditism, Anorchia.

Module II - Exploring Metabolic disorders (12 hrs) (19marks)
Unit 1. Disorders of carbohydrate metabolism- (4 hrs) -Galactosemia, Hereditary fructose intolerance, Glycogen storage disorders. Type 1, Type 2, Type 3,
Unit 2. Diseases of amino acid metabolism- (3 hrs) - Phenylketonuria, Alkaptonuria, Albinism, Maple syrup urine disease,
Unit 3. Disorders of lipid metabolism- (2 hrs) - Tay Sach's disease, Goucher's disease,
Unit 4. Disorders of nucleic acid metabolism- (1 hr) - Primary gout, Leishnyhan syndrome.
Unit 5. Mineral metabolism disorders and Peroxisomal disorder - (2 hrs)-Wilson disease, Menkes disease, Zellweger syndrome.

Module III- Reproductive and Developmental Genetics (12 hrs) (16marks)
Unit 1. Chromosome instability and Spontaneous abortions. (2 hrs)
Unit 2. Study of human birth defects- (6 hour)- Syndromology and Dysmorphology, Neural tube defect: Anencephaly, Meningocele, Spina bifida, Herlequinicthyosis,
Unit 3. Assisted Reproductive Techniques (ART) (4 hrs) - Computer Assisted Semen Analysis (CASA), IVF, GIFT, ZIFT, ICSI, IUI, Pre-implantation Genetic Diagnosis (PGD)

Module IV - Prenatal Diagnosis & Genetic Counselling (12 hrs) (17 marks)
Unit 1. Non-invasive techniques- Ultrasonography, foetal MRI (2 hrs)
Unit 2. Invasive techniques (4hrs)- Amniocentesis, chorionic villus sampling sampling, foetal skin sampling
Unit 3. Genetic counselling (6 hrs) – Definition, Indication for genetic counselling, Steps in genetic counselling, Psychological aspects of genetic counselling and Special considerations in genetic Counselling, Pre-natal counselling, Population screening.

Module V: Open Ended (12hrs): Design student activities like assignments, seminars, collection of notes/reference materials related to the topics Congenital diseases and Causes, surveying and report writing on the occurrence of : Cleft lip & cleft palate; Physiology, pathology, *treatment* & epidemiology of infectious Congenital adrenal hyperplasia, Angelman syndrome, Prader willi syndrome

Virtual Labs (Suggestive sites)

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7. Dhatolkar AB: Elements of Biomedical Genetics.
8. Lynn B. Jorde and John C.Carvy: Medical Genetics
9. Jack Pastor Nack: Human Molecular Gentics

10. Mahesh ,S. and Vedamurthy: Biotechnology
11. Read Andrew et al: New clinical Genetics
12. Phadke Subha R: Genetics for clinicians
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Online sources

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CO 3		3					3						
CO 4		3	2				3						
CO 5						3							3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
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Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6	✓			✓

HUMAN GENETICS IV: TECHNIQUES, GENOME, AND COMPUTATION

Programme	B.Sc. Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://onlinecourses.swayam2.ac.in/cec24_bt12 (4 Credit) 2. https://onlinecourses.swayam2.ac.in/cec24_bt07 (4 Credit) 3. https://onlinecourses.nptel.ac.in/noc21_bt02 (1 credit)				
Course objectives	Through the course the student gens awareness on advanced techniques and emerging trends in human genetics, Biotechnological applications, Human genome project, role of bioinformatics in the analysis of genomic information.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic cytogenetic laboratory techniques necessary to prepare tissue samples or cytogenetic analysis.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Illustrate use of modern tools and techniques for manipulation and analysis of genomic sequences and describe the use of recombinant DNA technology in Biotechnological research	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the chemical makeup of the entire human genetic code and development of the research tools that will allow scientists to identify genes involved in both rare and common diseases.	U	F&C	Short answer, Paragraph, questions
CO4	Describe different biological databases and tools and apply algorithms for searching the biological databases. Categorize sequence alignment methods, Implement phylogenetic tree construction algorithms. Analyse genomic and protein sequence	U	F&C	Short answer, Paragraph, questions
CO5	Analyse the innovative approaches in the field of genetics in analysis and treatment of genetic conditions, and make notes on it.	An & C	C&M	Assignments, seminars, report writing
CO6	Describe emerging trends in genetics, different gene therapy techniques, RNA interference technology, Liposome based Drug delivery etc.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Advanced Techniques and Emerging Trends in Human Genetics (15 hrs) (Out of 70: 25 marks)

Unit 1. Cytogenetic Techniques (7 hrs) - Routine Cytogenetic Techniques**:** Peripheral blood lymphocyte culture (PBLC), Preparation of stained slides and nomenclature, ISCN (International System for Human Cytogenetic Nomenclature), Sister Chromatid Exchange (SCE) and Micronucleus (MN) assays, Staining techniques: Giemsa staining, Acridine orange staining, and DAPI, (4',6-diamidino-2-phenylindole) staining

Unit 2 **Specialized Techniques (2 hrs) -** High-Resolution Banding (HRB), Fragile sites and their identification, Premature Chromosome Condensation (PCC), Karyotyping and interpretation of results

Unit 3. Diagnostic Tools (3 hrs) - Polymerase Chain Reaction (PCR): Types of PCR (Polymerase Chain Reaction), Reverse Transcriptase PCR (RT-PCR), Fluorescent PCR, Primer designing and purification techniques; Nucleic acid Sequencing**:** Principles of nucleic acid sequencing, Applications in diagnostics

Unit 4. Emerging Trends (3 hrs) - Gene Therapy in Human: Types of gene therapy: Germ line, zygote, somatic cell gene therapy, RNA Interference Technology, Biochips, Liposome-based Drug Delivery

Module II: Integrating Biotechnological Applications with Human Genetics in Medicine (12 hrs) (16 marks)

Unit 1. Introduction to Biotechnology in medical sciences(3hrs)- Recombinant DNA technique for Human Diseases, Applications of r-DNA technology: Medical products developed by using biotechnology tools

Unit 2. Major r-DNA products (in brief) (9hrs)- Somatic cell hybridization and Recombinant monoclonal antibodies, Recombinant tissue plasminogen activator, Recombinant erythropoietin, Recombinant antibiotics, Recombinant blood clotting factor VIII, Recombinant hepatitis B vaccine.
Metabolic engineering and genetic changes for overproduction of - insulin, interferon and growth hormones,

Module III: Human Genome Project (9 hrs) (14 marks)

Unit 1. Human Genome Project (HGP) (5hrs)– an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, expected scientific & medical benefits of this project, about the organizations behind this project.

Unit 2. How Human genome was mapped (4hrs)– physical mapping, genetic mapping.

Module IV: Bio-informatics (12 hrs) (15marks)

Unit 1. Overview of Bioinformatics (6hrs) -Databanks, techniques of alignment, role of bioinformatics in the analysis of genomic information, genomics, proteomics.

Unit 2. Biological databases (6hrs)- Nucleic acid – GenBank, EMBL, DDBJ. Protein – Swissprot, TreEMBL. Structural – PDB. Submitting sequences to databases – BankIt, SequIn, WebIn, and Sakura. Sequence retrieval by Entrez.

Module V: Open Ended (12hrs): Design student activities like assignments, seminars, collection of notes/reference materials related to the topics 1. CRISPR gene editing, methodology and therapeutic applications, 2. Next generation sequencing, methodology and applications, Stem cell technology, types of stem cells, culture methods, therapeutic applications

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Online sources

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Level	Correlation
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Assessment Rubrics:

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- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6	✓			✓

WILDLIFE BIOLOGY III: FIELD TECHNIQUES IN WILDLIFE STUDIES

Programme	B. Sc Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop an understanding on wildlife population estimation, sampling, field estimation, capture and handling of animals, field analytical methods, and modern methods of wildlife study.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe different methods of wildlife population estimation, sampling and field observation.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain different animal capture and handling techniques.	U	F&C	Short answer, Paragraph, questions
CO3	Describe field analytical methods, managing animals using different marking or tagging techniques, age estimation. Food habit analysis etc.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe modern methods of wildlife study like, Bio-loggers, hydrophones, different audio recording techniques, Wildlife photography, Remote sensing etc.	U	F&C	Short answer, Paragraph, questions
CO5	Conduct seminars, debates and prepare notes on ethical practices in field studies, its importance in ecotourism projects	An & C	C & M	Assignments, seminars, report writing
CO6	Compare different animal tagging methods and their suitability on different occasions.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Wildlife population estimation/ Sampling & Field observation (12hrs) (Out of 70: 20 marks)

Unit 1. Direct Count (6)- Total count, Drive count, Time area counts and transect count**,** Indirect Count: - Call count, Track count and Pellet count/dung count, Abundance estimation techniques for mammals (Line/ trail/ road/ vehicle transects; Waterhole census, total count, block count and camera trapping for carnivores), birds (point count, line transects and Mackinnen's sampling), reptiles and amphibians (time series count, surveys of coarse woody debris, Pitfall trapping, marker capture),

Unit 2. Capturing and Marking Techniques(4hrs) - Live trapping &marking of birds and Mammals, Peterson or Lincoln Index method. Techniques of field observation,
Unit 3. Behavioural sampling techniques(2hrs) - Ethogram development, Camouflages& Observation stations.

Module II: Capture Handling(12hrs) (15 marks)
Unit 1. Capture and handling of animals (4hrs)-purpose, restraint techniques, different capture methods and animal barriers.
Unit 2. Drug immobilization(4hrs)-drug delivery equipment and accessories; Immobilization drugs-action, dosage, response, side effects, safety measures and complications
Unit 3. Handling and transport of wild animals(4hrs)-designing sledge, crate and holding enclosures; Management and identification of animals in conflict.

Module III: Field analytical Methods (12hrs) (20 marks)
Unit 1. Recording & Evaluation of Data (5hrs) - Field note book and its records, Qualitative &Quantitative data, Field kit and its usage. An overview of hair and bone anatomical features used for species identification, Identification by natural marking, individual damage; behavioral idiosyncrasies, etc.
Unit 2. Managing problem animals (3hrs)- passive marking collars, tags, branding, rings, etc; Dynamic marking-betalight, radio tracking-harnesses and collars; Telemetering of physiological parameter.
Unit 3. Age estimation of large herbivores (2hrs) - counting of cementum growth layers, Determination of Age and sex in birds.
Unit 4. Food habit analysis (2hrs) - Scat analysis for studying food habits of carnivores & Gut content analysis of Birds

Module IV: Modern methods of Wildlife Study(12hrs) (15 marks)
Unit 1. Audio recording system (4hrs) - Bio-loggers and hydrophones and their applications, Various audio recording techniques, Sonogram and its evaluation.
Unit 2. Wildlife photography (4hrs) - Still and Videography, Camera Trap- Recording of calls, Tracks and Signs of Animals,
Unit 3. Remote sensing(4hrs) - Fundamentals of GIS, Functions of GIS, Digital tagging & its applications (e.g. implanting microchips).

Module V: Open ended (12hrs)
Teacher can design a module on Ethics in Field Studies; Dos & Don'ts in field studies and Regulatory permissions for field observations.

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Online Sources

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
CO 5						3							3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6	✓			✓

WILDLIFE BIOLOGY IV: WILDLIFE CONSERVATION & MANAGEMENT

Programme	B. Sc Zoology				
Type of Course	Major Elective				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course develops understanding on the history, scope of conservation, different conservation strategies, Zoo management and wildlife health, people role in conservation efforts, Human wildlife conflicts and wildlife conflicts.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe history of conservation, conservation categories of wildlife, the ecological, genetic, economic and philosophic reasoning conservation.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain different conservation strategies and methods, various aspects of zoo management, different kinds of Wildlife diseases, planning and management of wildlife management programmes.	U	F&C	Short answer, Paragraph, questions
CO3	Describe people role in wildlife conservation, cultural and traditional practices for wildlife conservation, man -wildlife conflicts etc.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe various rules and legislation on wildlife conservation.	U	F&C	Short answer, Paragraph, questions
CO5	Collect information on various local conservation programmes, cases of man- animal conflicts, analyze the problems, make reports on it,	C &An	C&M	Assignments, seminars, report writing
CO6	Suggest effective preventive measures against wildlife diseases.	Ap	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: History and Scope of Conservation (10Hrs) (Out of 70: 15 marks)

Unit 1. History of conservation in India (6Hrs)- Status of wildlife in India (Past and Present), Causes of depletion of Wildlife resources - habitat loss, construction of dams, collection for trophies, hunting, poisoning, poaching and other developmental activities, Degradation and destruction of natural habitats, Exploitation for commercial purposes, Deforestation, Agricultural expansion and grazing, Urbanization and industrialization, Forest fires.

Unit 2. Categories of wildlife(4hrs) - IUCN Red list, Extinct, Endangered, Threatened, Vulnerable, rare; data deficient categories. The e ecological, genetic, economic and Philosophic reasoning of conservation.

Module II: In situ & Ex situ Conservation (16Hrs) (20 marks)

Unit 1. In Situ and Ex situ conservation (Gene banking, conservation and exchange), Case studies(8Hrs)

(Silent Valley National Park, Periyar Tiger Reserve), National parks and wildlife sanctuaries in India with special importance to Kerala. Umbrella species, flagship species-based conservation programmes. Marine Sanctuaries and National Parks of India: Gulf of Mannar, Gulf of Kutch &Andaman(brief account), Man and Biosphere reserves (MAB) in India - concept, importance, ecological features and management (Brief Account). Nilgiri biosphere reserve (NBR) and Agastyavanam Biosphere reserve. Mention other biosphere reserves in India

Unit 2: Zoo management (3Hrs)

Basic consideration for designing a modern zoo, Functions of a modern zoo, Zoo layout and exhibition of animals, Zoo services, Zoo sanitation, Captive breeding, Safari parks, Moonlit zoo

Unit 3: Wildlife health (5Hrs)

Introduction to disease and epizootiology; Determinants of disease and disease transmission; Disease and population dynamics; Review of major viral, bacterial, protozoan, fungal and parasitic diseases of Indian wild mammals, birds, amphibians and reptiles; Non infectious diseases-nutritional diseases, poisoning, stress, shock, capture myopathy and physical trauma; Emerging and re-emerging diseases; Zoonoses; Planning and management of wildlife health program.

Module III: People and Conservation (14Hrs) (20 marks)

Unit 1. Traditions & culture for conservation (5Hrs) - Sacred groves, Women in conservation , Tribal groups in Kerala, Role of tribals in Wildlife conservation - Joint Forest Management, Ecodevelopment Projects, Importance of Tourism in Wildlife conservation, role of ecotourism in sustainable development, Environmental Impact Assessment (EIA) methods and their role in wildlife conservation.

Unit 2. Government and voluntary organization in wildlife conservation (3Hrs) - (IBWL, IUCN, ICF, WWF, BNHS, WPS, MNHS, TRAFFIC, CITES, NBA etc.)

Unit 3: Human-Wildlife Conflicts (6Hrs):

Basic concepts, reason for conflicts, Identification of damages caused by wild animals and control measures. Case studies – Elephant, gaur, wild boar, monkey, tiger and leopard, Translocation of Wild animals – Principles, Methods and application. Traditional knowledge in wildlife conservation, Species management for man wildlife conflict resolution and mitigation.

Threats and conservation issues (poaching, habitat loss, habitat fragmentation and habitat degradation, roadside kills, alien species, pollution, other anthropogenic activities, endemism etc.)

Module IV: Wildlife and legislation (8Hrs) (15marks)

Unit 1. Constitutional provisions National and International guidelines and protocols(4hrs) -, Government body for wildlife and forest managements at forest, taluka, district, state and national level, National policy governing wildlife protection in India, Role of Indian Board of Wildlife and State wildlife advisory board.

Unit 2. Rules for Wildlife Conservation (4Hrs) - Wildlife Protection Act (1972) and its amendments, Wildlife trade and regulations; Biodiversity Act 2000; National and International treaties, Treaties for wildlife conservation, Indian Forest act (Brief Account only).

Module V: Open ended (12hrs)

Teacher can design student activities like, seminars, assignment on different conservation schemes.

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16. WII(1985). A guide to chemical restraint of wild animals., Technical Report II.

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CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
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Level	Correlation
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Assessment Rubrics:

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Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5		✓		
CO6	✓			✓

DISCIPLINE SPECIFIC CORE COURSES

PHYSIOLOGY

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses https://books.google.co.in/books?id=tdODr5fpxEAC&printsec=copyright&redir_esc=y#v=onepage&q&f=false https://www.stanfordchildrens.org/en/topic/default?id=anatomy-and-physiology-of-the-ear-90-P02025 https://www.thieme.in/index.php?route=information/authorbooks&authorname=Sircar https://drcart.in/product/textbook-of-physiology-10ed-vol-1-vol-2-2023-by-a-k-jain/ https://bookeshi.com/college-life/s/physiology/				
Course objectives	The course imparts an understanding in structure and functioning og lymphatic system, human brain, sense organs, and environmental influence on growth and metabolism, physiological basis of stress and its management.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the environmental influence on the physiological function and performance of living organism	U	F&C	Short answer, Paragraph, questions
CO2	Discuss the physiology of Nervous system.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the functioning of visual and tasing organs and the disorders	U	F&C	Short answer, Paragraph, questions
CO4	Describe the functioning of smelling, touch and hearing organs, memory patterns, memory disorders.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Perform lab experiments to reveal the physiological functioning of the body	Ap	C & P	Laboratory experiments, exams
CO6	Acquire knowledge indifferent disorders and diseases affected in human sense organs	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

MODULE 1: LYMPHATIC SYSTEM & ENVIRONMENTAL PHYSIOLOGY AND STRESS PHYSIOLOGY(9hrs) (Out of 70: 15 marks)

Unit 1. Lymphatic System (4 hrs) - Lymph channels of the body**.** Composition and formation of lymph**.** Functions of lymph and lymphatic system including role of it in controlling Interstitial fluid protein concentration, interstitial fluid volume and interstitial fluid pressure. Disorders and diseases: Castleman diseases, Lymphangioma, Lymphoma, Lymphedema, Lymphadenopathy

Unit 2. Environmental Physiology and Stress Physiology: (5hrs) Environmental influence on growth and metabolism, Acclimatization, Concept of stress, stressors, integrated stress response, eu-stress, distress, stress adaptation and tolerance, mechanism of stress tolerance, endocrinology of stress, Endocrine stress axis, role of hypothalamo-hypophyseal-adrenal axis. Cardio-respiratory responses during high altitude acclimatization. Hormonal regulation of stress adaptation: Role of Nrf2 transcription factor in stress regulation. Stress and Heat Shock Proteins.Stress-induced diseases.

MODULE 2: PHYSIOLOGY OF CONTROL AND CO-ORDINATION (15hrs) (20 marks)

Unit 1. **Structural Organization of human brain – Cerebrum(5Hrs):** Cerebral cortex and its functional areas, somatosensory cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex , wernick's area, Brodman map, Cerebral dominance, corpus callosum and fornix, basal nuclei-organisation and function, .Brain stem- organisation and function.

Unit 2. Cerebellum and Medulla oblongata(2hrs): structure and function. Diencephalon organisation and function.

Unit 3. Functional brain systems (3hrs): Limbic system and reticular formation. Protection of brain Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.

Unit 4. Spinal cord (3hrs): structure, Reflex action, reflex arc, monosynaptic and polysynaptic reflexes, inverse stretch reflex and golgi tendon organ. Brief account on Peripheral Nervous System and Autonomic nervous system.

Unit 5. Disorders (2hrs): Guillain-Barré syndrome, ALS (Lou Gehrig's Diseases), Brain aneurysm, Numbness and tingling

MODULE 3: SENSORY PHYSIOLOGY -Vision and Taste (9hrs) (14marks)

Unit 1. Vision: (5hrs) - Structure of eye, Layers of Retina and photoreceptors (rods & cones). Brief notes on the neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex, Formation of image on the retina. A brief general account of electrophysiology of vision. Photochemistry of vision &colour vision. Disorders and problems: Amblyopia, Diabetic Retinopathy, Strabismus, AMD - wet and dry, Cataract

Unit 2. Taste: (4hrs) -Primary sensations of taste (agents and site of sensation) Taste buds (location, structure, receptors and nerve supply) Physiology of taste (receptor stimulation, generation of nerve impulse by taste buds and its transmission to CNS). Tongue diseases and problems: Oral thrush, Glossitis, Macroglossia, Burning tongue, Leukoplakia, Kawasaki syndrome, Fissured tongue.

MODULE 4: PHYSIOLOGY OF SMELL, TOUCH, HEARING AND MEMORY (12hrs) (21 marks)

Unit 1. Smell: (3hrs) -Olfactory membrane and receptor cells Physiology of olfaction (stimulation of olfactory cells and transmission of smell signals to CNS). Nasal problems: Sinusitis, Nasal polyps, Rhinitis

Unit 2. Touch: (3hrs) -Mechanoreceptors and their stimulation, Pain receptors and their stimulation Thermal receptors and their stimulation. Skin diseases: Acne, Alopecia areata, Atopic dermatitis, Psoriasis, Raynaud's phenomenon, Rosacea, Skin cancer, Vitiligo

Unit 3. Hearing: (3 hrs) -Auditory System: Structure of Ear, Organ of corti-ultramicroscopic structure, Structure of cochlea, Organ of Corti, Cochlear mechanics, Mechanism of hearing, auditory

pathway. Foramen of Luschke, Fissures of Santorini. Ear syndromes and problems: Pendred syndrome, Usher syndrome, Vestibular Schwannoma, Otosclerosis, Tinnitus, Ear infection.

Unit 4. Memory (3hrs)- definition, types of memory- short term, intermediate long term and long term memory, consolidation of memory. Brain disease and disorders - Schizophrenia, Alzheimers's diseases, Senile dementia, Parkinson's diseases, brain tumor, Encephalitis. Bipolar disorders, PTSD

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1. Identification of parts of Brain using Virtual dissection or charts, models etc.
2. Identification of Brain waves – Slow wave sleep, REM sleep etc
3. Testing of hearing loss by Weber's and Rinne's tuning fork test
4.Identification of parts of sensory organs (Eye, Ear, Nose, Skin& Tongue) in virtual mode or using charts, models etc.

Of the remaining experiments any 4 can be selected by the Institution from the following list.Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students

5. Demonstration of cranial nerve integrity
6. Demonstration of motor function.
7. Demonstration of assessment of cognitive function - Memory
8. Demonstration of assessment of speech and communication.
9. Identification of visual defects myopia, hypermetropia, presbyopia, astigmatism, cataract, nyctalopia
10. Identification of colour-blindness using Ishihara chart.
11. Examination of tactile receptors of the skin. (Two point touch discrimination test)
12.Examination of thermoreceptors of the skin. (Thermoreceptor adaptation test)
13. Practise of stress releasing excercises.

Institutional visit to Hospitals or other Medical centers to study the procedures to detect visual or auditory defects in children (not more than one day)

References

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ONLINE SOURCES
Humananatomy2 practical guide.pdf
ear_nose_and_throat_the_offici_sfo_uk_compressed.pdf

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Correlation Levels:

Level	Correlation
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Assessment Rubrics:

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CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

ENZYMOLOGY AND CLINICAL BIOCHEMISTRY

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	B. Sc. Zoology Degree or equivalent online courses				
Course objectives	To encompass students with basic knowledge of enzymes and their diagnostic significance. The students will be able to describe the diagnostic significance of the main laboratory investigations, the principle of analytical measurement in clinical biochemistry and identify the meaning and use of laboratory investigations in connection with diseases of the major organ systems				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain relationship between the structure and function of enzymes	U	F&C	Short answer, Paragraph, questions
CO2	Explain how enzymes are able to increase speed of an biochemical reaction in sense of thermodynamics, kinetics and molecular interactions;	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe catalytic strategies in interpreting mechanisms of enzymatic action; interpret and explain significant mechanisms of regulation of enzymatic action and specifies importance of enzymes in regulation of metabolism	U & Ap	F&C	Short answer, Paragraph, Essay questions
CO4	Apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems considering kinetics and thermodynamics of enzymatic reactions.	Ap	F&C	Short answer, Paragraph, questions
CO5	Perform laboratory experiments related to enzyme action	Ap	C&P	Laboratory experiments, exams
CO6	Apply theoretical, practical, IT and statistical knowledge during processing experimental results and their correct interpretation	Ap	F &C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1 Introduction to Enzymes (10 hrs) (Out of 70: 15 marks)
Unit 1. Nomenclature and classification ((2hrs); Enzyme Commission system of classification and nomenclature of enzymes (Class subclass and sub sub class with one example). Cofactors; Specificity of enzyme action; Isozymes, Holoenzyme, apoenzyme, and prosthetic group;
Unit 2. Interaction between enzyme and substrate (3hrs)- lock and key model, induced fit model., Features of active site, activation energy, Rate enhancement through transition state stabilization,
Unit 3. Chemical mechanism for transition state stabilization (5hrs). Enzyme specificity and types. Ribozymes, Abzymes. Coenzymes and their functions- NAD+, NADP+, FAD, FMN, lipoic acid, TPP, Pyridoxal phosphate, biotin and cyanocobalamin. Measurement and expression of enzyme activity, enzyme assays. Definition of IU, katal, enzyme turnover number and specific activity, Isolation, purification and characterization of enzymes and criteria of purity.

Module 2 Enzyme kinetics, Inhibition & Regulation (15 hrs) (20marks)
Unit 1. Enzyme kinetics (6Hrs) - Importance, order of reaction, study of the factors affecting the velocity of enzyme catalyzed reaction-enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators (explanation with graphical representation). Derivation of Michaelis Menten equation and Km value and its significance, Definition of Vmax value of enzyme and its significance, Lineweaver Burk plot; King and Altman Method to determine velocity Equations. Bi- substrate reactions: Classification. Reaction mechanisms - The Serine Proteases: An Illustrative Example. Allosteric enzymes: Examples of Cooperativity and Allostery in Proteins, Models of Allosteric Behaviour, Effects of Cooperativity on Velocity Curves.
Unit 2. Enzyme inhibition(3hrs): Reversible and irreversible-examples. Reversible-competitive, non-competitive and uncompetitive inhibition; Graphic determination of inhibitor type, Dose- response curves of Enzyme inhibition. Mutually Exclusive Binding of Two inhibitors; Structure-Activity Relationships and Inhibitor Design.
Unit 3. Regulation of Enzyme activity (6Hrs): Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric regulation - Aspartate trans carbamoylase. Isoenzymes- Lactate dehydrogenase and creatine phosphokinase.

Module 3 Disorders of Carbohydrate, amino acid, lipids, purine pyrimidine and porphyrin metabolism (10 hrs) (24 marks)
Unit 1. Disorders of Carbohydrate metabolism(4hrs). Normal sugar level in blood, renal threshold and regulation of blood glucose concentration. Definition and causes –Hypo and Hyperglycemia; Diabetes mellitus; Introduction, aetiology, types of diabetes mellitus, Gestational Diabetes.
Acute and chronic complications of Diabetes mellitus and diagnosis- Urine testing, random blood sugar and OGTT, Lactose intolerance, Galactosemia and Glycogen storage diseases and Fructosuria
Unit 2. Disorders of aminoacids metabolism (2Hrs)-Etiology and clinical manifestation of phenylketonuria, cystinuria, alkaptonuria, albinism and tyrosinemia, organic acid disorders, urea cycle disorders
Unit 3. Disorders in lipid metabolism (2hrs): Plasma lipoproteins –lipoproteinemias, lipid metabolism in liver and adipose tissue. Cholelithiasis, Obesity, Fatty liver-Hypo and hypercholesterolemia. Atherosclerosis–aetiology, clinical features and complications.
Unit 4. Disorders of purine, pyrimidine and porphyrin metabolism(2hrs)- Hyper uricemia and gout. Lesch-Nyhan syndrome, SCID. Orotic aciduria – Primary & Secondary (Reye`s Syndrome), Porphyrias.

Module 4 Urine and blood analysis, Physiological function tests:(10 hrs) (11 marks)
Unit 1. Urine: Normal composition of urine (3hrs)– Volume, pH, colour, specific gravity; Constituents- urea, uric acid, creatinine, pigment; Abnormal Constituents - glucose, albumin, ketone bodies, variations

in urea, creatinine, pigments and their clinical significance in brief.

Unit 2. Blood: Normal constituents of blood and their variation in pathological conditions (3hrs) - urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/globulin ratio. A brief review of units and abbreviations used in expressing concentrations and standard solutions. Specimen collection and processing (blood, urine and feaces), anti-coagulant and preservatives for blood and urine. Transport of biological samples.

Unit 3. Physiological function tests (4Hrs): Liver Function tests-Metabolism of bilirubin, jaundice - types, clinical features and test based on bile pigments level in blood and urine, plasma changes, PT test, differentiation of three types of jaundice; Renal function tests- Clearance tests-urea, creatinine, PAH test, concentration and dilution tests; Thyroid function test-Significance of T3, T4 and TSH-values, hypo-and hyper thyroidism; Gastric function tests- Collection of gastric contents, examination of gastric residium, stimulation tests, tubeless gastric analysis

Module 5: <u>Practicals (1 Credit, 30hrs)</u>

1.Assay of α amylase activity in Saliva
2.Determination of optimum pH of an animal enzyme
3. Studying the effect of different temperatures during enzyme activity measurements
4.Studying the effect of different pH during enzyme activity measurements
5.Substrate saturation & Determination of Km value from Michaelis-Menton Curve

Section B: Clinical Biochemistry

1.Quantitative estimation of Glucose in Serum or plasma
2.Quantitative estimation of Serum Albumin
3.Estimation of total protein in Blood &Urine
4. Estimation of Cholesterol& Lipoproteins (Lipid Profile) in serum
5. Estimation of Urea, Uric acid, and Bilirubin (Conjugated & Unconjugated)
6. Serum Enzyme Analysis AST, ALT, ACP, ALP - Any 2

REFERENCES

ENZYMOLOGY

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17. www.cyberlipids.com- Extraction of lipids
18. U Satyanarayana, Biochemistry, Elsevier Health Sciences, 2014
19 John E. Hall, Guyton and Hall Textbook of Medical Physiology, Saunders, 2015
20 Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, Molecular Biology of the Cell, Garland Science, 2014
21 Gerald Karp, Cell and Molecular Biology, Wiley, 2013
22 Lippincott, Disease & Drug Consult: Neurologic Disorders, Williams & Wilkins, 2009.
23 A text book of medical biochemistry Vasudevan , Sreekumsri
24. Fundamentals of Enzymology, Nicholas Price and Lewis Stevens, Third Edition, Oxford University Press.
25.Enzyme Kinetics: Catalysis & Control A Reference of Theory and Best-Practice Methods , Daniel L. Purich , Academic press.
26.The Enzymes edited by David S Sigman volume XX Mechanisms of catalysis third edition academic press, inc. 1992
27.The Enzymes kinetics and mechanism volume I1 Third Edition Edited by Paul D. Boyer academic press, New York and London 1970
28.Allosteric regulatory enzymes by Thomas Traut © 2008 Springer Science+Business Media, LL 2007
29.LubertStryer : Biochemistry, 5th edn. (Freeman)

Clinical Biochemistry

1. *BurtisA. Carland Edward R. Ashwood,* 1994) **Tietz textbook of clinical chemistry,** 2nd edition W.B. Saunders Company.
2. *Phlip. D. Mayne*, (2002) **Clinical Chemistry india diagnosis and treatment**. 6th edition, Arnold Association, New Delhi, Publication.
3. *Kumar, Abbas, Faustosaunders* (2010). **Rabbins and Corins Pathological Basics of disease**. An Imprint of Elseveir.7thEdition.
4. *William J Marshal,* (2008) **Clinical Biochemistry**, Metabolic and clinical aspects- 1stedition-, Elseveir Publication, NewYork.
5. *Allengaw C.* (1999) **Clinical Biochemistry**, Churchill Livingstone- London.
6. *Longo, Fauci, Kasper, Hause, jamenson, Loscalzo*, (2012) **Harrison's Internal Medicine**, MC GrawHill Publishers.18th Edition.
7. T.M. Delvin (editor), (1982), **Text book of biochemistry with clinical correlation**, Johnwiley & Sons Inc.USA

ONLINE SOURCES

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
CO 5					3								3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

ADVANCES IN ECOLOGICAL AND EVOLUTIONARY STUDIES

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	B. Sc. Zoology Degree or equivalent online courses				
Course objectives	Students understand the ecological and evolutionary processes including the role of genetic variation, heredity, and natural selection as well as the implications these processes have for the origins and evolution of modern humans and their biology.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain various concepts of population and community ecology	U	F&C	Short answer, Paragraph, questions
CO2	Describe various biogeochemical cycles, their significance, concepts of multifunctionality, landscape ecology and ecosystem modelling	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain how different types of mutation occur & affect genetic variation in a population, how organisms modify their environment, and the applications of evolutionary theory.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe the ecological aspects of human evolution, role of ecological and evolutionary research.	U	F&C	Short answer, Paragraph, questions
CO5	Perform laboratory experiments	Ap	C&P	Laboratory experiments, exams
CO6	Analyse the effects of human activities on the biogeochemical cycles, and suggest remedies for the ill effects	Ap	F &C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Frontiers in Population and Community Ecology (15hrs) (Out of 70: 15 marks)

Unit 1: Ecological interactions (3hrs)

Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation, competition–intraspecific and interspecific, Ecological and environmental significance of interactions.

Unit 2: Population dynamics (6hrs) - Concept of population, characters affecting population growth– density, natality, mortality and growth curves, life curves, age structure, function and

equilibrium; population regulation – biotic potential and environmental resistances. Factors of population regulation – density dependent and density independent; population crash and carrying capacity; the laws of population growth. Non-equilibrium population dynamics: chaos, bifurcation theory, spatial complexity.

Unit 3: Metapopulation dynamics(6hrs)- connectivity, source-sink models, landscape genetics. Niche theory: multidimensional approaches, environmental heterogeneity, competition and coexistence. Assembly rules: deterministic vs. stochastic, community assembly models, environmental filtering. Ecological networks: structure, stability, cascading effects, disease ecology. Eco-evolutionary dynamics: coevolution, adaptive phenotypic plasticity, gene-environment interactions.

Module 2: Advances in Ecosystem Ecology and Biogeochemistry (10hrs) (14 marks)

Unit 1: Global carbon, nitrogen, and phosphorus cycles (5hrs) : anthropogenic perturbations, feedbacks, and tipping points. Ecosystem services and valuation: ecological functions, economic approaches, policy implications.

Unit 2: Multifunctionality and resilience(5hrs): maintaining ecosystem services under environmental change. Landscape ecology: spatial processes, scaling, telecoupling, and meta-ecosystems. Ecosystem modeling: complex systems approaches, agent-based models, earth system models.

Module 3: New Frontiers in Evolutionary Theory (10 hrs) (21 marks)

Unit 1: Niche construction(5hrs): How organisms modify their environment and its evolutionary consequences. Phenotypic plasticity: evolution of adaptive responses to environmental change. The evolution of cooperation and altruism: game theory, kin selection, multilevel selection.

Unit 2: Evo-devo (5hrs): integrating developmental biology and evolutionary theory. Mention Hot dilute soup. Genomics and evolutionary change: population genomics, adaptive landscapes, molecular evolution: using genomic data to reconstruct evolutionary histories and identify genes involved in adaptation. Applications of evolutionary theory - Medicine, agriculture, conservation biology, human behavior.

Module 4: Interdisciplinary Approaches in Ecology and Evolution (10 hrs) (20 marks)

Unit 1: Human Evolution(5Hrs): Social evolution, Paleoecology, Conservation psychology. Future of Ecological and Evolutionary Studies: Artificial intelligence and machine learning in ecology and evolution.

Unit 2: The role of ecological and evolutionary research(5hrs): Addressing climate change and other global challenges. Ethical considerations in ecological and evolutionary research, such as gene editing and species reintroduction.

Module 5: Practicals (1 Credit, 30 Hours)

Mandatory experiments

1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
2. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, salinity, determination of pH, and Dissolved Oxygen content (Winkler's method), and free CO_2.
3. Study of fossils from models/ pictures: Dickinsonia, Paradoxides (Trilobita), Asteroceras (Ammonoid), Pentremites (Blastoid Echinoderm), Ichthyosaur, Archaeopteryx, Cynodont.
4. Phylogenetic trees, Construction & interpretation of Phylogenetic tree using parsimony/ Construction of dendrogram following principles of phenetics and cladistics from a data table.

(Of the remaining experiments any 4 can be selected by the institution from the following list. Two experiments other than the listed should be selected by the supervising teacher and introduced to the students)

5. Study of homology and analogy from suitable specimens.
6. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/ any place of ecological interest/ ecological uniqueness/ Zoological garden.
7. Estimate the litter arthropod diversity by a trap method.
8. Nutrients cycling in forest: Soil sampling & Organic carbon analysis.
9. Water quality analysis - Biological Oxygen Demand and Chemical Oxygen Demand
10. Collection of flora and fauna from wetland and diversity analysis.

REFERENCES

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- Peter Stiling, 2015. Ecology: Global Insights and Investigations 2nd Edition. McGraw-Hill international edition.
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Evolutionary Biology

- Evolution: Barton NH, Birggs DEG, Elsen JA, Goldstein A.E., Patel NH. Cold Spring Harbor Laboratory Press, Newyork, USA.
- Evolution: Hall B. K. and Hallgrimsson, B. Jones and Barlett Publisher, Sudbury, USA.
- Chattopadhyay S. 2012. Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
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- Dobzhansky T, Ayala FJ, Stebbins JL, Valentine JW. 1977. Evolution. Surajeet Pub., N.Delhi
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- Futuyma DJ. 1997. Evolutionary Biology. Sinauer Associates. Behavioural Science.
- Evolution: Dobzhansky Th. Et.al. Surjeet Publications.
- Animal Species and Evolution: Mayr E. Belknap Press.

Equivalent online resources

https://onlinecourses.swayam2.ac.in/cec20_bt06/preview
https://www.coursera.org/specializations/introduction-to-biology
https://ugceresources.in/view-lecture.php
https://study.com/academy/lesson/human-environmental-impact-ecological-conservation.html

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
CO 5					3								3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

MOLECULAR BIOLOGY AND CYTOGENETICS

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or the following online courses 1. https://www.udemy.com/course/molecular-biology-biotechnology-principles/ 2. https://onlinecourses.nptel.ac.in/noc24_bt07/preview 3. https://onlinecourses.swayam2.ac.in/cec20_ma13/preview				
Course objectives	The course develops understanding in eukaryotic genome organization, gene expression mechanisms, cellular reproduction sex determination and clinical cytogenetics				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the structural and functional aspects of eukaryotic genomes, including the organization of genetic elements, multigene families, transposable elements, and pseudogenes.	U	F&C	Short answer, Paragraph, questions
CO2	Explain the molecular mechanisms underlying gene expression and its regulation as well as protein processing	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe DNA damage and repair mechanisms, and regulation of gene expression in bacteriophages.	U	F&C	Short answer, Paragraph, questions
CO4	Analyze the Molecular Mechanisms of Cell Division and DNA recombination, ultrastructure and organization of Key Cellular components involved in cell division and dis-regulation of cell division in cancer development.	An	F&C	Short answer, Paragraph, Essay questions
CO5	Demonstration of isolation of genetic materials, separation techniques of protein and DNA, stages of meiosis, and analysis of normal and abnormal human karyotypes	Ap	C&P	Laboratory experiments, exams

CO6	Explain and analyze the mechanisms of sex determination, chromosomal anomalies and disorders and genetic counseling practices.	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

MODULE 1: INSIGHTS INTO EUKARYOTIC GENOME ORGANIZATION (11Hrs) (Out of 70: 15 marks)

Unit 1: Special features of eukaryotic genome (3 Hrs): Features, components and reassociation kinetics of Unique, Moderately repetitive and Highly repetitive DNA, Junk DNA, Satellite DNA and Selfish DNA, Cot value and complexity of genome, Organisation of human genome (brief account), Telomeres and Telomerases- Introduction and function of telomeres and telomerases, steps Involved regulation of telomere length

Unit 2: Multigene families (4Hrs): Definition and concept, Classification: Simple, Complex and Developmentally controlled complex multigene family. Examples: hemoglobin, immunoglobulins, histocompatibility antigens, actins, tubulins, keratins, collagens, heat shock proteins (Brief account only) reiterated genes (mention histones, ribosomal RNA, and transfer RNA genes.)

Unit 3: Transposable genetic elements (3 Hrs): Definition, features and types, Transposition mechanism, Transposons in bacteria, IS elements, Tn family, Mu phage as a transposable element, Transposons in eukaryotes, SINE, Alu family; LINE, L1, P elements in Drosophila, Retroviruses and transposition

Unit 4: Pseudogenes(1Hr): Definition, Origin and types, functions; Organisation and special features of interrupted genes, Evolution of interrupted genes

MODULE 2: MACHINERY OF GENE EXPRESSION AND PROTEIN PROCESSING (12 Hrs) (21 marks)

Unit 1: Transcription and Genome Maintenance (4 Hrs): Comparative study of prokaryotic and eukaryotic transcription (Brief account only). DNA Damage: Radiation damage, hydrolytic damage, oxidative damage, alkylating agents, chemical crosslinking agents, intercalating agents. DNA Repair: Direct reversal, Base excision repair, Nucleotide excision repair, mismatch repair, SOS repair.

Unit 2: Regulation of gene expression in eukaryotes (3Hrs): Nucleosomal level regulation-histone modifications, DNA acetylation and deacetylation, methylation, mention CpG islands, other epigenetic factors, transcriptional level regulation: Activators, enhancers, mediators, silencers, post-transcriptional level regulation: Spliceosomes and micro RNAs. Regulation of translation in eukaryotes (brief account)

Unit 3: Protein folding and processing (3Hrs): Role of chaperones and enzymes in protein folding, Proteolysis for protein maturation, Role of glycosylation, myristoylation, prenylation, palmitoylation, phosphorylation in protein maturation. Protein degradation: Ubiquitin proteosome pathway.

Unit 4: Protein targeting (2 Hrs): Nuclear translocation of proteins, Translocation of proteins to ER, signal hypothesis, fate of proteins in ER. Role of golgi apparatus in protein targeting, brief account on vesicular transport Gene expression and regulation in bacteriophages and viruses (brief account only)

MODULE 3: CELLULAR REPRODUCTION AND GENETIC DIVERSITY (11 hrs) (14 marks)

Unit 1: Molecular mechanism of cell division (6 Hrs): Amitosis, Endomitosis and Mitosis, cell cycle check points, role of cyclins and cyclin dependant kinases in cell cycle, Ultra structure and organization of centrosome, centromere, Kinetochore, Microtubules and their dynamic instability, Microtubule Associated proteins, Anaphasic movements, Cytokinesis, Alteration of cell cycle regulation in cancer

Unit 2: Molecular mechanisms involved in recombination of DNA (5Hrs): Genetic recombination – types with example Site specific recombination, Non-homologous recombination, Homologous recombination, Molecular mechanism involved in homologous recombination of DNA in eukaryotes - Holliday intermediate, heteroduplex DNA, gene conversion, Role of Rec A protein in genetic recombination

MODULE 4: SEX DETERMINATION AND CYTOGENETIC DISORDERS (11 hrs) (20 marks)

Unit 1: Mechanism of Sex determination in animals (5Hrs): Chromosomal mechanism of Sex-Determination, Genic balance theory of Bridges. Haploid-diploid mechanism of sex determination in honey bee. Environmental Sex Determination: Bonellia and Crocodile. Hormonal influence on sex determination: Sex reversal in fowl and free martin in cattle; Gynandromorphism – types and causes, Dosage compensation – Barr body – Lyon hypothesis.

Unit 2: Clinical cytogenetics(6Hrs): Karyotyping, Classification of chromosomes: Patau and London System of classification. Normal human karyotype. Chromosomal anomalies and disorders: Mechanisms underlying chromosome abnormalities (non-disjunction, translocation, deletion, duplication, inversion) Autosomal - Down's, Patau's, Edward's and Cri du Chat syndromes. Sex chromosomal - XXX Syndrome, Turner's syndrome, Klinefelter's syndromes, Gene mutations: Autosomal mutation - albinism, PKU, alkaptonuria, galactosemia, Tay-Sach's syndrome, Gaucher's disease, Sickle cell anaemia, thalassemia and brachydactyly. Sex chromosomal mutations: Fragile X syndrome, Haemophilia, Lesch– Nyhan syndrome, dermal hypoplasia. Polygenic traits: cleft palate / lip, club foot and hydrocephaly. Holandric genes – Y chromosome infertility, hypertrichosis, porcupine man, webbed toes. Prenatal cytogenetics, Eugenics, Euthenics and Euphenics.

MODULE 5 – PRACTICALS (1 credit, 30 Hrs)

Mandatory experiments

1. Isolation of DNA from animal tissues
2. Isolation of RNA from animal tissues
3. Temporary mount of buccal epithelial cells to observe Barr body
4. Study of different stages of meiosis in grass hopper testes
   Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.
5. Poly acrylamide gel electrophoresis for separation of proteins
6. Agarose gel electrophoresis for separation of DNA
7. Study of normal karyotype of male and female through photographs
8. Study through photographs of the Karyotype: Down's, Klinefelter's, Turner's and Edward's Syndrome.

VIRTUAL LABS (SUGGESTIVE SITES)

https://www.vlab.co.in
https://zoologysan.blogspot.com
www.vlab.iitb.ac.in/vlab
www.onlinelabs.in
www.powershow.com
https://vlab.amrita.edu
https://sites.dartmouth.edu
https://faculty.uobasrah.edu.iq/uploads/teaching/1645858465.pdf

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8. Watson, J. D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2006). Molecular Biology of the Gene, Pearson Education.
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13. Benjamin Lewin (2008): Genes, Vol. IX, Boston, Jones, Bartlet.
14. Bruce Alberts, Alexander Johnson, Julia Lewis, Martin Raff, Keith Roberts, and Peter Walter (2002), Molecular Biology of the cell.4rth ed. Garland Science. New York.
15. De Robertis, E.D.P. and De Robertis Jr. E.M.F. (1996).Cell and Molecular Biology, 8th Ed. B.I. Waverly Pvt. Ltd, New Delhi.
16. Karp, G. (2002). Cell and Molecular Biology. John Wiley, New York.

ONLINE SOURCES

https://www.udemy.com/course/molecular-biology-biotechnology-principles/
https://onlinecourses.nptel.ac.in/noc24_bt07/preview
https://onlinecourses.swayam2.ac.in/cec20_ma13/preview
https://www.udemy.com/course/molecular-biology/?couponCode=IND21PM
https://ocw.mit.edu/courses/res-7-008-7-28x-molecular-biology/

Mapping of COs with PSOs and POs :

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CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
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CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
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Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses 1. https://www.biologyonline.com/tutorials/developmental-biology 2. https://onlinecourses.nptel.ac.in/noc21_bt43/preview				
Course objectives	The student develops understanding in the internal structural organs and organ systems and the development history of organisms, and compare the various organ systems of vertebrates. Course also aims to understand the advanced aspects of animal development like genetic and molecular in selected groups				

Course outcome

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify the terms related to organs and organ systems of organisms, internal structure of different vertebrates.	R	F	Short answer, Paragraph, questions
CO2	Compare the organ systems of invertebrates and vertebrates, understands the concepts of the living structures and helps to propose homology hypotheses between different organs.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the basic concepts of development like, cell fate, potency, commitment, differentiation, embryogenesis and organogenesis	U	F &C	Short answer, Paragraph, Essay questions
CO4	Explain the cellular, molecular and genetic basis of development.	U	F &C	Short answer, Paragraph, questions
CO5	Perform laboratory experiments related to comparative anatomy and	Ap	C&P	Laboratory experiments, exams
CO6	Explores and establishes the correspondences between body parts of organisms from different species.	U	F &C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

SECTION A- COMPARATIVE ANATOMY (20 hrs)

Module 1. Comparative Anatomy – Part I (12hrs) (Out of 70: 15 marks)
Unit 1: Introduction, &General Concepts (02 hrs)

Historical perspective and general concepts of Comparative Anatomy, Anaplasy, Homoplasy. Body plan of animals-evolutionary perspectives. Body plan of protochordates –their affinities with invertebrates and chordates, Origin of vertebrates – major life forms, Methods and tools used to study animal body.

Unit 2: Digestive System (03 hrs)

General organization of the digestive tract of invertebrates. General organization and microscopic structure of the gut of vertebrates. Adaptive features of the digestive tract of vertebrates- evolutionary perspectives.

Unit 3: Excretory system (04 hrs)

Excretory organs- Organs of excretion among invertebrates; Gross anatomy development and evolution of kidneys. Structure of the nephron in relation to excretion and osmoregulation.

Unit 4: Respiratory System (03 hrs*)*

Respiratory structures among invertebrates- General structure and types of internal gills; External gills; Lungs and gas bladder of fishes; Evolution of lungs from amphibians to mammals.

Module 2: Comparative Anatomy – Part II (8 hrs) (21 marks)

Unit 1: Circulatory System (04 hrs)

Organization of the vascular system in invertebrates. Heart of vertebrates-evolutionary modifications; Evolution of major aortic and venous channels of vertebrates.

Unit 2: Nervous System (04 hrs)

General organization of the nervous system in animals; Photoreceptors and chemoreceptors of insects; Comparative account of brain and evolution of telencephalon; Cranial nerves of vertebrates. Sense organs: Eye, ear, olfactory organs, Lateral line. Nervous system and electroreceptors of vertebrates.

SECTION-B: DEVELOPMENTAL BIOLOGY (25 hours)

Module 3. Basic concepts, Embryogenesis & Organogenesis (11 hours) (16marks)

Unit 1- Basic concepts of development (4 hours)

Cell fate, potency, determination and differentiation; Commitment; Specification - autonomous, conditional, syncytial; Genomic equivalence and cytoplasmic determinants; Morphogenetic gradients; Genomic Imprinting

Unit 2- Embryogenesis & organogenesis (7 hours)

Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center, primary embryonic induction, mechanism of axis formation; Anterior posterior patterning in Amphibians - Hox code hypothesis; Anterior posterior patterning in *Drosophila* – anterior forming genes (bicoid, hunchback), posterior forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes-gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes; Dorso- ventral patterning in *Drosophila*- dorsal protein gradient; Limb development in chick- Formation of the limb bud, generating the proximal-distal axis of the limb, Specification of the anterior-posterior limb axis, Generation of the dorsal-ventral axis; Insect wings and legs formation

Module 4. Cellular, molecular and genetic basis of development (14 hours) (I8 marks)

Unit 1- Cellular and molecular basis of development (5 hours)

Induction and competence- cascade of induction- reciprocal and sequential inductive events, instructive and permissive interactions; Epithelial- Mesenchymal interactions- paracrine factors - The Hedhog family, The Wnt family, Juxtacrine signaling and cell patterning, notch pathway; Cellular interactions concerned in fertilization, blastulation, gastrulation and organogenesis; Molecular basis of cellular differentiation – Cadherins

Unit 2- Genetic basis of development (5 hours)

Differential gene transcription –Promoters and Enhancers, DNA methylation, Transcription factors, Silencers and Insulators; Differential RNA processing- X chromosome inactivation- dosage

compensation; Control of gene expression at the level of translation-Differential mRNA longevity, selective inhibition of mRNA translation, Selective activation of mRNA translation, micro RNAs, Control of RNA expression by cytoplasmic localization; Post translational regulation of gene expression; Reversibility of patterns of gene activity-cell fusion, transdifferentiation.

Unit 3- Regeneration and ageing (4 hours)

Types of regeneration - Super, Hetero, Epimorphic, Morphallactic and Compensatory regeneration, Histological process during regeneration; Ageing – The biology of senescence, cellular and extra cellular ageing, Genes and ageing, DNA repair enzymes, Ageing and the insulin signaling cascade, The mTOR pathway, Chromatin modification, Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1.Comparative study of brain of vertebrates

2.Comparative study of different types of fish scales / feathers

3. Preparation of temporary/permanent whole mounts of chick embryo of the 20, 24, 33, 48 & 72hours of incubation stages to study the extent of development in detail

4.Experimental analysis of insect development - *Drosophila*

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5.Comparative functional and structural anatomy of fore limbs of vertebrates

6.Comparative study of pectoral girdles of *Varanus, Pigeon* and *Rabbit*

7.Comparative study of pelvic girdles of *Varanus, Pigeon* and *Rabbit* .

8.Identification of different developmental stages of frog - Egg, blastula, gastrula, neurula, tadpole external gill and internal gill stage.

9. Regeneration studies in frog tadpole tail.

10.Morphological and histological studies of different types of placenta in mammals

11.Study of invertebrate/vertebrate larval forms (minimum 5) and preparation of their stained temporary/permanent mounts

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Developmental Biology

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1. https://courseware.cutm.ac.in/courses/developmental-biology/

2. https://ocw.mit.edu/courses/7-22-developmental-biology-fall-2005/
3. https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/154
4. https://www.classcentral.com/course/swayam-introduction-to-developmental-biology-19906

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		3	2				3						
CO 5					3								3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATONS

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop a thorough knowledge in computational biology, its tools, its applications and IT tools in biostatistics				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the historical context and importance of computational biology in contemporary biological research.	U	F&C	Short answer, Paragraph, questions
CO2	Explain diverse biological databases and their retrieval systems, their role in phylogenetic studies, drug design, the use of various software such as Phylip, PAUP, RAxML, MrBayes, and Mauve in phylogenetic study as well as different computational methods in drug design including QSAR techniques, and software tools like Autodock and Gold.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe IT tools like spreadsheets and databases for efficient biostatistical data management, apply statistical analysis methods with software such as R, SAS, and SPSS, and utilize visualization techniques like ggplot2 and matplotlib for clear communication of biostatistical findings and retrieve and analyse data from these databases through online tools and resources.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Apply Bayesian methods and Markov Chain Monte Carlo (MCMC) algorithms using software tools like Stan and JAGS for Bayesian inference and interpret the results in the context of biostatistics research	Ap	F&C	Short answer, Paragraph, questions

CO5	Perform experiments using biological databases, Biostatistical tools	Ap	C&P	Laboratory experiments, exams
CO6	Explain the use of machine learning methods like decision trees and support vector machines through software packages like scikit-learn in Python and caret in R for predictive modeling and also interpret high-throughput data from next-generation sequencing and microarrays using bioinformatics tools such as Bio conductor in R and Galaxy	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Fundamentals of Computational Biology (12hrs) (Out of 70: 15 marks)

Unit 1 Introduction to Computational Biology (1hr): Overview of computational biology, significance in modern biological research; Historical background and milestones,

Unit 2 Biological Databases and Data Retrieval (5Hrs): Overview of biological databases, Scope and applications Sequence, structural, literature, gene expression and metabolic pathway databases, Small molecule databases: Pubchem, drug bank, zinc database and cambridge structure database. Data types in biological databases: Primary, secondary and tertiary databases, data formats: text, sequence data, protein structure and links. Data retrieval and analysis using online databases and tools

Unit 3: Introduction to Algorithms in Computational Biology (3Hrs): Definition and importance of

algorithms in computational biology, Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, sorting. Algorithm types in computational biology.

Unit 4: Programming languages (3hrs): Introduction to programming languages, installation and setup of development environments: Python, R, Java Matlab, Perl; Programming Fundamentals: Variables, data types, and operators, Control structures: loops and conditional statements, Functions and modules; Data Structures and File Handling: Lists, tuples, dictionaries, reading from and writing to files

Module II Tools in computational biology (12hrs) (20 marks)

Unit 1: Genomics and proteomics(3hrs): Pairwise and multiple sequence alignment methods: BLAST, ClustalW, : Protein identification and quantification methods (MS/MS, label-free quantification), Protein structure prediction methods (homology modeling, ab initio modeling), visualization and modeling software (e.g., PyMOL, Swiss-PdbViewer) , Construction and analysis of biological networks (protein-protein interaction, metabolic networks), network visualization and analysis using software tools Cytoscape, Genome assembly and annotation methods, Transcriptomics data analysis (RNA-Seq, differential gene expression analysis) data analysis using HISAT2, DESeq2

Unit 2: Metabolomics in computational biology (3hrs): Overview of metabolite identification, quantification, and profiling techniques. Pre-processing steps for raw metabolomic data (e.g., normalization, peak detection, alignment). Computational methods for metabolite annotation and identification (e.g., MS/MS spectral matching, database searching). Computational approaches for biomarker discovery in metabolomic data. Reconstruction of metabolic networks from metabolomic data. Metabolic Fluxomics: Computational modeling of metabolic flux distributions. Visualization techniques for exploring and interpreting metabolomic data: heatmaps, pathway analysis approach.

Overview of software tools and databases for metabolomic data analysis MetaboAnalyst, XCMS, MetFrag.

Unit 3: Phylogeny (3hrs): Definition and significance of phylogenetic analysis in computational biology, Phylogenetic Reconstruction Methods: Distance-based methods (e.g., neighbor-joining, UPGMA), Character-based methods (e.g., maximum parsimony), Likelihood-based methods (e.g., maximum likelihood), Bayesian inference methods. Introduction to commonly used software for phylogenetic analysis: Phylip, PAUP, RAxML, MrBayes, Mauve.

Unit 4: Computational Methods in Drug Design (3hrs): Identification of lead compounds: structure-based and ligand-based approaches; Molecular docking techniques including algorithms and scoring functions; Virtual screening through combinatorial chemistry and databases of ligands; Designing ligands for established target sites using de novo techniques. Application of pharmacophore models based on ligands and targets. Implementation of Quantitative Structure-Activity Relationship (QSAR) techniques for predicting bioactivity. Introduction to software tools such as Autodock, Gold, and others.

Module III: Introduction to IT Tools in Biostatistics (10hrs) (15 marks)

Unit 1: Basics of Biostatistics and Data Management (3hrs): Introduction to biostatistics and its importance in life science. Overview of data types, data sources, and data collection methods in biostatistics. Introduction to data management techniques including data cleaning, data transformation, and data integration. Utilization of IT tools such as spreadsheets and databases for data management in biostatistics.

Unit 2: Statistical Analysis Using Software Packages (3hrs): Introduction to statistical software packages commonly used in biostatistics - R, SAS, SPSS. Basics of data analysis including descriptive statistics, hypothesis testing, and regression analysis.

Unit 3: Visualization and Presentation of Biostatistical Data (2hrs): Importance of data visualization in biostatistics for communicating results effectively. Types of data visualization techniques - histograms, boxplots, scatter plots. Utilization of IT tools for creating visualizations and graphs - ggplot2 in R, matplotlib in Python.

Unit 4: Data Sharing and Reproducibility (2hrs): Importance of data sharing and reproducibility in biostatistical research. Introduction to version control systems for tracking changes in data and analysis scripts-Git. Documenting and organizing data and analysis workflows. Ethical considerations and guidelines for data sharing and reproducibility in biostatistics research.

Module IV: Advanced Topics in IT Tools for Biostatistics (11 hrs) (20 marks)

Unit 1: Bayesian Methods and Markov Chain Monte Carlo (MCMC) (3hrs): Introduction to Bayesian statistics and its applications in biostatistics. Overview of Markov Chain Monte Carlo (MCMC) algorithms for Bayesian inference. Bayesian data analysis using software tools- Stan, JAGS. Interpretation and communication of results from Bayesian analysis in biostatistics.

Unit 2: Machine Learning in Biostatistics (2hrs): Introduction to machine learning techniques and algorithms - decision trees, random forests, support vector machines in biostatistics. Applications of machine learning in predictive modeling, classification, and clustering of biomedical data. machine learning using software packages- scikit-learn in Python, caret in R. Evaluation and interpretation of machine learning models in biostatistics research.

Unit 3: High-Throughput Data Analysis (3hrs): Introduction to high-throughput technologies in biostatistics - next-generation sequencing, microarrays. Overview of bioinformatics tools and pipelines for processing and analyzing high-throughput data. Analyzing high-throughput data using bioinformatics software tools - Bioconductor in R, Galaxy. Challenges and considerations in analyzing and interpreting high-throughput data in biostatistics.

Unit 4: Big Data Analytics in Biostatistics (3hrs): Introduction to big data analytics and its applications in biostatistics. Overview of tools and techniques for handling and analyzing large-scale biomedical datasets. big data analytics using distributed computing frameworks - Hadoop, Spark. Ethical and privacy considerations in big data analytics for biostatistics research.

Module V: Practicals* Credit 1, 30hrs)

1. Sequence data retrival from different database such as GenBank
2. Aligning of DNA/amino acid sequences with BLAST to understand relationships.
3. Protein structures prediction using software PyMOL and interpretation of results to predict function.
4. Metabolomic raw data processing using XCMS and application of statistical methods for biomarker discovery, and visualization of results with heatmaps.
5. Phylogenetic Tree Construction using software PAUP, and analysis of evolutionary relationships.
6. Molecular docking interactions between ligands and receptors and predicting binding affinities using Autodock
7. Hypothesis testing and regression analysis of biological datasets utilizing R
8. Genomic data analysis using hadoop

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ONLINE SOURCE

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CO 3		3					3						
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Level	Correlation
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CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

ADVANCES AND APPLICATIONS OF IMMUNOLOGY

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	Basic Immunology and Biotechnology course of 6th semester				
Course objectives	The student develops understanding of the mechanism and functioning of Immune system and immune related diseases, modern techniques in Immunology which gain importance in understanding immune therapeutics.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe Hematopoiesis, maturation, and antigen-antibody interactions and appreciation of the mechanism of generation of antibody diversity.	U	F&C	Short answer, Paragraph, questions
CO2	Explain the mechanisms of humoral and cellular immunity, immune cell receptor, and intracellular signal cascades related to immune system activation and response.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Comprehend key principles behind host microbiome interactions, complement responses, and the importance of gut microbiota in developing immunity.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Evaluate the various causes and immune mechanisms behind hypersensitivity, allergic responses, transplant rejection, and immune deficiency diseases.	E	F&C	Short answer, Paragraph, questions
CO5	Collect information on advanced immune techniques, and discriminate, distinguish and apply their basic scientific principles, procedures, and applications used in the biomedical field and to develop new methods and techniques on the basis of the earned knowledge, prepare analytical notes on it.	An & C	C&M	Assignment and seminars.
CO6	Conduct surveys on immunological disorders in any selected locality and prepare reports.	An & C	C, M & P	Report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Introduction to Hematopoiesis and Antigen-Antibody Interactions (10hours) (Out of 70: 15 marks)

Unit 1: Hematopoiesis: (2 Hrs) Process of hematopoiesis and Immune cell lineages, Regulation and hematopoietic growth factors.

Unit 2: Immunoglobulins- Diversity and properties (8Hrs): Immunoglobulin genes: Generation of Antibody diversity and DVJ, recombination. Antigenic determinants of immunoglobulin: (a) Isotype, (b) Allotype, (c) Idiotype.; Strength of antigen-antibody interactions: (a)Affinity, (b) Avidity, (c) Cross-reactivity, (d)Precipitation reactions, (e) Agglutination reactions

Module II: Generation of B and T-cell Responses and Effectors (11 hours) (20 marks)

Unit 1: Humoral and Cellular immunity(8Hrs): Cells involved in Immune responses (antibody mediated and cell mediated) and Immune Mechanisms in detail (Phagocytosis, ADCC, etc.); B-cell receptor (BCR) and T-Cell receptor TCR-CD3 complex; Activation, maturation, and differentiation of B-Cells and T-Cells.

Unit 2: Cytokines (3 Hrs): Cytokines and Chemokines, Properties of Cytokines, Cytokine antagonists, Cytokine secretion by TH1 and TH2-cells.

Module III: Host Microbiome Interactions and Complement System (10 hours) (14 marks)

Unit 1 Host microbiome interactions (5 hours): Immune regulation by dietary factors and intestinal microbiota. Microbiota and innate lymphoid cell interactions: Toll-like receptors.

Unit 2 Complement components and functions (5 hours): Complement Activation pathways (Classical, Alternate, Lectin), Complement regulation, biological consequences of complement activation, and complement deficiencies.

Module IV: Clinical Immunology (17 hours) (21 marks)

Unit 1 Hypersensitivity Reactions (3Hrs): Allergens, Types I-IV Hypersensitivity reactions; Immune mechanisms and examples, Cytokine shock or Cytokine release syndrome (CRS), Cytokine related diseases; (Bacterial septic shock, Chaga's disease, lymphoid and myeloid cancers).

Unit 2 Tumor Immunology (3 Hrs): Tumor specific and Tumor associated antigens, Cells involved in cancer cell detection and clearance- Functions of Macrophages, natural killer cells, and dendritic cells in cancer.

Unit 4 Primary and secondary immune deficiency diseases (3 Hrs): Primary immune deficiency diseases: Burton's disease, Di-George syndrome, SCID; Secondary immune deficiency diseases: AIDS, HIV transmission, vaccines.

Unit 4 Transplantation antigens (5Hrs): MHC molecules, structure and functions, MHC genes, types of grafts, Antigen processing and presentation, Exogenous and Endogenous pathways; Presentation of non- peptide antigens; Immunological basis of graft rejection. General immune suppressive therapy.

Unit 5 Vaccines and Immuno-therapy (3 hours): Types of Vaccines (Active and passive immunization, Whole organism vaccines; Recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines; Multivalent vaccines, Adoptive cellular therapies in cancer, Immunotherapy; and therapeutic uses of cytokines; Clinical uses of Monoclonal Antibodies

Module V: Open ended - (12 hours)

The teacher can design student activities related to Advanced Immunological Applications:

Suggestions: Immuno-techniques: Competitive and non-competitive assays (ELISA, RIA, Immunodiffusion, Direct and indirect agglutination reactions, Immunoelectrophoresis, Immuno Blot, Immuno-histochemistry, Immuno fluorescence, Flow cytometry) etc.

Antisera- Production and applications, Antibody engineering, Antiviral Immunity

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ONLINE SOURCE

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6					3					2		2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6		✓		

ADVANCES IN BIOTECHNOLOGY AND MICROBIAL PROCESSING

Programme	B.Sc. Zoology Honours				
Type of Course	Major				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop understanding in gene cloning, biotechnological techniques like FISC, McFISH, GISH, construction of genomic library, Chromosome walking etc., Intellectual property rights, Ethics in genetic engineering; Bioprocesses and microbial use in industry, and bioprocess technology				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the features of various types of cloning vectors and explore different steps involved in molecular cloning	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the techniques involved in the production of molecular probes, Genomic and cDNA library, analyse techniques involved in isolation, sequencing and synthesis of genes, and get familiar with the biotechnological techniques like antisense RNA and their applications	U &An	F&C	Short answer, Paragraph, questions
CO3	Describe the basic principles of bioprocess, types of fermentation, upstream processing	U	F&C	Short answer, Paragraph, questions
CO4	Describe role of microbes in Industry, the functioning of Bioreactors, and down-stream processing	U	F&C	Short answer, Paragraph, Essay questions
CO5	Conduct seminars, submit assignments,	An	F&C	Assignments, seminars
CO6	Explain various aspects of IPR, the ethical issues in cloning, GM food crops and social implications of biotechnology in the body.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

PART A BIOTECHNOLOGY

MODULE 1. Introduction to gene cloning methods (13hrs) (Out of 70: 21 marks)

Unit 1. Cloning vectors(4hrs)–Plasmids: pBR322 and pUC; Phages: λgt10 and M13vector; Cosmids: general features; Phagemids: general features; Viruses: SV40 and CaMV; **Transposones**; Ac transposon and Ds transposon of Maize, P-element of *Drosophila;* **Artificial chromosomes**: BAC, YAC and MAC.; Shuttle vectors: applications and example; **Expression vectors**: mention commonly used promoters in expression vectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus

Unit 2. Construction of chimeric DNA (3Hrs)- (Blunt end ligation, cohesive end ligation, homo-polymer tailing, use of linkers) Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization; Amplification – Multiplication, Expression, and integration of the DNA insert in host genome.

Unit 3. Molecular probes and Applications (2hrs) - FISH, McFISH and GISH

Unit 4. Construction of Genomic library. (4hrs) -Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity; **Chromosome walking**

MODULE 2. Advanced techniques in Biotechnology and Intellectual property rights (15hr) (15 marks)

Unit 1: PCR methods(3hrs)- Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR, Applications of PCR in Biotechnology and genetic engineering

Unit 2: DNA sequencing and gene synthesis(3hrs) – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method, NGS. ; Gene synthesis machines

Unit 3: Anti-sence Technology (2Hrs): Antisense RNA and its applications in biomedical and agri-culture fields, RNA interference, Gene knockouts and Knock out mouse

Unit 4: Cloning procedures (2hrs): (adult DNA cloning, Therapeutic cloning, Embryo cloning)– Advantages and disadvantages of cloning

Unit 5. Intellectual property rights and ethical and social implications of Biotechnology (3hrs)

Intellectual property protection, Patents, copy right, trade secrets, trademarks, GATT and TRIPS, patenting of biological materials, International co-operation, obligation with patent applications, implications of patenting- current issues, Social acceptance of medical biotechnology- Various cloning procedures,

Unit 6: Ethics of Genetic engineering (2hrs) - Social impacts - Human safety-Virus resistant plants-Animals and ethics- Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology, Social acceptance of biotechnology-Transgenic crops - Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology

MODULE 3: Module 4: Introduction to Bioprocess & Microbes in Industry (9hrs) (14 marks)

Unit 1. Introduction to bioprocess engineering (6Hrs): Basic principles of bioprocess. Types of fermentation: batch, fed batch and continuous fermentation systems. Microbes in industrial process: Isolation, screening and maintenance of microbes for industrial processes. Strain improvement. Microbial growth kinetics.

Unit 2. Upstream processing (3hrs): Microbial Nutrition, Media formulation for industrial fermentation. Development of inocula for the industrial fermentations. Scale up procedures.

MODULE 4: Bioprocess Technology (11hrs) (20 marks)

Unit 1. Bioreactors (4Hrs): batch, fed –batch and continuous bioreactors, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.

Unit 2. Industrial production of chemicals (3hrs): alcohol (ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol, antibiotics (pencilliin, streptomycin, tetracycline), amino-acids (lysine, glutamic acid), single cell protein. Enzyme and whole cell immobilization and their industrial applications.

Unit 3. Downstream processing (4hrs): Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid – liquid extraction chromatography, Membrane process. drying and crystallization. Effluent treatment D.O.C. and C.O.D. treatment and disposal of effluents.

MODULE 5: Open ended (12hrs)

The teacher can design student activities related to Module 2 and 3

References

Part- A- Biotechnology

1. Alphey - DNA sequencing-Bios Scientificpublishers-
2. Bernard R. Glick and Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press WashingtonD.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification- Experimental procedures and process rationale - Oxford UniversityPress.
4. Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall ofIndia
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge Universitypress.
6. Dale. J.W. and Malcom von Scantz. From genes to genome- Concepts and Applications of DNA Technology
7. Dominic, W.C. Wong-The ABCs of gene cloning-Springer internationaledition
8. Dubey, R.C. -A text book of biotechnology-S. Chand &Co.
9. Emmanuel. C., Rev. Fr. Ignacimuthu. S. and Vincent. S. Applied Genetics: Recent Trends and Techniques, MJP Publishers,Chennai
10. Gupta. P.K. -Elements of biotechnology-Rastogipublications.
11. Singh, B.D.(2002).Biotechnology-Kalyanipublishers.
12. Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt.Ltd.
13. Wilson and Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low priceeditions.
14. Ausubel, F.M., Brebt,R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith,J.A. and Struht,K.(2002). Short Protocols in Molecular Biology. John Wiley and Sons,Inc.
15. Alberts, B., Bray, D., Lewis, J., Raff., M, Roberts, K. And Watson, J.D. (2000). Molecular Biology of the cell. Garland Science, NewYork.
16. Brown .T.A. (2002).Genomes II ed. John Wiley and Sons, NewYork.
17. Freshney, Ian R. (2006). Culture of Animal Cell. 5thed. Wiley-LissPublications.
18. Glick, B. R. and Pasternak, J.J. (1998). Molecular Biotechnology-Principles and Applications of Recombinant DNA.

BIOPROCESSING

19. Reference Books: 1. Biochemical Engineering, Aiba,S., Humprey,A.E., and Millis,N.F., Unty. of Tokyo Press, Tokyo.
20. 2. Biochemical Reactors. Atkinson,B., Pion, Ltd., London.
21. 3. Biochemical Engineering Fundamentals. Baily,J.E., and Ollis,D.F., McGraw – Hill Book Co. New York.
22. 4. Bioprocess Technology: Fundamentals and applications, KTH, Stockholm. 5. Process Engineering in Biotechnology, Jackson,A.T., Prentice Hall, Engelwood Cliffs.
23. 6. Bioprocess engineering: Basic Concepts, Shuler,M.L., and Kargi,F., Prentice Hall, Engelwood Cliffs.
24. 7. Principles of Fermentation Technology. Stanbury,P.F., and Whitaker,A., Pergamann Press, Oxford.
25. 8. Bioreaction Engineering Principles ,Neilson,J., and Villadsen,J. Plenum Press.
26. 9. Chemical Engineering Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE. 30
27. 10. Biochemical Engineering, Lee,J.M., Prentice hall Inc.
28. 11. Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression, Vieth, W.F., John Wiley and Sons, Inc.

ONLINE SOURCE

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

DISCIPLINE SPECIFIC ELECTIVE COURSES

ENVIRONMENTAL BIOLOGY I: ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	Students develop fundamental understanding of law with Environmental law and its policies. Which prepares students in the context of how to create their own presence felt in the society after completing the program, develop service orientation amongst the students				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the meaning, Concept, basic knowledge of environment, pollution, Various principles and legislations.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain the Constitutional provisions for the protection of environment.	U & An	F&C	Short answer, Paragraph, questions
CO3	Analyse the need for minimizing the environmental impacts of developmental activities.	U	F&C	Short answer, Paragraph, questions
CO4	Explain the environmental legislation and clearance procedure in the country.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Prepare analytical reports on recent amendments of environmental laws, Conduct an environmental audit	An	F&C	Assignments, seminars
CO6	Explain various metrics for assessing the environmental impacts of any developmental activities.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Environmental Laws (17 hours) (Out of 70: 21 marks)

Unit1: **Concept and development of environmental law (4hrs)**: International development of Environmental Laws -Role of UNO with environment -Stockholm declaration -1972 -Bhopal gas tragedy. Role of judiciary in environment protection. Remedies for environmental pollution under the different laws.

Unit 2: National Environmental Policy Statement on abatement of pollution legislation(9hrs): The Environmental Protection Act, 1986.The Air (Prevention and Control) Act, 1981 – Noice pollution; The Water (Prevention and Control) Act, 1974; The Environmental (Protection) Act, 1986;. Ozone depleting substances (Regulation and Control) Rules, 2000; National Green Tribunal Act, 2010., Single use plastic (Regulation) Act, 2022., CPCB and SPCB., Functions and powers of CPCB. Sustainable development, Polluters pays principle, Role of M.C. Mehta in protection of environment pollution.
Unit 3. Biodiversity Conservation acts (4hrs): Indian forest Act, 1927, The Forest Conservation Act, 1980; The Wildlife Protection Act, 1972; Biodiversity Act, 2002

Module 2: Organizations and Conventions (9 hours) (14 marks)
Unit 1: **National and International Organizations dealing with Environmental Issues(4hrs)**: UNEP, IUCN, UNDP, UNCCD, NBA, MoeFCC, BNHS, ANERT.
Unit 2: **Famous Environmental Conventions (5hrs)**; Role of Government and NGO's in environmental protection; Women participation. UNFCCC - COP25, Kyoto, Montreal Protocol, Bonn convention.

Module 3: National Action Plan (10 hours) (15 marks)
Unit 1: National Action Plan on Climate Change (7hrs)- Eight National missions– Solar Mission, Mission for Enhanced Energy Efficiency, Mission on Sustainable Habitat, Water Mission, Mission for Sustaining the Himalayan Ecosystem, Mission for a 'Green India', Mission for Sustainable Agriculture, Mission on Strategic Knowledge for Climate Change).
Unit 2: Environmental impact metrics (3hrs): Ecological footprint, Carbon Footprint, Carbon Trading, Carbon Diet, Carbon Credits.

Module 4: EIA and Environmental Audit (12 hours) (20 marks)
Unit 1: Aims and objectives of Environmental Impact Assessment (6hrs): EIS; EMP; Environmental Clearance; Impact Assessment Methodologies; EIA Notification –2006 and amendments; Public Participation; Status of EIA in India-Current trends and strategies.
Unit 2: Life-cycle analysis(6hrs); cost-benefit analysis; Guidelines for Environmental Audit; Environmental Management System Standards (ISO 14000 series); Eco-labeling schemes, Eco-tourism-major ecotourism projects in India and Kerala.

Module 5: Open ended (12hrs): Teacher can design student activities based on latest amendments, laws and acts discussed in module 1

REFERENCES

1. Environmental Audit, Shrivastava, A. K., New Delhi, India.
2. Environmental Impact Assessment, Canter, L.W., McGraw Hill, New York.
3. Environmental Protection and Laws, Jadhav, H &Bhosale, V.M., Himalaya Pub. House, Delhi.
4. Handbook of Environmental Laws, Rules Guidelines, Compliances and Stadards, Vol I and II, Trivedi R.K., Enviro Media.
5. Text Book on Environmental Impact Assessment, Barthwal, R. R., New Age International Private Limited.
6. Environmental Law P. S. Jaiswal
7. Environmental Law Sukanta Nanda
8. Environmental Law S.C. Tripathi
9. Environmental Law M. M. Chaturvedi
10. Environmental Law Lal Environmental Law S.K. Mohante

Visit to pollution control Board
• Interaction with Eminent Environmental Experts
• Field trip to tribal areas
• Visit to NGO for environment protection

Online resources:
Swayam
http://egyankosh.ac.in//handle/123456789/80118

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate/ Medium
3	Substantial / High

Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

ENVIRONMENTAL BIOLOGY II: ENVIRONMENTAL CHEMISTRY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	Students develop fundamental understanding of law with Environmental law and its policies. Which prepares students in the context of how to create their own presence felt in the society after completing the program, develop service orientation amongst the students				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the smog formation, the features of different types of atmospheric pollution	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the water quality parameters and its analysis	U & An	F&C	Short answer, Paragraph, questions
CO3	Describe the methods of soil analysis	U	F&C	Short answer, Paragraph, questions
CO4	Describe the instrumental techniques for environmental analysis, metallurgical and refinery operations, manufacturing of cement.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Analyse ecological parameters of selected area, report preparation	Ap	F&C	Assignments, seminars, report writing
CO6	Explain the composition of air, classification of elements, different ions and radicals in the atmosphere.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Atmospheric chemistry (15hrs) (Out of 70: 21 marks)

Unit 1: Chemistry of troposphere and stratosphere (4hrs): Chemical composition of air, Classification of elements, chemical speciation' Particles, ions and radicals in the atmosphere.

Unit 2: Chemistry of smog formation (3hrs): Aerosols: PM 10, PM 2.5; chemistry of acid rain, sources of NOX and SOX, role of CFCs in ozone layer depletion. Photochemical smog**.**

Unit 3: Environmental pollution(8hrs): Definition. Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear pollution. Solid waste management: Causes, effects and control measures of urban and industrial wastes, Case study analysis.

Module II: Water chemistry (10hrs) (14 marks)
Unit 1: Fundamentals of water quality(6hrs): Properties of water, Concept of DO, BOD, COD, hardness; Solubility of gases in water; Concept of acidimetry, alkalimetry, iodometry, gravimetry, conductimetry.
Unit 2: Water pollutants(4hrs): Types sources. Aquatic chemistry of heavy metals like Hg, Cd, Cr and As, metalloids-organic, biological and radioactive., impact on living system

Module III: Soil Chemistry (11hrs) (15 marks)
Unit 1: Soil composition (5hrs): Types, origin and evolution, particles in soil**,** Soil profile, distribution of inorganic and organic components in soil.
Unit 2: Physicochemical properties of soils (6hrs)- Saline, Acidic and Alkaline soils. Relation between organic carbon and organic matter, inorganic and organic components in soil; soil humus; nitrogen, phosphorus and potassium in soil.

Module IV: Industrial applications and techniques (10hrs) (20 marks)
Unit 1: Industrial Chemistry (7hrs): Basic metallurgical operations (pulverization, calcinations, roasting, refining of Aluminium). Composition and uses of coal, Mining and refining of Petroleum; Classification and manufacture of cement.
Unit 2: Instrumental Techniques (3hrs): Principle and application of Atomic Absorption Spectrophotometry and Flame photometry.

Module V: Open ended (14hrs): Teacher can design student activities like seminar, assignments and project activity like, analyzing ecological parameters of the campus of any selected area, preparation of reports.

REFERENCES
1. Environmental Science. S. C. Santra, New Central Book Agency.3rd edition, 2011.
2. Environmental Science: Toward a Sustainable Future. Richard T. Wright, Dorothy F. Boorse, Pearson Publications, 12th Edition, 2015.
3. Environmental Studies. Benny Joseph. McGraw Hill Education; Third edition, 2017.
4. Fundamentals of Environmental Studies. MahuaBasu and Xavier Savarimuthu SJ, Cambridge publications. 2017.
5. Vogel's Text book of Quantitative Inorganic Analysis.
6. Instrumental Methods of Analysis H. Kaur

Online resources:

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

ENVIRONMENTAL BIOLOGY III: ENVIRONMENTAL MICROBIOLOGY AND BIO-TECHNOLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student develops understanding in Biotechnological applications for environmental restoration and agricultural practices, diversity of microbes in environment				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain Biotechnological applications in agricultural practices: production of bio-opesticides, bio-compost etc.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain Biotechnological applications in environmental restoration, bioremediation, Oil and metal recovery etc.	U &An	F&C	Short answer, Paragraph, questions
CO3	Describe the applications of biopolymers, biosensors, bioplastics, etc., concept of bio-indicators.	U	F&C	Short answer, Paragraph, questions
CO4	Explain the diversity of microbes in air, water and soil; techniques of bacteriological analysis, composition of sewage.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Analyse microbial diversity of soil and water of selected area.	An	F&C	Assignments, seminars, report writing
CO6	Explain the factors influencing the bio-compost production,	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Biotechnology for Sustainable Agriculture (14hrs) (Out of 70: 20 marks)

Unit 1: Environmental Biotechnology (7hrs(: Meaning, objectives, need and scope. Applications of environmental biotechnology . Bio-pesticides: Classification of bio-pesticides, Microbial bio-pesticides production process, stabilization, formulation, mode of action, Plant Product as bio-pesticides. Bio-fertilizers: Types of bio-fertilizers, Production and role in soil fertility, Agro based solid waste & its use

Unit 2: Composting(4hrs): Composting technology and methods of production, Design aspects and factors influencing the process, Temperature trends and influencing factors, Composition and quality of compost**.** Vermicomposting: Earthworm life cycle, Operating process, Characteristics of vermicomposting
Unit 3: Genetically Modified Organisms (GMOs)(3hrs): GMO's concept, Environmental, ethical, social and health problems associated with GMO's, Biosafety regulations, Cartagena protocol

Module II: Bioremediation (13hrs) (15 marks)
Unit 1: Microbial Remediation Process(4hrs): Principles of bioremediation, Concept of bio augmentation and bio stimulation, Factors affecting the bioremediation process: microbial metabolism, environmental conditions and nature of pollutants, Types of Bioremediation.
Unit 2: Phytoremediation(5hrs): Concept, factors affecting phytoremediation, Plants useful for phytoremediation, removal of metals and organic pollutants. Types of phytoremediation: Phytoextraction, Phyto-stabilization, Rhizo-filtration, Phyto-transformation, Phytovolatilization, Current developments in the process.
Unit 3: Oil and Metal recovery(4hrs): Microbial Enhanced Oil Recovery (MEOR), Methods used and role of microorganism in MEOR. Metal recovery: Types of bioleaching, Methods for bioleaching, metal precipitation, Microbes for bioleaching, Advantages and disadvantages of bioleaching.

Module III: Biopolymers, Biosensors and Bio-indicators (8hrs) (15 marks)
Unit 1: Biopolymers and bioplastics (4hrs): Biopolymers. Types of biopolymers and its applications. Bio-sensors. Design and components. Applications of biosensors in environmental monitoring
Unit 2: Bio-indicators (4hrs): Concept of bio indicators, Plankton community as indicators of water pollution; microbiological quality of potable waters, Microbial indicators organisms, lichens as air pollution indicators.

Module IV: Microbial population in Environment (13hrs) (20 marks)
Unit 1: Microbial population in Air (4hrs): Indicator microorganisms in air, Distribution and sources of air borne microorganisms Air borne diseases Bioleaching of metals, acid mine drainage.
Unit 2: Microbial Population in Water (4hrs): Microbial communities in natural water Sanitary quality of water: bacteriological evidence of faecal pollution, indicators of faecal pollution. Bacteriological analysis techniques of water
Unit 3: Microbial Diversity in Soil (5hrs): Introduction and historical background of soil microbiology, Soil microflora, Interactions among soil microorganisms: neutralism, symbiosis, commensalisms, ammensalism, parasitism and predation. Sewerage system: Composition of sewage, kinds of sewerage systems-sanitary, storm and combined sewers Microorganisms in sewage-fungi, protozoa, algae, bacteria and viruses

Module V: Open ended (12hrs) Teacher can design student activities related to module IV, conduct microbial analysis of soil and water of selected area, and prepare report

REFERENCES:

1.Environmental Biotechnology. M. H. Fulekar.
2.Environmental Biotechnology: Basic Concepts and Applications. InduShekhar Thakur, I. K. International Pvt. Ltd.

Online Sources
1

2
3

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

PARASITOLOGY I: GENERAL PARASITOLOGY AND NON-HELMINTH PARASITES

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop understanding about various groups of parasites, and organisms which serve as their hosts, important protozoan parasites of humans and other animals etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Recognize different groups of organisms in terms of their role as hosts and vectors of the parasites, Explain the parasitic adaptations, ecological terms in parasitology, the role of different animal groups as hosts and vectors of parasites, parasitic effects on hosts.	U	F&C	Short answer, Paragraph, questions
CO2	Analyse the features of host organisms and predict the probable condition of parasitic infection, list out the invertebrates and vertebrates, which serves as hosts for parasites.	U &An	F&C	Short answer, Paragraph, Essay questions
CO3	Describe the morphology, life cycle, pathology and prophylaxis of the protozoan parasites.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Describe the importance of arthropods from the medical and veterinary point of view, morphology, life cycle, pathology, importance and control measures of arthropod parasites and vectors.	U	F&C	Short answer, Paragraph, questions
CO5	Prepare notes, assignments, seminars on other arthropods of medical and veterinary importance.	An	C& M	Assignments, seminars

CO6	Describe the importance of control of parasitic diseases and its effects on world economy.	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

MODULE. 1. Introduction to Parasitology (9hrs): (Out of 70: 15 marks)
Unit 1. History of Parasitology(2hrs); Parasitology and human welfare; Types of parasites and hosts; Transmission of parasites;
Unit 2. Parasitic adaptations(2hrs)- morphological, physiological, biochemical and Immunological.
Unit 3. Ecology of parasites(5hrs) –Epidemiology, ecosystem and parasites; Parasitism as an interspecific interaction; host demography; ecological terms in Parasitology. Parasitic Zoonoses – Epidemiology of parasitic zoonoses, social and cultural aspects of parasitic zoonoses; world economy and parasitic diseases.

MODULE 2. Hosts and Vectors of parasites (10hr) (16 marks)
Unit 1. Invertebrates and vertebrates as vectors and hosts(3hrs) – Annelida, Arthropoda, Mollusca; Fishes, Amphibians, reptiles, Birds, Mammals;
Unit 2. Parasites as vectors of pathogens (1hr)– Nematodes, Leaches, insects.
Unit 3. Effects of parasites on hosts(6hrs) -parasite induced modifications of the host, growth factors, effect on behavior, parasitic castration, effects of toxins, poisons and secretions, modification of the host cells produced by intracellular protozoa; parasite effects benefitting parasites; counter measures of hosts; parasitism and altruism; parasitism and life history theory; parasite effects benefiting hosts.

MODULE 3. Protozoology (18hrs) (20 marks)
Unit 1. General characters and outline classification of parasitic protozoa (3hrs)
Morphology, life cycle, pathology and prophylaxis of the following
protozoan parasites:
Unit 2. Phylum Mastigophora & Sarcodina (7hrs)- *Trypanosoma, Leishmania, Chilomastix, Giardia, Histomonas, Trichomona;* Phylum **Sarcodina** – *Entamoeba, Naegleria floweri*
Unit 3. Phylum Ciliophora& Apicomplexa(6hrs)– *Balantidium,* Phylum **Apicomplexa** – *Eimeria, Toxoplasma, Plasmodium, Babesia, Theileria, Sarcocystis*.
Unit 4. Phylum Myxozoa &Microspora (2hrs)– *Myxosoma cerebralis;* Phylum **Microspora –** *Nosema bombysis*

MODULE 4. Medical and Veterinary Entomology (11hrs) (19 marks)
Unit 1. Introduction(2hrs)- Importance of arthropods from the medical and veterinary
point of view.
Morphology, life cycle, pathology/ vector importance and control
measures of following arthropods:
Unit 2. Diptera & Siphonaptera (5hrs)- : *Phlebotomus, Glossina, Anopheles, Culex, Aedes, Mansonia, Tabanus, Chrysops*., Siphonaptera: *Ctenocephalides, Xenopsylla, Pules, Tunga*
Unit 3. Phthiraptera & Hemiptera(4hrs): *Pediculus, Pthirus,* A brief account on lice of veterinary importance, Hemiptera: *Cimex,* Triatomine bugs.

MODULE 5. Open ended(12hrs): The teacher can design student activities related to the Module 4, like assignments, seminars, collection of parasite; collecting notes and references on other arthropode parasites like, Arachnida *a)* Ticks: *Argas, Rhipicephalus, Boophilus, Hamaphysalis*

b) Mites: *Sarcoptes, Knemidokoptes, Leptotrombidium* Crustacea *Lernaea, Sacculina, Caligus*
Myiasis: Definition, types, medical and veterinary importance, Venomous, Urticating and Allergic Arthropods

References:

Chandlar, A.C & Read, C.A (1961): Introducation to Parasitology, john Wiley and Sons, Inc,Newyork
Chatterjee, K.D (1981): Parasitology, Chatterjee Medical Publisher, India
Cheng, T.C (1986): General parasitology, Academic Press, college Division, New York
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Online Sources

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

PARASITOLOGY II: HELMINTHOLOGY

Programme	B. Sc. Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop understanding in diversity and biology, pathogenesis, prophylaxis of helminth parasites.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the role of helminth parasites in the human and animal welfare, classification of helminths.	U	F&C	Short answer, Paragraph, questions
CO2	Explain the biology, pathogenicity and prophylaxis of trematode parasites.	U &An	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the biology, pathogenicity and prophylaxis of Aschelminth parasites.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Enlist major molluscan hosts of trematode parasites, and describe their classification and role in parasitic transmission	U	F&C	Short answer, Paragraph, questions
CO5	Prepare the reports on the cases of parasitic infection, effects on hosts due to parasitic infection.	An& C	C& M	Assignments, seminars
CO6	Suggest methods to prevent parasitic infections, based on their mode of infection and life cycle.	C	C&M	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Introduction& Classification of parasitic helminthes (11hrs) (Out of 70: 15 marks)

Unit 1. Importance of helminth parasites to human and to animal welfare (3hrs)

Unit 2. Characters and outline classification of parasitic helminthes upto orders(8hrs)– Trematodes, Cestodes and Nematodes and Acanthocephala

Module 2: Helminth parasites (15hrs) (20 marks)

Morphology, life cycle, pathology and prophylaxis of the following helminth parasites.

Unit1. Phylum Platyhelminthes (8hrs)-Trematodes a) Monogenea :*Polystoma* b) Digenea : *Schistosoma, Fasciola, Clinostomum; Paragonimus, Clonorchis, DicrocoeliumEchinostoma*
Unit 2. Cestodes (7hrs): *Diphyllobothirum, Taenia, Echinococus, Dipylidium, Hymenolepis ,Stilesia, Moniezia*

Module 3: Aschelminthes (12hrs) (20 marks)
Unit 1. Nematoda(11hrs) *Strongyloides, Ancylostoma, Haemonchus, Ascaris, Enterobius, Heterakis Wuchereria, Brugia, Loa, Dracunculus, Trichiura, Trichinella,*
Unit 2. Phylum Acanthocephala (1hr):*Macracanthorhynchus*

Module 4: Freshwater and marine molluscs as intermediate hosts of trematode parasites(10hrs) (15 marks)
Unit 1. Classification of molluscan hosts. (4hrs) – Bivalvia, Gastropoda
Unit 2. Snail hosts found in Kerala (6hrs); *Pila, Bellamya, Limneae, Indoplanorbis, Thiara, Gabbia.* anti- snail measures.

Module 5. Open ended(12hrs): The teacher can design student activities related to the Module 2 & 3 like assignments, seminars, collection of parasite– infected host specimens, and recording of morphological and behavioural changes found in the hosts.

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Melhorn, H(ed) 2008- Encyclopedia of Parasitology vol 112 Springer
Noble, E.R & Noble, G.A (1982): parasitology, Lea & F. Ebiger, Philadephia
Parija, S.Ch. (1990): Review of Parasitic Zoonoses, A.I.T.B.S. Publishers, Delhi
Pathak, K.M.L (1987): Parasitic zoonoses, AgroBotonical Publisher, India
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Solusby, G.D& Roberts, L.S (1989): Foundations of Parasitology, Time Miror/Mosby, St.Louis
Tranger, William (1988): Living together- The Biology of Animal Parasitism, Plenum Publishing Corporation, New York.
World Health Organisation (1993): tropical Diseases – Research Progress 1991 and 1992 W.H.O. Geneva

Online Sources
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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		2		2	3		3					2	

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

PARASITOLOGY III: BIOCHEMICAL, MOLECULAR AND IMMUNOLOGICAL ASPECTS OF PARASITISM

Programme	B. Sc. Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course develops awareness in the metabolic specializations, adaptations, the nature of micro-environments, gene expression and regulation in parasites, diagnostic techniques for parasites				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain Nutritional requirements, Metabolic specializations and adaptations of parasites.	U	F&C	Short answer, Paragraph, questions
CO2	Explain the micro-environments of parasites, host finding mechanisms, and different aspects of effects of parasitic infection on hosts.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Explain the genetics of parasitism: molecular basis of antigenic variation in Trypanosomes and malaria, the kinetoplast and kinetoplast DNA (kDNA), gene expression and regulation in parasites- telomeric gene expression, discontinuous transcription of mRNA, trans-splicing and RNA editing of protozoan parasites	U	F&C	Short answer, Paragraph, Essay questions
CO4	Enumerate diagnostic techniques for parasites.	U	F&C	Short answer, Paragraph, questions
CO5	Prepare the survey reports on the frequency of diagnostic tests for parasitic infection.	An& C	F&C	Assignments, seminars, report writing
CO6	Describe principles of molecular diagnostic techniques for parasitic infections.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1 Structure and functions of host(12hrs) (Out of 70: 15 marks)

Unit 1. parasite interface in intracellular and extracellular parasites. (1Hr)

Unit 2. Nutrition and Metabolism (6hrs): Nutritional requirements, uptake of nutrients, digestion, biochemistry (energy metabolism: carbohydrate and energy metabolism in anaerobic protozoa, aerobic protozoa, apicomplexa and in parasitic helminthes; aminoacid and protein metabolism in parasites, energy sources and respiration,
Unit 3. metabolic specialization and adaptations in parasites(5hrs): excretory system, nitrogen excretion, water and ionic regulation. Neurotransmitters in nematodes and platyhelminthes.

Module 2: Micro- environment and the phases of parasitism(12hrs) (20 marks)
Unit 1. Host organ system as habitat(2hrs): Vertebrate alimentary canal, mammalian blood: phases of parasitism- host finding, physiological effect.
Unit 2. Effects of parasites on hosts(5hrs): parasite induced modifications of the host, growth factors, effect on behavior, parasitic castration, effects of toxin. poisons and secretions, modification of the host cells produced by intracellular protozoa.
Unit 3. Parasites and hormones(5hrs): parasite hormones, influence of parasites on host endocrine system, importance of host hormones for parasites, therapeutic use for a better understanding of Parasites endocrine system, parasitic maturation and reproduction, cultivation of parasites in vitro with special reference to differentiation in the life cycle.

Module 3 Genetics of parasites(12hrs) (20 marks)
Unit 1. Parasitic genomics(2hrs). Molecular organization and gene structure in protozoa.
Unit 2. Platyhelminthes, nematodes and ticks(3hrs): molecular basis of antigenic variation in African Trypanosomes and malaria,the kinetoplast and kinetoplast DNA (kDNA), gene expression and regulation in parasites- telomeric gene expression, discontinuous transcription of mRNA.
Unit 3. RNA processing in parasitic organism(7hrs): trans-splicing and RNAediting in kinetoplastid parasites, transfection systems in kinetoplastid flaellates, homologous gene recombination, genetic exchange in malarial parasites and trypanosomes; chromosome and gene exchange in malarial parasites and trypanosomes; transcription–unusual modes of transcription in trypanosomes and in nematodes; chromosome and gene mapping in parasites.

Module 4: Diagnosis of parasitic infections(12hrs) (15 marks)
Unit 1. Histological & Serological Diagnosis(8hrs)- Histological- Biopsy, Faecal exam- (Ova and Parasite test); serological tests – ELISA, RST, Neutralization assay, CLIA, LFIA, IFA, Agglutination assay, Precipitation test, Western Blot, Complement fixation test,
Unit 2. Molecular Diagnosis (2hrs) - Role of rDNA technology in parasitic diagnosis, taxonomic and systematic relationships.
Unit 3. Drug resistance in parasites and medical implications of Molecular Parasitology (2hrs)

Module 5. Open ended(12hrs): The teacher can design student activities related to the Module 4, like assignments, seminars, conduct survey to find the frequency of diagnostic tests for parasitic infections conducted in clinical laboratories.

References:
Chandlar, A.C & Read, C.A (1961): Introducation to Parasitology, john Wiley and Sons, Inc, Newyork
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Cheng, T.C (1986): General parasitology, Academic Press, college Division, New York
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Mapping of COs with PSOs and POs :

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CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

FORENSIC BIOLOGY I: BIOLOGICAL EVIDENCES & FORENSIC SEROLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course is to make the students become familiar with the fundamentals of various disciplines in forensic science with an emphasis on forensic biology related to sero-biology, DNA, medicine, odontology, microbes and wild life. The course discusses and justifies the application of biological sciences to forensic sciences. The teacher designed modules help in demonstrating their skills in biologically based laboratory analysis and interpret the findings by applying their critical thinking skills in forensic sciences.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the importance of biological fluids in crime investigations and gain knowledge of composition, formation and function, collection and preservation of biological fluids.	U	F&C	Short answer, Paragraph, questions
CO2	Describe the morphological and biochemical organization & to know the forensic importance of hair evidence & fibres, and identification of various botanical evidences in forensics	U	F&C	Short answer, Paragraph, questions
CO3	Describe the basis of blood typing and understand how characterization of blood stains is done, Understand the collection, evaluations and tests for identification of blood, urine, semen, saliva, sweat and milk–in crime investigations	U	F&C	Short answer, Paragraph, Essay questions
CO4	Explain the usefulness of genetic markers in forensic investigations, The forensic importance of blood stain patterns and their documentation.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Critically assess the principles and strategies employed in managing insect pests, including both ecological and traditional methods.	An	F&C	Assignments, seminars

CO6	Explain the basic principle of DNA analysis, the forensic significance of DNA typing, Understand the importance of short tandem repeats and restriction fragment length polymorphism in DNA technique	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module I: Biological evidences(12hrs) (Out of 70: 15 marks)

Unit 1. Hair analysis (4hrs)-Morphology and biochemistry of human and animal hair, Structure of hair and hair follicle, Hair cycle- anagen, catagen, telogen. Collection and preservation of hair samples. Morphological and microscopic examination of human and animal hair. Microscopic features- diameter, pigment, cortex, cuticle, cross section. ABO grouping and isozyme typing from hair roots. Determination of species origin, race, sex and site from hair.

Unit 2. Forensic aspect of fibre examination(3hrs)- Types of fibre: fluorescent, optical properties, refractive index, birefringence, dye analysis etc. Collection and preservation of fiber evidence, Forensic Examination of Fiber.

Unit 3. Diatoms(2hrs): Isolation of diatoms from various body organs and their forensic significance in drowning cases.

Unit 4. Types of woods, timbers, seeds and leaves and their forensic importance(2hrs): Identification and matching of various types of wood, timber varieties, seeds and leaves.

Unit 5. Identification of pollen grains, Identification of starch grains, powder and stains of spices etc. (1hr)

Module II: Body fluids (10hrs) (9 marks)

Unit 1. Introduction (7hrs): Composition, formation and function of body fluids. Collection and preservation of biological fluids. Types and distribution of body fluids (semen, synovial fluid, gastrointestinal secretions, tear, milk, faeces, saliva, aqueous humour, Vaginal fluid, epithelial cells, etc.).

Unit 2. Blood and its variants (3hrs): Blood composition, Blood group antigens and classification of blood cell antigens, Forensic significance of ABO blood group.

Module III: Immunology, Serology& DNA Profiling (14hrs) (25 marks)

Unit 1. Methods on Blood and other body fluids(6hrs) (Methods of ABO blood grouping (absorption-inhibition, mixed agglutination and absorption elution) from bloodstains and other body fluids/stains viz. menstrual blood, semen, saliva, sweat, tear, pus, vomit, hair, bone, nail etc., blood group specific ABH substances. Secretors and non- secretors; Blood groups that make racial distinctions. Lewis antigen, Bombay Blood groups. HLA antigens and HLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls in red cell typing.

Unit 2. Possible sources for DNA(6hrs): Collection, transportation and preservation of various forensic samples for DNA profiling. DNA extraction techniques for different forensic samples (early techniques, solid phase extraction, differential extraction, chelex extraction, automated techniques, commercial extraction kits), RNA extraction from different forensic samples. Determining quality and Quantity of DNA and RNA, Gel elution technique. DNA Amplification: Types of PCR.

Unit 3. Profiling Applications(2hrs): Case studies in disputed paternity cases, child swapping, missing person's identity, civil immigration, veterinary, wild life and agriculture cases.

Module IV: Determination of human and animal origin (12hrs) (21 marks)

Unit 1. Determination of human and animal origin(6hrs) From bones, hair, flesh, nails, skin, teeth body tissue, fuids/ stains viz. blood, menstrual blood, semen, saliva, sweat, tear, pus, vomit, etc., through immune diffusion and immuno - electrophoresis, cross reactivity among closely related species. Individualization of blood stains: Determination of blood groups, sex age and racial origin from dried bloodstains.
Unit 2. Red cell enzymes(2hrs): Genetics, polymorphism and typing of PGM, GLO-I, ESD, EAP, AK, ADA etc. and their forensic significance.
Unit 3. Serum proteins(4hrs): Genetics, polymorphism and typing of- Hb, HP, Tf, Bf, C3 etc. and their forensic significance.

Module 5: Open end(12hrs)
The teacher can design student activities related to Module I, II (as a. to examine hair morphology and determine the species to which the hair belongs, b. to prepare slides of scale pattern of human hair c. to carry out microscopic examination of diatoms , to cite a crime case in which diatoms have served as forensic evidence) & give assignments & seminars from Module III & IV on Immunology of blood grouping and various blood grouping systems, DNA profiling techniques in Forensics

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Virtual Labs (Suggestive sites)

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ONLINE SOURCES

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
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CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
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Assessment Rubrics:

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- Project/Practical
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Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

FORENSIC BIOLOGY II: WILDLIFE FORENSICS AND FORENSIC MEDICINE

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course is to make the students become familiar with the fundamentals of various disciplines in forensic science with an emphasis on forensic biology related to sero-biology , DNA, medicine, odontology, microbes and wild life. The course discusses and justifies the application of biological sciences to forensic sciences. The teacher designed modules help in demonstrating their skills in biologically based laboratory analysis and interpret the findings by applying their critical thinking skills in forensic sciences.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the nature of wild life crimes and methods of identification, the legal aspects of wild life crimes	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the potential microbes in warfare and Microbes of Forensic Importance & have knowledge of the analytical techniques in toxin analysis	U &An	F&C	Short answer, Paragraph, questions
CO3	Explain the steps involved in processing the death scene and the importance of ascertaining whether the crime was staged to appear as suicide or accident	U	F&C	Short answer, Paragraph, questions
CO4	Explain the importance of bloodstain patterns in reconstructing the crime scene.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Perform analysis of pugmark, insect bite, reptilian skins and scales, microbes, identification of bones, taking their measurements etc	Ap	C&P	Assignments, seminars, report writing
CO6	Explain the recovery and identification of human skeletal remains for analysis	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Wild Life Forensics (11 hrs) (Out of 70: 10 marks)

Unit 1. Protected and endangered species of animals and plants (7hrs) ; Sanctuaries and the importance ;Types of wildlife crimes, different methods of killing and poaching of wildlife animals; Enforcement of wildlife protection policy, Wild animals as pharmacopeias, Wildlife artifacts (Bones, skin, fur, hair, nails, blood, feather, etc.),Trade in wild animals, elephant, Indian rhino, wild cat, poisonous snakes for venom and skin, crocodiles, salamanders, deer, birds (feathers Macau parakeets), whales, sharks, spectacle bear, Himalayan antelopes. Recovering evidence at poaching scenes, Locating the burial: Anomalies on the surface international trade in reptile skins.

Unit. 2. Challenges to species identification of reptile skin products (4hrs): species and products represented in the reptiles kin-trade, reptile scale morphology basics and current limitations, Identifying features of major reptile groups. Identification of pug marks of animals, Wildlife (Protection) Act-1972.

Module II: Microbial Forensics (18hrs) (21 marks)

Unit 1. Introduction (2hrs): Defining the microbial forensics programme, epidemiology, Microbial forensic tools. Dynamics of disease transmission, Outbreak Investigation. Deliberate introduction of a biological agent.

Unit 2. Microbes of Forensic Importance (5hrs): *Bacillus anthracis, Yersinia pestis, Francisella tularensis, Brucella spp., Burkholderia Pseudomallei, Clostridium botulinum, Listeria monocytogenes* and their morphological & biochemical studies. DNA of microbes in soil for crime detection.

Unit 3. Fungi of forensic importance (3hrs): Opportunistic mycoses, *Chytridiomycota zygomycota*, *Aspergillus fumigates*, *Microsporidum*, *Pneumocytosis jiroveci*, *Asp. Flavus* & *Candida* sp, epidemiology, Antifungal agents. Food borne – shigella, salmonella. etc**.**

Unit 4. Forensic Aspects of Biological Toxins (8hrs): Microbial Forensic Analysis of Trace and Unculturable Specimens, etc, Biological agents in warfare: Collection, transportation and preservation of microbial forensic samples; Categories of biological weapons, study of potential bacteria, fungi, viruses, and their toxins, mode of action, identification, preventive measures during handling, laboratory setup, epidemiologic investigation for public health, investigation of suspicious disease outbreak, Biosafety and biosecurity, Bio surveillance, documentation, and case studies, Toxin analysis using mass spectrometry, Non-DNA methods for Biological Signatures, Electron beam based methods for bio-forensic investigations, proteomics development and application for bio-forensics, design of genomics, design of nucleic acid signature for pathogen identification and characterization.

Module III: Forensic Medicine (10hrs) (25 marks)

Unit 1. Death(7hrs): Causes, manner and mode of death, Signs of death and changes after death. Somatic death, molecular death, early changes after death - Algor mortis, rigor mortis, cadaveric spasm, heat stiffening, cold stiffening, post mortem lividity, fluidity of blood. Late changes – putrefaction- external and internal changes-Adipocere, mummification. Determination of time since death, Destruction of body and tissues by maggots and other insects, rodents, fish and crabs, moulds. Medico legal aspects of death- Asphyxia, syncope, coma, death by starvation, Asphyxial death-hanging, strangulation and drowning and Causes and mechanism of traumatic death.

Unit 2. Mechanical Injuries(3hrs): Abrasions, Bruises, Lacerations, Incised wounds, Stab wounds, Firearm injuries, Defence injuries, fabricated injuries. Thermal injuries: Burn and scalds, Lightning, Electricity, Explosions. Chemical trauma. Injuries- Accidental, self-inflicted, or inflicted by others.

Module IV: Forensic Odontology (9hrs) (14 marks)

Unit 1. Definition and Scope of Forensic Odontology(4hrs): Types of dentition, Basic structure of human teeth, types of teeth & their morphology, and determination of age from teeth using various methods, dental anomalies and their role in Personal Identification.

Unit 2. Bitemarks (5hrs): Types & forensic importance. Collection and preservation of samples, analysis of Bite marks, presentation of bite mark evidences in court of law. Role of Forensic Odontology in mass disaster victim identification. Dental Charting. Comparison of Ante-mortem and post-mortem dental records.

Module IV : Open end(12hrs)

The teacher can design student activities related to Practicals of Module I,II,IV(a. Identification of Pugmarks of animals, bite marks of insects, reptilian skins and scales, microbes, b. To study identification and description of bones and their measurements c. Identification of age from dental morphology, d. To investigate the differences between animal and human bones. etc.) & give assignments & seminars from Module III.

Virtual Labs (Suggestive sites)

REFERENCES

1. Concept in wildlife Management, Hosetti, B.B Daya publishing 103House
2. Forensic science in wild life investigation, Linarce, Adrian CRC Press, Taylor & Francis
3. The wild life (protection) act, Baalu, T.R.1972, Nataraj Publication
4. Wild life (Protection act, 1972), Universal Publication
5. Wildlife protection act, 1972; Natraj Publishers
6. Environmental Law- The Law & policy relating to protection of environment, Ball SimonUniversal Law Pub Co, Delhi,
7. Environmental Forensic Principles and Applications, Morrison Robert D, CRC Press,
8. Microbial Forensics : Roger G Breeze, Bruce Budowle, Steven E Schutzer
9. Microbial Forensics : Bruce Budowle, Steven E Schutzer, Roger G Breeze, Paul S Keim,Stephen A Morse Chemical and Physical Signatures for Microbial Forensics: Cliff, J.B, Kreuzer, H.W,Ehrhardt C.J, Wunschel,D.S
10. B.V.Subrahmanyam; Modi's Medical jurisprudence, Lexis Nexis butterworth, (1988)
11. WDS. Mclay; Clinical forensic medicine, Greenwich medical media, (1990)
12. Nandy; Principals of forensic medicine, New central book agency, (1995)
13. R.Shepherd; Simpson's forensic medicine, Oxford University press,(2003)
14. A.K.Mant;Taylor'spriniciples&practiceofmedicaljurisprudence,Wingking-Tongco.Ltd., (2003)
15. D.J.Maio& V.J. Maio; Forensic pathology, CRC press, (1993)
16. C.H.Wecht; Legal medicine annual , ACC Press, (1970)
17. C.H. Polson; Essentials of forensic medicine, Pergamon press, (1973)
18. R. Mortiz& R.C. Morris; Handbook of legal medicine, C.V. Mosby company, (1975)
19. S.K. Lahiri; Elements of medical jurisprudence ,Prabasi press, (1973)
20. I.Gordon&H.A.Shapiro; Forensic medicine, Longman group Ltd., (1982)
21. Forensic recovery of human remains: Dopras, Schultz, Whirler, Williams
22. Advances in Forensic Taphonomy, Method theory and Archaeological perspective.
23. Forensic Dental evidence, Mike Bowers, Elsevier Publ
24. Practical forensic odontology, DH Clark, Butterworth-HeinemmanPublis
25. Forensic odontolgy, G Gustafson, 1st Ed, Elsevier, 1966
26. Forensic Radiology, B.G. Brogdon, 1st Ed, CRP Press, 1998
27. Bite Mark Evidence, Robert BJ Dorian, 1st Ed, CRP Press, 2004

28. Dental Autopsy, William E Silver, Richard R Souviron, 1st Ed, CRP Press, 2009
29. Forensic Dentistry, Senn DR and PG Simson, 2nd Ed, CRP Press, 2010.

ONLINE SOURCES

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

FORENSIC BIOLOGY III: FORENSIC ENTOMOLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course is to make the students become familiar with the fundamentals of various disciplines in forensic science with an emphasis on forensic biology related to sero-biology, DNA, medicine, odontology, microbes and wild life. The course discusses and justifies the application of biological sciences to forensic sciences. The teacher designed modules help in demonstrating their skills in biologically based laboratory analysis and interpret the findings by applying their critical thinking skills in forensic sciences.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Distinguish among major insect types associated with forensic biology, and explain their characteristics	U	F&C	Short answer, Paragraph, Essay questions
CO2	Identify the relationship between insect type and the stages of death, explain their collection procedure.	U	F&C	Short answer, Paragraph, questions
CO3	Describe how insect specimens help to estimate time of death.	U	F&C	Short answer, Paragraph, questions
CO4	Types and identification of microbes of forensic significance.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Identify insects of forensic importance	Ap	C& P	Assignments, seminars
CO6	Describe the factors influencing the insect succession in carrion.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Taxonomy and Biology of forensically important insects (10hrs) (Out of 70: 19 marks)
Unit 1. Insects of forensic importance (7hrs): Coleoptera–General characters, taxonomy and biology of Silphidae (carrion beetles), Staphylinidae (rove beetles), Histeridae (clown beetles), Dermestidae (hide & skin beetles), Cleridae (checkered beetles), Carabidae (Ground beetles).
Unit 2. Diptera (3hrs)–General characters, taxonomy and biology of Calliphoridae, Sarcophagidae, Phoridae, Muscidae, Fannidae.

Module II: Evidence during death investigations (10hrs) (15 marks)
Unit 1. Collection of entomological evidence during legal investigations; collection of meteorological data, specimens before body removal, ground-crawling arthropods on and around the body, entomological samples from the body, entomological samples during autopsy, specimens from buried remains, from enclosed structures & aquatic habitats.

Module III: Entomological evidences during death investigations (12hrs) (15 marks)
Unit 1. Laboratory rearing of insects of forensic significance: Larval rearing, rearing containers, monitoring growth, larval dispersal in laboratory, adult emergence, rearing aquatic insects, unique host preference, rearing beetles in the laboratory. (9 hrs)
Unit 2. Factors influencing insect succession on carrion, its application to forensic entomology. (3 hrs)

Module IV: Insect succession on carrion (13hrs) (21 marks)
Unit 1. Stages of decomposition of dead body (7hrs): in terrestrial and aquatic region, Insect succession on carrion and its relationship to determine time since death, geographical differences in succession, effects of season, humidity, effects of sunlight exposure, urban versus rural scenarios, bodies found in side buildings, effects of burial, bodies in water, bodies in vehicles, bodies in enclosed spaces, hanged bodies, burnt remains, wrapped remains, estimating the post mortem interval.
Unit 2. Soil environment and forensic entomology, entomo-toxicology(6hrs) : Current concepts, trends, challenges and techniques. Implication of morphometric and growth rate, chemo-ecology, molecular methods for forensic entomology.

Module V: Open end(15hrs)

The teacher can design student activities related to Practicals of Module II & III as Identification of insects of forensic importance, rear some of the insects of forensic significance, give assignments & seminars from Module IV

Virtual Labs (Suggestive sites)
REFERENCES

1. J.H.Byrd and J.K. Tomberlin, 3rd Edition Forensic Entomology (2009).
2. D.B.Rivers And G.A. Dahlem, 1st Edition, the Science of Forensic Entomology(2022).
3. J.Amendt, M.Lee Goff and C.P.Campobasso, Current Concept of Forensic Entomology (2010)
4. Forensic Entomology: Jason H Byrd & James L Castner
5. Insect Biology :Hovard Evan
6. Fundamentals of Entomology, Richard J. Flzinga Prentice hall of India pvt ltd, (1978)
7. Entomology&death-AproceduralguideCattsE.P&HaskellNH;Joyce'sprintshop(1990)
8. AmanualofForensicEntomologySmithDGV;IthacaNYCamstockUniv.Press,USA(1986).
9. GeneraltextbookofEntomology,O.W.Richards&R.G.Davis;Chapman&hallltd,(1973).

Suggested Online Courses:

S.No.	Course offered	University	Link of the course
1	Introduction to Forensic Sciences	Nanyang Technological University, Singapore	(https://www.coursera.org/learn/forensic-science)
2	Veterinary Forensics	WUF Health , University of Florida	(https://online.forensics.med.ufl.edu/
	Wild Life Forensics		
	Forensic Medicine		
	Online degree course in Forensic		
3	BSc in Forensic Sciences ,	Arizona State University	(https://start.asuonline.asu.edu/undergraduate/bs-forensic-science/a/?utm_source=xyzmedia&utm_medium=ppl&utm_content= Conversion_Pagevisitors_Forensicscience-BS&utm_campaign=22-Nat_Acq_Hi&utm_ecd22=22&utm_term=hmlForensicScienceOnline46237fsbfs_%7Bs2sId%7D

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

MARINE BIOLOGY I: THREATS TO MARINE ECOSYSTEM

Programme	B. Sc. Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course develops an understanding in the basic concepts in marine biology, threats to marine ecosystem due to pollution, current scenario of marine environment and tourism, marine biodiversity conservation etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the introductory concepts in marine biology; major threats to biodiversity in our seas.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the impact of pollutants on marine environment, effects of oil pollution, bio-accumulation and biomagnification of organochlorine pesticides.	U	F&C	Short answer, Paragraph, Essay questions.
CO3	Describe current scenario of marine environment and tourism**;** Microbial aspects of pollution monitoring, and develop various strategies, conservation policies and legislations, methods for restoring marine ecosystems	U	F&C	Short answer, Paragraph, questions
CO4	Describe conservation status of marine organisms, CITES, Red data list and its categories, regulations concerned with the conservation of marine fauna and flora. Marine sanctuaries., Integrated Coastal Zone Management. International regulations related to maritime boundaries, etc.	U	F&C	Short answer, Paragraph, questions
CO5	Conduct seminars on regulations, laws and policies for marine conservation existing in the present scenario with special reference to India, their effective implementation, limitations etc.	An	F&C	Assignments, seminars
CO6	Describe the concept of community ecotoxicology, Microcosm, mesocosm experiments etc.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1. Introduction to Marine Biology and marine pollution(16hrs) (Out of 70: 20 marks)

Unit 1. History of marine Biology(2hrs): Major oceanographic expeditions and scientists;

Unit 2. Marine ecosystem(6hrs) : Various marine ecosystems, flora and fauna, Primary production in the ocean; Planktons, Marine biodiversity: Zonation of the marine ecosystem.

Unit 3. Marine pollution (8hrs): Ocean Climate Service, GESAMP definition and its role. Major threats to marine ecosystem diversity and function – overexploitation, pollution, climate change, diseases. Sources of Marine Pollution - domestic, industrial and agricultural waste. Effect of mining and dredging operation on marine environment. Introduction of invasive species. Community ecotoxicology- introduction, definitions, trophic interactions in community ecology. Microcosm and mesocosm experiments

Module 2. Impact of pollutants on marine environment-(9hrs) (20 marks)

Unit 1. Effect of oil pollution, Microplastics(6hrs) – Sources, bioaccumulation and its impacts on marine organisms and marine food web. Bio-accumulation and biomagnification of organochlorine pesticides (DDTs), lead, cadmium, chromium and mercury in food chain.

Unit 2. Threats to coral reefs (3hrs): Coral diseases-– black band disease, pink line syndrome, white band disease and yellow band disease.; Impact of coral reef destruction.

Module 3Current scenario of marine environment and tourism (10hrs) (15 marks)

Unit 1. Ocean and human health(6hrs): Microbial aspects of pollution monitoring, blue flagging of beaches. Biological methods for the assessment of pollution effects – biomonitoring, indicator species, mussel watch. Environmental Impact Assessment, EIA guidelines - methodologies, tools and best practices, Indian Environments law - Water Pollution Act.

Unit 2. Restoring marine ecosystems(4hrs) – Ecoethics-general principles, Restoring marine ecosystems ecosystem - based conservation and management. Tools to preserve, manage and restore marine ecosystems - re-introduction of species. Methods to control invasive species.

Module 4. Marine Biodiversity conservation (10hrs) (15 marks)

Unit 1. Biodiversity valuation (4hrs): Conservation status, endangered marine organisms, CITES, Red data list and its categories. Regulations concerned with the conservation of marine fauna and flora. Marine sanctuaries.

Unit 2. Marine Protected Areas (MPAs) (6hrs): Large Marine Ecosystems (LMEs) etc. Integrated Coastal Zone Management. International regulations related to maritime boundaries (UNCLOS, ANMJ, BBNJ etc.), EEZ, Sea ethics and territorial waters.

Module 5. Open ended (15hrs)

Teacher can design a module on regulations, laws and policies for marine conservation existing in the present scenario with special reference to India.

References:

Joseph, M. Mohan & Jayaprakash, A.A. (2003). Status of Exploited Marine Fishery Resources of India. CMFRI, Kochi

Tom, S. Garrison. (2009). Oceanography: An invitation to Marine Science (7thEdition). Brooks Cole Elliott A. Norse, et al (2013).Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Michael E. Marine Conservation Biology Institute.

Brian Silliman, Avigdor Abelson, Christine Angelini, Gesche Krause, Megan Irene Saunders, Tjisse Van Der Heide. Marine Ecosystem Restoration (MER) – Challenges and New Horizons. Frontiers Media SA.

Online Sources

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2
3

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

MARINE BIOLOGY II: MARINE RESOURCES AND PLANKTONOLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop an understanding in extensive, marine resources, methods for their analysis and screening, types of planktons, their adaptations, sampling methods etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the variety of bioactive substances from marine organisms, Methods for screening, isolation and characterization of marine natural products, Genomics of Marine Toxins etc.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Enlist the biomaterials from the marine environment, explain the process of microbial Fermentation, the concept of algal biotechnology, its applications, Applications of algae in waste treatment, bioethics, IPR and patenting issues etc.	U	F&C	Short answer, Paragraph, questions
CO3	Describe the characteristics of Plankton, classification, factors affecting the composition, occurrence, breeding, growth and seasonal variations of planktons, adaptations to planktonic life, methods of plankton sampling, Culture techniques of phytoplankton.	U	F&C	Short answer, Paragraph, questions
CO4	Importance of plankton in marine food webs, Productivity measurement of phytoplankton, harmful Algal Blooms and its impacts on marine ecosystems, Phytoplankton-Zooplankton relationships, Measuring secondary production, etc.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Conduct experiments on culturing of phyto and zooplanktons	Ap	C&P	Assignments, seminars, report writing

CO6	Describe the characteristics of planktons inn Kerala cost	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Bio active compounds and their separation (12hrs) (Out of 70: 20 marks)

Unit 1. Bioactive substances from marine organisms (5hrs.) - alkaloids, terpenoids and steroids. Nucleosides, peptides, depsipeptides, polyketides & macrolides. Antibacterial, antifungal, antiviral, anticancer and analgesic compounds. Methods for screening, isolation and characterization of marine natural products. High throughput and high content screening,

Unit 2. Bioassays for screening biomolecules(5hrs) - Design of assays – LC 50, LD 50, Cytotoxicity assay, Antimicrobial assays, Anticancer assays, Comet assay, MTT assay, Lactate dehydrogenase (LDH), Caspase assay, Antimitotic assay.

Unit 3. Genomics of Marine Toxins(2hrs) - Paralytic shellfish poisoning (PSP), Neurotoxic shellfish poisoning (NSP), Diarrhetic shellfish poisoning (DSP), Ciguatera poisoning, Amnesic shellfish poisoning (ASP).

Module 2 . Useful biomaterials from marine environment(12hrs) (15 marks)

Unit 1. Biomaterials from the marine environment (6hrs)– chitin, chitosan, oils and fats, surfactants, biopolymers and novel enzymes from marine organisms. Microbial Fermentation – bioreactors - upstream and downstream processes. Single cell proteins.

Unit 2. Algal Biotechnology (6hrs)– Pharmaceutical application, antimicrobial compounds. Industrial products - fertilizers, micronutrients, alginates, agar, carrageenan, diatomaceous earth. Applications of algae in waste treatment. Photobioreactors - algae as food and feed, Bioethics, IPR and patenting issues.

Module 3. Introduction to Planktonology (12hrs) (15 marks)

Unit 1. Plankton(4hrs)-Definition, Phytoplankton and zooplankton classification, Factors affecting the composition, occurrence, breeding, growth and seasonal variations of planktons, adaptations to planktonic life.

Unit 2. Methods of sampling (4hrs)-phyto and zoo, Types of plankton collecting gears, preservation techniques, analysis and estimation of biomass and composition.

Unit 3. Brief description about the planktons (4hrs)- Occurring in coastal waters of Kerala, Arabian Sea, Indian Ocean and Bay of Bengal. Culture techniques of phytoplankton *Skeletonema costatum, Chlorella* and *Tetraselmis.* Culture techniques of commercially important zooplanktons *Artemia, Rotifer and Copepod.*

Module 4. Ecology of Planktons(12hrs) (20 marks)

Unit 1. Role of plankton in marine food webs (7hrs)- Productivity measurement of phytoplankton- methods of estimation of primary production- Oxygen method, C14 methods, Remote sensing. Factors affecting primary production. Regional and seasonal variations in primary productivity in different latitudes. Harmful Algal Blooms and its impacts on marine ecosystems. Detection of algal blooms by remote sensing.

Unit 2. Phytoplankton-Zooplankton relationships(5hrs)- Measuring secondary production, Food and feeding habit of zooplankton. Diurnal- Vertical migration of Zooplankton. Ecological and economic importance of planktons, plankton as Indicator species, Plankton and fisheries, productivity in relation to fisheries.

Module V Open ended (12hrs)
Teacher can design student activities related to Module 3&4, and conduct activities like assignment, seminar and culturing of phyto and zooplanktons

References:
Alister, C. Hardy (Sir.) (1958). The Open Sea, Its Natural History: The World of Plankton (Part 1). Collins. Barnes, H. (1959). Apparatus and Methods of Oceanography. George Allen & Unwin.
Colin, S. Reynolds. (2006). Ecology of Phytoplankton. Cambridge University Press. ISBN: 1139454897.
Davis, C.C (1955). The Marine and freshwater plankton. East Lansing, USA: Michigan State University Press.
Ringelberg, J. (2010). Diel Vertical Migration of Zooplankton in Lakes and Ocean: Causal Explanations and Adaptive Significance. Springer. ISBN: 904813093X
James, H. Fraser. (1978). Nature Adrift: The Story of Marine Plankton. University Microfilms.
Newell, G.E & R. C. Newell (1969). Marine Plankton – A practical guide. Pisces Conservation Limited.

Online Sources
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3

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

MARINE BIOLOGY III: ADVANCES IN MARINE BIOLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course aims to develop understanding in the techniques and tools for sampling and other analytical studies, collection, preservation, of marine biodiversity, the software for community structure analysis, advancements in marine biological research, biomimetics of marine organisms				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the techniques and tools for sampling and other analytical studies on marine biodiversity.	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the techniques for collection, preservation and analysis of marine biodiversity, software for community structure analysis.	U	F&C	Short answer, Paragraph, questions
CO3	Describe the advances in different fields of marine biological research	U	F&C	Short answer, Paragraph, questions
CO4	Describe the cases of biomimetics of marine organisms.	U	F&C	Short answer, Paragraph, Essay questions
CO5	Collect information on more examples of biomimetics of marine organisms, and make replicas of it.	An	F&C	Assignments, seminars
CO6	Explain advanced biotechnological techniques for controlling biofouling organisms.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1. Techniques and tools for Marine biological studies (12hrs) (Out of 70: 20 marks)
Unit 1. Sampling (2hrs) - strategies and methodology design of water and sediment parameters.

Unit 2. Instruments for Sampling and analytical studies (10hrs): water samplers such as Niskin sampler, Hydro-Bios sampler, Rosette samplers. Sediment samplers such Sieves, Grabs, Box corers, Hydraulic corers, Acoustic direction finder, Multibeam Echosounder; Bottom penetrating echo-sounder; seismic array(Sleeve Guns); CTD Rosetta frame with water samplers; Deep Sea Mooring with ADCP, current meter and Sediment Trap; Deep Digging Dredge (Triple-D) for sampling benthic macrofauna; Altrap Bottom Landerwith larvae collector; Albex multi-purpose Bottom Lander for measurements and experiments at the sea floor; Mobile underwater vehicle (MOVE), ROVs, AUVs,Use of analytical instruments AAS, ICP, GLC, Spectrofluorometer for analyzing Petroleum hydrocarbon, Pesticides, Heavy metals etc.

Module II Techniques for collection, preservation and analysis of marine biodiversity (12hrs) (15 marks)

Unit 1. Collection, preservation, qualitative and quantitative analysis (4hrs) - of bacteria, plankton, benthos and nekton. Mention methods of estimation of standing crop

Unit 2. Software related to biodiversity and community structure analysis (8hrs) -Diversity and related indices - species richness, diversity, evenness and dominance, niche breadth, niche overlap and concordance, Census of marine life (CoML) – Barcoding ofmarine organisms, Ocean Biographic information system (OBIS), taxonomic databases (FishBase, SeaLifeBase, WORMS, CephBase, etc.).

Module III Advances in marine biology research (12hrs) (20 marks)

Unit 1. Research on Invertebrates (10 hrs) - Protists as model organisms in molecular biology and genomics; Applications of algae in waste treatment. Photobioreactors; Molecular studies of cnidarian venom and its applications; Artificial reef systems, Coral immune system; Recent researches in the regenerative properties of starfish and other invertebrates; The future of invertebrate cognition: Problem-solving octopuses, dancing bees, and the rise of neuro-invertebrate research; Citizen science in invertebrate ecology research: The use of marine organisms as bioindicators of environmental health.

Unit 2. Biotechnological approach to biofouling control, Recent Approaches to control Fouling Organisms. (2hrs)

Module IV (12hrs) Biomimetics of marine organisms (15 marks)

Unit 1. (12hrs) Sea Sponge Filtration and Water Purification Systems, Mussel Adhesives and Underwater Bonding, Bioluminescent Organisms and Sustainable Lighting, Shark Teeth and Biocompatible Materials, Humpback Whale Fins and Efficient Wind Turbine Blades, Shark Skin and Drag Reduction, streamlined bodies of dolphins and sharks to design faster, more energy-efficient boats, Boxfish Body Shape and Crash-Resistant Vehicle, Dolphin Echolocation and Biosonar Technology

Module V Open ended (12hrs).

Teacher can design different student activities related to Module 4

References:

Committee on Marine Biotechnology: Biomedical Applications of Marine Natural Products, National Research Council. (2002). Marine Biotechnology in the 21st century – Problems, Promise and Products. Washington, D.C: National Academy Press.

Fingerman, Milton., Rachakonda, Nagabhushanam & Mary-Frances, Thompson. (1999). Recent Advances in Marine Biotechnology (Vol 3): Biofilms, Bioadhesion, Corrosion, and Biofouling. Science Publishers.

Freshney, R.I. (2010). A Manual of Basic Techniques - Culture of animal cells. John Wiley & Sons.

Bye, V. J. (1983). Application of Genetics in Aquaculture. CMFRI Special Publication, 13, 1-90.

Gjedrem, T. (Ed.). (2005) Selection and Breeding Program in Aquaculture. New York: Springer.

Lynch, J.M & Hobbie, J.B (Eds.). (1988). Micro-organisms in Action: Concepts and Applications in Microbial Ecology. Oxford: Blackwell Scientific Publications.

Anastasios, Eleftheriou.,&Alsdair, Mclntyre. (2013). Methods for the Study of Marine Benthos (4th Edition). Wiley-Blackwell.

Barbara,Charton. (2007). The Facts on File Dictionary of Marine Science (Facts on File Science Dictionary). Facts on File

Barnes R.S.K., R.N. Hughes (1999). An Introduction to Marine Ecology (3 rdEdition). Blackwell Publishing.

Odum, E.P. (1971). Fundamentals of Ecology (3 rdEdition). W.B Saunders Co.

Hill, M.N. (Ed.). (1962). The Sea. John Wiley and Sons. 6. Hydres, H.B.N. (1972). The Biology of Polluted Waters. University Torondo Press.

Howe, J.A., Austin, W.E.N., Forwick, M &Paetze, M. (2011). Fjord Systems and Archives: Special Publication 344 (Geological Society Special Publication).

James, B. McClintock & Bill, J. Baker. (2001). Marine Chemical Ecology (Marine Science), CRC Press.

Jeffrey, S. Levinton. (2017). Marine Biology: Function, Biodiversity, Ecology (5 th Edition). Oxford University Press, USA.

Mann, K.M. and Lazier, J.R.N. (2005). Dynamics of Marine Ecosystem, Biological- Physical Interaction in the Ocean(3 rdEdition. Wiley-Blackwel.

Online Sources

1
2
3

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

RESEARCH METHODOLOGY IN ZOOLOGY

Programme	B. Sc Zoology Honours				
Type of Course	Major Elective				
Semester	VIII				
Academic Level	400-499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The course develops an understanding in the procedure of research design, data collection, research article writing and ethics in research etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the importance of developing a research plan, importance of literature review,	U	F&C	Short answer, Paragraph, Essay questions
CO2	Explain the different data collection and analysis methods	U &An	F&C	Short answer, Paragraph, questions
CO3	Describe procedure of writing research paper, thesis, preparing conference presentations etc.	U	F&C	Short answer, Paragraph, questions
CO4	Describe the intellectual property right and the laws related to it	U	F&C	Short answer, Paragraph, Essay questions
CO5	Attain skill in research paper writing etc.	Ap	C &P	Assignments, seminars
CO6	Practise the use of statistical tools, and data collection methods	Ap	C & P	Assignments, seminars, report writing
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1 Introduction and Research design (12hrs) (Out of 70: 15 marks)

Unit 1: Meaning, Objectives, types and significance; identifying gap areas by literature review
Unit 2: Selection of problem, defining the problem; Ethics in research
Unit 3: Principles of experimentation; Formulation of research problem;
Uni 4: Design of experiments and testing of hypothesis;
Unit 5: Ethical issues of using animals in experimental research.

Module 2 Data collection and analysis (12hrs) (20 marks)

Unit 1: Sources of Data- Primary, Secondary- tertiary
Unit 2; methods of data collection, sampling methods, sample size, sample error

Unit 3: Data processing and analysis
Unit 4: Computer application for data entry and analysis – Using excel for data entry, analysis, graphical representation.
Unit 5: Statistical Analysis: Softwares, SPSS, R, Past programmes
Unit 6: Reference management Tools – End note, Zotero

Module 3: Scientific documentation (12hrs) (20 marks)
Unit 1: Types of report- technical reports and thesis
Unit2: Literature collection and documentation
Unit 3: Lay out – Introduction, review of literature, methods, results, discussion, references
Unit 4: Oral presentation – planning, presentation, technical considerations, power point presentation.
Unit 5: Poster presentation – Key points to highlight, Lay out and design

Module 4: Intellectual property and ethical issues (12hrs) (15 marks)
Unit 1: Intellectual Property right and patent law, copy right, royalty
Unit 2: Reproduction of published documents: pattern of citation, style manual for citation, citation index, impact factor, acknowledgement
Unit 3: Plagiarism – software for checking plagiarism
Unit 4: Ethical issues – ethical committee in animal experiment and clinical trials

Module 5: Open ended (12hrs)
Teacher can design student activities like, preparation of review paper, organising oral presentation etc.

References:

Chad L. Cross, Wayne W. Daniel 2018 Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition John Wiley & Sores, New York

Duncary, P. 2003 Authorising Ph. D thesis: How to plan draft, write, ad finish doctoral dissertation. Palgrave macmillan

Garg, B. I. ,Karadla, R. and Agarwal, F and Agarwal, G. K. 2002 An introduction to Research methodology RBSA publishers.

B. L. Wadehra 2004Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications. Universal Law Publishing Co Ltd

Mapping of COs with PSOs and POs :

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CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6					3					2		2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6		✓		

MINOR COURSES

GENERAL ZOOLOGY

FOUNDATIONS OF ENVIRONMENTAL BIOLOGY AND ANIMAL BEHAVIOR

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The student develops understanding in the organization and functioning of ecosystems, the concept of population, population interactions, biogeochemical cycle, behavioural patterns of animals, their social organisation, etc.				

Course outcome

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the various components of ecosystem along with their interactions and flow of energy in ecosystem and the importance of productivity of ecosystem, food chain and food web, and types of biogeochemical cycles and their importance.	U	F&C	Short answer, Paragraph, Essay type questions
CO2	Identify the terms related to population, biotic community, types of community interactions; the concepts of k and r species and Keystone species, characteristics of habitat and its types, policies and laws for environmental protection..	R	F	Short answer, Paragraph type questions
CO3	Describe innate behaviour and its components, concept of FAP, learned behaviour and its various types and examples, the concept of animal communication; the types of animal communication, emphasizing the relation between animal communication and social behaviour of animals.	U	F&C	Short answer, Paragraph type questions
CO4	Describe sociobiology of different animals, the concept of social organisation in animals, and the concept of proximate factors.	U	F&C	Short answer, Paragraph , Essay type questions
CO5	Acquire skill in estimating ecological parameters like dissolved Oxygen, Carbon dioxide, pH etc..	Ap	C&P	Practical lab exams, Viva- voce
CO6	Compare the characteristics of different types of ecosystems, pattern of flow of materials and energy in ecosystem, etc.	U	F&C	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1. Ecosystem (12hrs) (Out of 70: 18 marks)
Unit 1: Introduction, Ecosystem &Energetics. (02 hrs) Fundamentals of Environmental Sciences. Scope of Environmental Science. Ecology as an inter-disciplinary science, Sub division of Ecology- Autecology, Synecology, Scope of Ecology.
Unit 2: Ecosystem-Concept, Structure and functions:(**08 hrs)** Structures - Biotic and Abiotic components. Functions - Energy flow in ecosystems & law of thermodynamics, energy flow models energy transfer & transformations.
Productivity of ecosystem- primary (GPP, NPP, NCP), secondary productivity, standing crop, material removed and production rate. Ecological efficiencies. Trophic structures and ecological pyramids. Trophic levels, food chains and food webs.
Unit 3: Biogeochemical cycles(02hrs) -Concept and Basic types. Gaseous cycle -carbon & nitrogen cycles, Sedimentary cycle- phosphorus cycle. Decomposition and transformation.

Module 2: Ecosystem classification and Habitat Ecology (11hrs) (13 marks)
Unit 1: Basics of Ecosystem classification (05 hrs): *Types of Ecosystem*: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), *Oceanic Biomes:* Concept, classification and distribution. Characteristics of different biomes (mention): Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chaparral, Savanna, Tropical Rain forest.
Unit 2: Habitat ecology: (06hrs)
Terrestrial ecology -Tropical wet evergreen, tropical dry deciduous forests- its characteristics. Faunal characteristics & adaptations.
Freshwater ecology- Lentic &lotic habitats- its characteristics. Faunal characteristics & adaptations.
Marine ecology- Biotic divisions and its characteristics. Pelagic realm-Planktonic& nektonic adaptations. Benthic realm-littoral & Abyssal adaptations. Adaptations of animals on sandy, muddy & rocky seashore.

Module 3: Population, Community and Habitat (10 hrs) (17 marks)
Unit 1: Population Ecology- (05hrs) Characteristics of population, - Biotic potential, concept of carrying capacity, population growth (S and J shaped curves) and regulations. Population fluctuations, dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species.
Unit 2: Community ecology: **(03 hrs)**Biotic community: Definition, community concept, types and interaction - predation, herbivory, parasitism and allelopathy.
Unit 3 :Overview of Environmental Laws in India(02hrs)
National Water Policy, 2012; National Environmental Policy, 2006; The Plastic Waste Management Rules, 2016; The Solid Waste Management Rules, 2016; The e-waste (Management) Rules 2016.

Module 4: Animal Behaviour (12hrs) (22 marks)
Unit 1: Foundations of Ethology (02hrs)-Introduction and historical development of ethology, Key figures in ethological approach, its scope and relation with other branches of biology.
Unit 2: Innate/Stereotyped behaviour (02hrs)- orientation -taxes, kinesis, simple reflexes, instincts, Fixed action patterns (FAPs) and releaser stimuli. Examples of instinctive behaviours in different species.
Unit 3: Acquired behaviour/Learned behaviour (02hrs): Habituation, Conditioned reflex, latent learning, Imprinting, Habituation and Trial and error and learning with suitable example.
Unit 4.: Types of communication (03 hrs)1. Visual 2.Auditory3.Tactile 4.Chemical with suitable examples.
Unit 5: Sociobiology (03hrs) Social organization in Animals: Termites and Elephants.
Proximate factors.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1.Estimation of dissolved oxygen in water sample using Winklers method (Pond water, well-water, Tap water). Discuss the ecological significance of dissolved oxygen in water.
2.Identify soil micro-organisms in soil samples collected from different localities-by floatation process & Berlese funnel method. Discuss the ecological significance of soil characteristics.
3.Demonstration of Phototaxis by earthworm
4.Demonstration of alarm pheromones in ants
Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5.Estimation of dissolved CO2 in water sample (Pond water, well-water, Tap water). Discuss the ecological significance of dissolved CO2 in water.
6.Estimation of PH of water (Pond water, well-water, Tap water) Discuss the ecological significance of PH characteristics.
7.Locomotory behavior of dipteran larvae on different types of substrata
8.Determination of salinity of water
9.Determination of moisture content in different types of soil (sand, clay, laterite, etc.)
10.Estimation of water holding capacity of different types of soil.(sand, clay, laterite, etc.)
Field study: A). Conduct a field trip to assess the biodiversity of a chosen ecosystem- by preparation of food chains and food web. Add a note on its significance, B) A visit to natural habitat of wild animals or birds, or zoo, aviary etc, and observation of behaviour patterns of those animals; and submit a detailed field study report at the time of semester end practical examination.

REFERENCES:

ENVIRONMENTAL BIOLOGY

- Odum, E. P. & Barrett. G. W. 2004- Fundamentals of Ecology 5tn Ed. -Brooks/ Cole 624pp
- Goyal, M. K, 2020: Essential Environment - Shri Vinod Pusstak Mandir 351pp
- Miller, G. T. &Spoolman, S.. 2010 Environmental Science 13 Ed. Brooks/ Cole 452pp
- Miller, G. T. Jr 2017. Living in the Environment - Brools/ Cole 832pp
- Molles. M. 2015 - Ecology: Concepts and Applications McGraw-Hill Education 592pp
- Townsend, C. R. Begon, M. and Harpe, J. L. 2008 Essentials of Ecology John Willey & Sons 532pp.
- Cunningham, W. P & Cunningham, M. A Principles of Environmental Science McGraw-Hill Education 410pp

ANIMAL BEHAVIOUR

- Dugatkin, L. A. 2020 Principles of Animal Behavior 4th Ed. - University of Chicago Press 576pp
- Manning, O.2016 Introduction to Animal behaviour South Asia Ed, 6th Ed. Cambridge University Press, India 456pp
- Mathur, R. 2022 Animal Behaviour -Visionias 676pp
- Alcock, J. 2005 Animal Behavior - SP Oxford University Press 556pp

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2	3						3						
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO 6		3					3						

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

INTRODUCTORY HUMAN PHYSIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or the following online courses 1.https://www.coursera.org/learn/physiology 2.https://learn.utoronto.ca/programs-courses/courses/2159-basic-human-physiology 3.https://www.classcentral.com/classroom/youtube-anatomy-physiology-45834 4.https://www.ivyroses.com/Revise/AnatomyPhysiology/index.php 5.https://www.medicalnewstoday.com/articles/organs-in-the-body#organ-systems 6.https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/physiologypti.pdf				
Course objectives	The student develops understanding in the organization and functioning of human physiological systems and will be able to perform simple experiments related to it.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the structural and functional organization of human body	U	F&C	Short answer, Paragraph type questions
CO2	Explain the mechanism of transport and exchange of respiratory gases and its control	U	F&C	Paragraph, Essay type questions
CO3	Identify and describe different components of blood and various blood groups; cardio-vascular problems	U	F	Short answer, Paragraph type questions
CO4	Compare the different types of neurons; Explain mechanism of nerve impulse transmission; the ultrastructure of skeletal muscles and biochemical events and energetics involved in muscle contraction, the need of physical exercise in good physical and physiological condition.	U	F&C	Short answer, Paragraph, Essay type questions

CO5	Acquire skill in estimating and enumerating blood parameters; calculating BMI, measuring the respiratory volumes, etc.	Ap	C&P	Practical lab exams, Viva- voce
CO6	Explain the mechanism of excretion and its hormonal control; enumerate common renal disorders in man.	U	F&C	Short answer, Paragraph type questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Unit 1: Introduction to human physiology :(3 hrs) (Out of 70: 7 marks)
Branches of human physiology, Components of body system, Human body systems and functions, vital and non-vital organs, Levels of physiological regulation: Intracellular, local and extrinsic regulation. Homeostasis, Anthropometry, BMI and its significance.

Module 2: Physiology of Respiration & Circulation (18 hrs) (22 marks)
Unit 1: Respiration (8 hrs) : Measures of lung volume : Vital capacity, tidal volume, residual volume etc., Structure, types and functions of hemoglobin, Transport of oxygen and carbon dioxide in blood, factors influencing transport of gases, Oxygen dissociation curves and the factors influencing it; Carbon monoxide poisoning; Nervous and chemical control of respiration, Respiratory problems in new born babies and old age, COVID associated problems, COPD, Problems and adaptations at high altitude.
Unit 2: Circulation (10 hrs)
Pace maker and conducting system, Components of blood and their functions; Haemostasis, Biochemical pathway of Blood coagulation: Clotting factors, Disorders of blood clotting, Haemopoiesis; ESR, Haemoglobinopathies, Blood groups: Rh factor, ABO and MN; Blood transfusion and agglutination, Apherisis, ECG, Cardiovascular problems: Hyper and hypotension, Artheriosclerosis, Bradycardia and tachycardia, Myocardial infarction, Angina pectoris, Cardiac arrest.

Module 3: Physiology of Excitation (12 hrs) (22 marks)
Unit 1: Nervous system (5 hrs): Structure and types of neurons, Propagation of nerve impulse, myelinated and non-myelinated nerve fibers, Types of synapse and synaptic transmissions; Saltatory conduction, Neurotransmitters, synaptic delay, synaptic fatigue, numbness, tingling, tickling.
Unit 2: Muscular system (7 hrs) : Types of muscles; Ultra structure of skeletal muscle; Physiology and biochemistry of muscle contraction:- Sliding filament theory, physiological changes, Muscular relaxation, Energy for muscular contraction, Neuromuscular junction; muscle twitch; summation, tetanus and Rigor mortis. Sports Physiology - Aims and its benefits, Effect of sports on physical health, Benefits of exercise, Physical ergonomics.
Module:4 -Physiology of Digestion and Excretion (12 hrs) (19 marks)
Unit1. Digestion (6hrs): Structural organization and functions of gastrointestinal tract and associated glands; Hormonal control of digestion. Nutrition in pregnancy. Nutritional disorders: Cachexia, Bulmia Nervosa, Anorexia nervosa, obesity, flatulence, Peptic ulcer; physiological causes of vomiting and hiccups
Unit2. Excretion (6 hrs): Ornithine cycle, Juxta glomerulus apparatus, Urine formation and Counter current mechanism, Hormonal and enzymatic control of urine formation. Role of kidney in osmoregulation, Abnormal constituents of human urine and its significance: Glycosuria, Albuminuria, Heamaturia, Ketonuria, Haemoglobinuria, Uraemia, Pyuria. Dialysis.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1. Determination of ABO Blood group
2. Detection of Abnormal constituents of urine (Glucose, Protein, Ketone bodies)
3. Determination of Lung volume, tidal volume etc. by using Spirometer
4. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum, liver, trachea, lung, kidney, Types of Muscles, (Virtual Model/Slide)

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

5. Estimation of haemoglobin using Sahli's haemoglobinometer
6. Preparation of haemin crystals
7. Calculation of BMI
8. Recording of blood pressure using a sphygmomanometer
9. Demonstration of Blood clotting time
10. Demonstration enzymatic activity of Amylase, Protease and lipase
11. Recording of simple muscle twitch

Field study: A) Visit to Anatomy Museum B) Visit to Diagnostic centres, and submission of detailed field study report at the time of semester end practical examination.

Virtual Labs (Suggestive sites)

https://www.vlab.co.in
https://zoologysan.blogspot.com
www.vlab.iitb.ac.in/vlab
www.onlinelabs.in
www.powershow.com
https://vlab.amrita.edu
https://sites.dartmouth.edu
https://faculty.uobasrah.edu.iq/uploads/teaching/1645858465.pdf

REFERRENCES

- Hall, J.E (2015): Guyton and Hall Text book of Medical Physiology,13th Edition, ISBN-10:1455770051, Saunders, 1168 pages
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills
- Chatterjee, C.C (2016): Human Physiology, 11th Edition, ISBN-10 8123928726 Medical Allied Agency.
- Arthur Vander, James Sherman and Dorothy Luciano (1998) Human Physiology: The Mechanisms of Body Function, ISBN-10: 9780070670655, William C. Brown Pub., 818 pages
- Sembulingam, K and Sembulingam, P (2016): Essentials of medical physiology, 7th Edition, ISBN-10: 9789385999116, Jaypee Brothers Medical Publ, 1067p.
- Tortora, G.J. &Grabowski, S. (2006): Principles of Anatomy & Physiology. XI Edition John Wiley & sons
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

ONLINE SOURCES

7. https://study.com/learn/anatomy-and-physiology.html

8. https://alvernia.libguides.com/oer/anatomy
9. https://www.udemy.com/course/human-physiology-notes-powerpoint-slides-practice-exams/
10. https://www.physiology.org/career/teaching-learning-resources/student-resources/what-is-physiology?SSO=Y
11. https://www.getbodysmart.com/
12. https://byjus.com/biology/human-body-anatomy/

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CO 3	3						3						
CO 4		3					3						
CO 5				3					3				
CO6		3					3						

Correlation Levels:

Level	Correlation
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Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

ANIMAL DIVERSITY, REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop an outlook on the Animal diversity, Human reproduction, causes of infertility in humans and assisted reproductive and Prenatal Diagnostic technologies and basic concepts of animal embryology.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Enumerate the salient features and examples of Phylum - Rhizopoda, Dinoflagellata, Apicomplexa, Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Arthropoda, Onychophora, Mollusca, Echinodermata, and the structural organization of *Penaeus* sp.	U	F&C	Short answer, Paragraph type questions
CO2	Describe the characteristic features and classification of phylum Chordata with examples and, the structural organization of *Oryctolagus cuniculus*	U	F&C	Short answer Paragraph, Essay type questions
CO3	Explain the structural and functional features of human reproductive system and the process of fertilization, pregnancy, gestation, placentation, parturition and lactation in humans, Assisted Reproductive technologies and Pre Natal Diagnostic techniques.	U	F&C	Short answer, Paragraph type questions
CO4	Enumerate the types of eggs and cleavage, the different types of blastula, morphogenetic movements during gastrulation and germ layers and their derivatives.	U	F&C	Short answer, Paragraph, Essay type questions
CO5	Perform experiments like mounting of specialized organs of selected non-chordates and chordates, and dissections of specimens by standard laboratory protocols.	Ap	C&P	Practical lab exams, Viva- voce

CO6	Prepare field study report on observing local biodiversity	C	C&P	Short answer, Paragraph questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Section A: ANIMAL DIVERSITY

Module 1 Protists and Non-chordates (12hrs) (Out of 70: 14 marks)

Unit 1: Kingdom Protista (2 hrs) - General characters.;
Phylum Dinoflagellata: e.g. *Noctiluca*
Phylum Ciliophora: e.g. *Vorticella*
Phylum Apicomplexa: e.g. *Plasmodium* (exclude life cycle)

Unit 2: Kingdom Animalia Part I: Non-chordata (7hrs)
Salient features of phyla, classification down to classes (mention the names only) (7 hrs)
Phylum Porifera: e.g. *Leucosolenia*
Phylum Cnidaria: e.g. *Obelia, Sea anemone*
Phylum Platyhelminthes: e.g. *Fasciola*
Phylum Nematoda: e.g. *Ascaris*
Phylum Annelida: e.g.: *Hirudinaria*
Phylum Arthropoda: e.g.: *Limulus, Sacculina, Eupagurus*
Phylum Onychophora: e.g.: *Peripatus*
Phylum Mollusca: e.g. *Perna, Teredo, Pinctada*
Phylum Echinodermata: e.g. *Asterias, Holothuria*

Unit 3. Phylum Arthropoda Type: *Penaeus* sp. (3hrs). Morphology, digestive system, nervous system, sense organs (statocyst and compound eye), reproductive system (Exclude details of larval stages)

Module 2. Kingdom Animalia Part II: Chordata (12hrs) (23 marks)

Unit 1: Chordata Classification (8hrs)
Salient features, (Mention classes)
Subphylum Urochordata e.g. *Ascidia*
Subphylum Cephalochordata e.g. *Branchiostoma*
Subphylum Vertebrata:
Division I: Agnatha eg. *Petromyzon*
Division II: Gnathostomata
Super class: Pisces
Class: Chondrichthyes: e.g. *Narcine*
Class: Osteichthyes: e.g. *Echeneis, Hippocampus,Brama, Sahyadria denisonii* (Miss Kerala)
Super class: Tetrapoda
Class Amphibia: e.g. *Ichthyophis, Salamandra, Rhacophorus,* Mention *Nasikabatrachus sahyadrensis*
Class Reptilia: e.g. *Chamaeleo, Chelone, Naja, Bungarus, Daboia*
Class Aves e.g. *Columba*
Class Mammalia eg. *Pteropus*

Unit 2: Chordata Type: *Oryctolagus cuniculus* (4 hrs)
External features, skeletal system (Skull with dentition, and typical vertebra only), digestive system, sense organs and nervous system. [Exclude skin, respiratory system, circulatory system, autonomous nervous system and endocrine system].

Section B: REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY

Module 3. Human Reproductive system and Reproductive Biology(13hrs) (16 marks)

Unit 1: Male reproductive system (1 hr)- Structure of testis, semen production and composition.

Unit 2: Female reproductive system (2hrs) - Structure of ovary and graafian follicle, ovulation. Mention corpus haemorrhagicum, corpus luteum and corpus albicans. Accessory reproductive organs. Secondary sexual characteristics. Menstrual cycle and its hormonal control.

Unit 3: Gametogenesis and Fertilization (4 hrs) - Spermatogenesis and oogenesis.; Fertilizin and anti-fertilizin, capacitation, agglutination, sperm penetration, activation of egg and amphimixis. Physiological and biochemical changes during and after fertilization. Pregnancy, Gestation, Placentation, parturition and lactation.

Unit 4: Infertility and Assisted reproductive techniques (4hrs)- Infertility: Causes and problems in male and female; Infertility management: collection, preservation and storage of semen and ova, artificial insemination; Cryopreservation and embryo transfer: Collection, care and preservation of embryos; In vitro fertilization (IVF) and embryo transfer: Major steps; Test tube babies; Assisted Reproductive Techniques (ART): GIFT, ZIFT, ICSI, oocyte donation and embryo donation; surrogacy

Unit 5- Prenatal diagnosis (2 hours) Different methods: Ultrasonography, amniocentesis, chorionic villus sampling and alpha-foetoprotein estimation; female foeticide: ethical issues and laws (Mention PNDT Act

MODULE 4. Developmental Biology (8hrs) (17 marks)

Unit 1: Introduction to Embryology (1 hr) -Embryology v/s Developmental biology. Mention phases in development. Cell differentiation, totipotency, pluripotency, de-differentiation and redifferentiation.

Unit 2: Types of eggs (2 hrs) -Classification of eggs with examples based on: Amount of yolk (micro-, meso-& macrolecithal); Distribution of yolk (iso-, centro- and telolecithal); Presence or absence of shell (cleidoic & non cleidoic); Types of development (determinate and indeterminate). Egg membranes: primary, secondary and tertiary; functions of egg envelopes.

Unit 3: Cleavage and Blastulation (2hrs)- Types of cleavage with examples based on: Plane of cleavage (Meridional, Vertical, Equatorial and Latitudinal); Amount of yolk (Holoblastic and Meroblastic); Types of development (Determinate and Indeterminate); Pattern of arrangement of blastomeres (Radial and Spiral). Different types of blastula.

Unit 4: Gastrulation (3hrs) - Basic Cell movements (Morphogenetic movements) in gastrulation (Invagination, Involution, Ingression, Delamination and Epiboly-Brief account only). Germ layers and derivatives.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1. Spotters

A. Animal Diversity

Phylum Dinoflagellata : *Noctiluca*
Phylum Porifera : *Leucosolenia*
Phylum Cnidaria : *Obelia, Physalia,*
Phylum Platyhelminthes : *Fasciola*
Phylum Nematoda : *Ascaris*
Phylum Annelida : *Hirudinaria.*
Phylum Arthropoda : *Eupagarus, Limulus, Sacculina*
Phylum Onychophora : *Peripatus*
Phylum Mollusca : *Sepia, Pinctada, Perna*
Phylum Echinodermata : *Asterias, Holothuria.*

Phylum Chordata
Protochordates : *Ascidia/ Branchiostoma.*
Cyclostomata : *Petromyzon.*
Superclass: Pisces : *Narcine, Echeneis, Hippocampus, Scomberomorus, Brama* (Any 3)
Class Amphibia : *Ichthyophis, Axolotl* larva, *Rhacophorus* (Any 2)
Class Reptilia : *Chamaeleo, Daboia, Bungarus*
Class Aves : *Columba*
Class Mammalia : *Pteropus*or any other Bat.

B. Osteology : Rabbit : Skull showing Dentition, Pectoral and Pelvic girdle

2. Mounting:

Penaeus: Appendages (minor)
Cockroach: Salivary apparatus (major).
Honeybee: Mouth parts (minor).
Shark: Placoid scales (minor).

3. Dissections :

*Penaeus :*Nervous system (major)
Sardinella : Alimentary canal (major)

4. Spotters – Developmental Biology

- Types of eggs (Insect, Amphioxus, frog, chick, and human- use slides/diagrams/models).
- Cleavage in frog (use slides / diagrams/models).
- Types of Blastula (use slides / diagrams/models).
- Gastrula of frog or any organism (use slides / diagrams/models).

II. Two experiments related to Reproductive biology or Developmental biology other than the listed should be designed by the Faculty and introduced/demonstrated to the students.

Field study: Explore the local Biodiversity and submit a diversity register of animals belonging to a minimum of **ten classes**, at the time of semester end practical examination.

Virtual Labs (Suggestive sites)

REFERENCES

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- Dhami, P. S. &Dhami, J. K.: Invertebrate Zoology. R. Chand & Co, New Delhi.
- Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N. (1985). A Manual of Zoology Vol. I [Part I & II], S. Viswanathan Pvt. Ltd., Madras
- Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N. (2009) Manual of Zoology, Chordata, Vol. II (Part I& II), ISBN-10: 8187156384, S. Viswanathan Pvt. Ltd., Madras.
- Jordan E.L. & Verma, P.S. (2010) Chordate Zoology, ASIN: B00QUYL0ZY, Kindle Edition, S. chand& Co.1092 pages
- Jordan E.L.&Verma, P.S. (2009) Invertebrate Zoology,15th Edition, ISBN-10: 9788121903677, S. Chand & Co., 1127 pages
- Kotpal, R.L. (2014) Modern Text Book of Zoology – Invertebrates, ISBN, 10: 9350780402, Rastogi
- Verma, A. (2005). *Invertebrates: Protozoa to Echinodermata.* Alpha Science Intl., Oxford.
- Balinsky, B.I. (1981*) An Introduction to Embryology*, 5th Edition, *Embryology*, ISBN-
- 4833700298 (International ed.), Saunders College Pub., 768 pages

- Berril N. J. (1971) *Developmental Biology*, ISBN 10: 0070050201, McGraw Hill
- Berry, A.K. (2008) *An introduction to Embryology*, Emkay publications.
- Bruce Carlson (2013) Human embryology and Developmental Biology, 5th Edition,
- eBook ISBN**:** 9780323279352, Saunders, 520 pages
- Michael J.F. Barresi (Author), Scott F. Gilbert (Author) (2019) *Developmental Biology*, 12th Edition, ISBN-10: 1605358223, Sinauer Associates, 888 pages
- Sastry K. V. & Vineetha Shukla (2018): *Developmental Biology*,2nd Revised Edition, ISBN: 9789350781289372, Rastogi, 372 pages
- Verma, P.S. & Agarwal V.K. (2010): *Chordate Embryology*, ISBN-10: 9788121902618, S.Chand Pub., 667 pages
- Wolpert, L. (1994): *Principles of Development*, 3rd Edition, ASIN: B008WDHBB8, Oxfor-dUniversity Press.
- Scott F. Gilbert (2016) *Developmental Biology* 11th Edition, Sinauer Associates is an
- imprint of Oxford University Press, ISBN-10: 9781605356044, 500 pages
- Abul K. Abbas, Andrew H. Lichtman & Shiv Pillai (2017) *Cellular & Molecular Immunology* 8th Edtion, Paperback ISBN: 9780323479783, Elsevier, 608 pages
- David Male, Jonathan Brostoff, David Roth and Ivan Roitt (2013) *Immunology*, 8th Edition, ISBN: 9780323080583, Elsevier, 482 pages
- Helen Chapel, ManselHaeney, SirajMisbah& Neil Snowden (2014) *Essentials of Clinical-Immunology*6th Edition, ISBN: 978-1-118-47295-8, Wiley Blackwell, 376 pages
- Ian Todd, Gavin Spickett& Lucy Fairclough (2015) *Immunology Lecture Notes* 7th Edition, 1118451643, Wiley Blackwell, 248 pages
- Jeffrey K. Actor (2011) *Immunology & Microbiology*, 2nd Edition, ISBN: 9780323074476, Elsevier, 192 pages
- Kenneth Murphy, Paul Travers & Mark Walport (2009) *Janeway's Immunobiology,* 7th
- Edition, ISBN I978-0-8153-4123-9, Garland Science, 865 pages
- Owen, Punt and Stanford (2013) *Kuby's Immunology,* 7th Edition, ISBN-10: 1464119910, W.H. Freeman, 692 pages
- William E paul (2012) *Fundamental Immunology* 7th Edition, ISBN-10: 9781451117837, Lippincot Williams & Wilkins, 1312 pages.

ONLINE SOURCES

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

HUMAN PHYSIOLOGY

BASICS IN CELLULAR PHYSIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or the following online courses 1. https://www.coursera.org/learn/physiology 2. https://learn.utoronto.ca/programs-courses/courses/2159-basic-human-physiology 3. https://www.ivyroses.com/Revise/AnatomyPhysiology/index.php 4. https://www.medicalnewstoday.com/articles/organs-in-the-body#organ-systems 5. https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_science_students/physiologypti.pdf https://www.classcentral.com/classroom/youtube-anatomy-physiology-45834/60c82bd43739c				
Course objectives	The course aims to students delve into topics such as cell biology, Mendelian inheritance, genetic disorders, and microscopy, gaining both theoretical knowledge and practical skills essential for further studies or careers in biology-related fields.				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the structure and functions of a cell, plasma membrane and cell organelles, the structure of carbohydrates, lipids, proteins, control of gene activity and tissues.	U	F&C	Short answer, paragraph, essay questions
CO2	Illustrate the structure of DNA, DNA replication, Mitosis, Meiosis, Chromosomes, Gene and genetic code, types of chromosomes,	U	F&C	Short answer, paragraph, questions
CO3	Predict possible inheritance patterns, in the real life or imaginary situations	AP	C& M	Short answer, paragraph, questions
CO4	Describe the characteristics of various types of chromosomal anomalies	U	C	Short answer, paragraph, essay questions

CO5	Acquire skill to handle microscopes and to do biological experiments	Ap	C&P	Practical lab exams, Viva- voce
CO6	Compare the characteristics of mendelian and non-mendelian inheritance patterns	U	C	Short answer, paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: CYTOLOGY (15hrs) (Out of 70: 22 marks)

Unit 1: Cellular organization (10 Hrs) -Cell theory, cell principle; Cell structure, plasma membrane (fluid mosaic model), Structure and function of cell organelles (Mitochondria, ribosome, ER, Golgi bodies, Lysosomes, cytoskeleton and interphase nucleus); Cell inclusions-brief description of the structure of carbohydrates, lipids and proteins; Unicellularity to multicellularity, differentiation. Brief mention of spatial and temporal control of gene activity; Tissues- brief description of major types.

Unit 2: Cell division (5 Hrs)- Cell cycle: G1, S, G2 and M phases, Checkpoints Go Phase; Mitosis; Description of all stages and significance; Meiosis. Description of all stages and significance

Module 2: Genes and chromosomes (12 hrs) (13 marks)

Unit 1: DNA, the genetic material (5hrs) Structure of DNA, DNA replication-Semiconservative method, Okazaki fragments, leading strand, Lagging strand, the role of enzymes in DNA replication

Unit 2: Concept of a gene(3hrs) – Classical and modern concept, genetic code, introns, exons.

Unit 3: Morphology of chromosomes(4Hrs) -size, shape, karyotype, ideogram, kinds of chromosomes; Linkage and crossing over, sex-linked chromosomes.

Module 3: Elements of heredity and variation(12hrs) (15 marks)

Unit 1: Mendelian principles (5hrs)- Mendel's work and laws of inheritance (monohybrid cross, dihybrid cross, test cross).; Brief explanation of terms-alleles, homozygosity, heterozygosity, genotype, phenotype.

Unit 2: Non-Mendelian inheritance patterns (7hrs)- Brief description of other patterns of inheritance and genotype expression-incomplete dominance, co-dominance, multiple alleles, epistasis, pleiotropy.

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Module :4 Mutations and Genetic disorders (6hrs) (20 marks)

Unit 1: Mutations (3hrs)- Gene Mutation-Kinds of mutation, classification (Somatic, gametic, point, spontaneous, induced, dominant, recessive and silent mutations). Gene mutation disorders - albinism, phenylketonuria, alkaptonuria, galactosemia, brachydactyly.

Unit 2: Chromosomal anomalies (3hrs)- Autosomal anomalies - Down's syndrome, Edward's syndrome, Cri du chat syndrome.; Sex chromosomal anomalies - Klinefelter's syndrome and Turner's syndrome.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1. Operation and maintenance of Microscopes (Simple and Compound)
2. Observation of cell structure using human cheek epithelial cells.
3. Study of Mitosis using onion root tip.
4. Experiments on monohybrid and dihybrid cross (Mendelian inheritance).

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

Virtual Labs (Suggestive sites)

5. Study of different types of tissues using permanent slides.
6. Determination of human blood group using ABD antisera.
7. Demonstration of Meiosis using grass hopper testes.
8. Study on models of DNA and RNA structure.
9. Study of normal human karyotype (Male & Female)
10. Study of autosomal anomalies (Down's, Edward's and Cri du-chat)
11. Study of sex chromosomal anomalies (Klienfelter's & Turner's)
12. Simple Mendelian traits in humans and its inheritance (Pedegree analysis)

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2. Guptha, P.K., Cell and Molecular Biology, Rastogi Publications, Meerat.
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4. Strickberger W.M-Mac Millon, Genetics.
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6. Roothwell, Human Genetics, Prentice Hall.
7. Lodish;Verk; et.al; Molecular Cell Biology, W.H. Freemann publishers.
8. Verma, P. S. and Agarwal, V. K., Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S. Chand and Co. New Delhi.
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Online Sourses:

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	2	3	-	-	-	-	3					
CO 2	2	3	-	-	-	-	3					
CO 3	-	2	-	-	3	-	2				3	
CO 4	2	4	-	-	-	-	3					
CO 5	-	-	-	3	-	-	3					
CO 6	-	-	3	-	-	-	3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

NEUROPHYSIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop understanding in characteristics of nervous system, its components, functions, to develop skill in doing experiments revealing the functions of nervous system.				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify and explain the characteristics of different types of nerve cells, glial cells and nerve fibres.	R &U	F	Short answer, paragraph, questions
CO2	Describe the structure and functions of CNS and reflex actions, types of reflex actions.	U	F&C	Short answer, paragraph, essay questions
CO3	Describe the structure and functions of the Cerebellum and Basal Ganglia.	U	F&C	Short answer, paragraph, essay questions
CO4	Describe the structure and functions of the Cerebral Cortex, the functions of Brain in communication, and various theories of sleep and imaging techniques.	U	F&C	Short answer, paragraph, questions
CO5	Attain skill in doing experiments related to neurophysiology.	Ap	P	Practical lab exams, Viva-voce
CO6	Identify various functional deformities of brain from the symptoms shown by individuals in real life or imaginary situations.	Ap	M	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: The Nervous System (11Hrs) (Out of 70: 11 marks)

Unit 1 Divisions of Nervous system and tissue (6hrs) - (CNS, PNS – somatic and autonomic); Nervous tissue (neurons, nerve fibres, nerves, synapse); Non nervous tissue and other materials (neuroglia, meninges, Cerebro-spinal fluid, Blood- CSF and blood-brain barriers).

Unit 2: Nerve impulse(5hrs) - generation, conduction, synaptic transmission, the role of calcium ions,action of transmitter substances on the postsynaptic neuron, types of transmitter substances.

Module 2: The Central Nervous System (11Hrs) (23 marks)

Unit 1: Brain (3hrs) – an overview (Forebrain, midbrain, hindbrain).

Unit 2: Spinal cord (2hrs)– an overview of its structure and organization.

Unit 3: Reflex Action (4hrs)– reflex arc, muscle spindle, Golgi tendon organ, Types of reflexes- monosynaptic reflex, multi-synaptic reflex, crossed extension reflex, mass reflex.

Unit 4: Neural control of muscle tone and posture (2hrs).

Module 3: The Cerebellum and the Basal Ganglia (11Hrs) (16 marks)

Unit1: The Cerebellum and its motor functions.(2hrs)

Unit 2: Anatomical functions, areas of the cerebellum.(3hrs)

Unit 3: Function of the cerebellum in overall motor control(2hrs)

Unit 4: The basal ganglia-their motor functions(4hrs), role of the basal ganglia for cognitive control, functions of neurotransmitters with basal ganglia.

Module 4: The Cerebral Cortex, sleep and Techniques in Neurophysiology(12hrs) (20 marks)

Unit 1: Functions of the specific cortical areas(4hrs) –association areas (parieto-occipito-temporal, prefrontal and limbic association areas with special emphasis on Wernicke's area and Broca's area), area for recognition of faces, the concept of the dominant hemisphere.

Unit 2: Function of the brain in communication (2hrs)- Sensory and Motor aspects of communication

Unit 3: - Sleep (2hrs) –Basic theories of sleep, Brain waves, Slow-wave sleep and REM sleep

Unit 4: Techniques in neurophysiology(4hrs). Brain imaging – CT, MRI, PET, CBF, EEG, Lesioning, and Electrical Stimulation of Brain (ESB).

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS

1.Identification of parts of Brain using charts, models etc.
2. Identification of Brain waves – Slow wave sleep, REM sleep etc.
3. Demonstration of reflexes- Superficial reflexes, Deep tendon reflexes, Primitive or spinal reflexes, Tonic or brainstem reflexes
4. Demonstration of cranial nerve integrity
5. Demonstration of motor function.
6. Demonstration of assessment of cognitive function - Memory
7. Demonstration of assessment of speech and communication

For conducting the experiments from No. 3 to 7, the students can visit any Physiotherapy clinic or institute, or the teacher can find the help of any professionals from Medical field. The total duration of the institutional visit or the consultation with the professional must not exceed 10hrs. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

REFERENCE:

1. Schneider A.M &Tarshis B., An introduction to Physiological Psychology, Random House, NewYork.
2. Guyton & Hall – Textbook of Medical Physiology, 12 thEdn., Saunders.
3. Sherwood L, Thomson, Human Physiology.
4. Kalat J.W, Wadsworth C.A, Biological Psychology.
5. Levinthal C.F, Introduction to Physiological Psychology, Prentice Hall, New Delhi.
6. K.Sembulingam and PremaSembulingam, Essentials of Medical Physiology, Jaypee brothers Medical Publishers Pvt. Ltd.
7. Chatterjee, C.C, Human Physiology, Medical Allied Agency

Online Sources

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3						3						
CO 2		3					3						
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO 6					3						3		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

PHYSIOLOGY OF BEHAVIOUR AND SENSES

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The student develops an awareness in physiological basis of emotions and behaviour like, hunger, thirst, sexual drive; senses like, vision, hearing etc.				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the physiological control of thirst and hunger, factors affecting hunger and thirst, etc.	U	F&C	Short answer, paragraph, questions
CO2	Explain importance of sex hormones, causes of stress, and the list of hormones influencing sexual behaviour	U	F&C	Short answer, paragraph, essay questions
CO3	Predict the nature of defects caused by the damage or deformity of different parts of eye and ear	Ap	F&C	Short answer, paragraph, essay questions
CO4	Describe the sensory pathways for the gustatory, olfactory, thermo-sensory, pain sensations	U	F&C	Short answer, paragraph, questions
CO5	Attain skill in doing experiments related to sensory functioning	Ap	C&P	Practical lab exams, Viva-voce
CO6	Prepare report on visiting institutions like, hospitals to study the sensory perception analysis procedures	An	C&P	Assignment, report writing

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Module 1: Physiological basis of hunger and thirst (10Hrs) (Out of 70: 14 marks)

Unit 1: Physiology of Hunger (6hrs)- Neural control of food intake - Role of the hypothalamus, Neural centers that influence; Mechanical process of feeding.; Factors that regulate the quantity of food intake, role of hormones (effect of Cholecystokinin, Peptide YY, GLP, and Ghrelin).; Short-term regulation of food intake, intermediate and long-term effects of food intake.; (Effect of blood concentrations of glucose, amino acids, lipids on hunger and feeding), temperature regulation of food intake.; Obesity - causes and treatment, eating disorders (Bulimia, Anorexia, Inanition, Cachexia, Picca).

Unit 2: Physiological basis of thirst (4Hrs)- Peripheral factors in water regulation. Central factors in water regulation (cellular dehydration thirst and hypovolemic thirst).; Angiotensin and thirst, Dehydration and water toxicity

Module 2: Physiological basis of emotions and sexual behaviour (14Hrs) (21 marks)

Unit 1: Neural basis of emotion& Stress physiology (5hrs)-Role of frontal lobes.; Behavioural functions of the hypothalamus and associated limbic structures, Reward centers, Rage – its association with punishment centers, placidity and tameness.; Functions of Amygdala. ; Stress physiology: Stress and strain- Environmental stressors

Unit 2: Physiology of sexual behaviour (9hrs) - Hormones and sexual development – Foetal hormones and the development of reproductive organs, Sex differences in the brain, Perinatal hormones and behavioural development, Puberty: hormones and development of secondary sexual characteristics.; Effects of gonadal hormones on adults – Male reproduction-related behaviour and testosterone, Female reproduction-related behaviour and gonadal hormones. ; Neural mechanisms of sexual behaviour – Structural differences between the male hypothalamus and female hypothalamus, the hypothalamus and male sexual behaviour, the hypothalamus and female sexual behaviour**,**

Module 3: Physiology of Vision and Hearing (10Hrs) (15 marks)

Unit 1: Vision (5hrs) - Structure of the human eye, Organization of the retina and visual pathways.; Functioning of the eye, visual coding, chemistry of vision, transduction in the retina, theories of colour vision, visual perception, Visual defects (myopia, hypermetropia, presbyopia, astigmatism, cataract, colour blindness, nyctalopia).

Unit 2: Auditory System (5Hrs) - Characteristics of sound &audible sound frequency; Anatomy of the auditory system.; Auditory pathways, auditory perception and hearing abnormalities.; statoreceptors**.**

Module 4: Gustatory, Olfactory and cutaneous system (11Hrs) (20 marks)

Unit 1: Physiology of taste (3hrs)- Anatomy of taste buds and its function, primary sensations of taste (agents and site of sensation), taste thresholds and intensity discrimination, taste preferences and control of the diet; Taste pathways and transmission of signals into the central nervous system.

Unit 2: Physiology of smell (2hrs) - Organization of the olfactory membrane, sense of smell and stimulation of the olfactory cells; Categorizing smell, the transmission of smell signals into the central nervous system.

Unit 3: Cutaneous senses (6hrs) - Classification – the mechanoreceptive somatic senses (tactile and position), thermo-receptive senses (heat and cold) and pain sense.; Detection and transmission of tactile sensations – tactile receptors, detection of vibration, tickling and itch; Sensory pathways for transmitting somatic signals into the central nervous system,; Somatosensory cortex, position senses, position sensory receptors.; Thermal sensations - thermal receptors, their excitation and transmission of thermal signals; Pain – purpose, types, pain receptors, pain suppressive system, pain sensation**.**

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

1.Identification of parts of Eye using charts, models etc.
2. Identification of parts of Ear using charts, models etc.
3. Identification of visual defects myopia, hypermetropia, presbyopia, astigmatism, cataract, nyctalopia
4. Identification of colour blindness using Ishihara chart.
5. Practise of stress releasing excercises.

Two experiments other than the listed should be designed by the Supervising teacher and introduced to the students.

Institutional visit to Hospitals or other Medical centers to study the procedures to detect visual or auditory defects in children (not more than one day)

REFERENCE:

1. K. Sembulingam and Prema Sembulingam, Essentials of Medical Physiology, Jaypee brothers Medical Publishers Pvt. Ltd.
2. Guyton & Hall, Textbook of Medical Physiology 12 thEdn., Saunders.
3. Sebastian M.M, Animal Physiology, Madonna.
4 Kalat J.W, &Wadsworth C.A, Biological Psychology.
5. Barrett E. Kim, Barman M. Susan et.al; Ganong's review of Medical Physiology, Tata McGraw Hill Education Pvt. Ltd.
6. Sarada Subrhmanian and K. Madhavan Kutty, A Text Book of Physiology. Orient Longman Publication.
7. Sujith K. Chaudhari, Concise Medical Physiology, New Central Book Agency, Delhi.
8. A. K. Jain, Text Book of Physiology Vol.1 & 2, Avichal Publications.
9. Schneider A.M &Tarshis B, An introduction to Physiological Psychology, Random House, New York.
10. Sherwood L, Thomson, Human Physiology.
11. Levinthal C.F, Introduction to Physiological Psychology, Prentice Hall, New Delhi.
12. Pinel P.J John, Biopsychology, Pearson.
13. Neil.R.Carlson, Physiology of behavior, Pearson publishers.
14. Barrett E. Kim; Barman M. Susan et al., Ganong's Review of Medical Physiology; Tata McGraw Hill Education Pvt. Ltd.
15Alcock John, Animal Behavior, 6 th edition, Sinauer Associates, Inc. Sunderland, Massachusetts.
16. Carlson, Neil, R., Physiology of Behavior, 8 th edition, Pearson

Online Sources

1
2
3

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3					3		3						
CO 4		3					3						
CO 5				3					3				
CO 6				3				3					

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

VOCATIONAL MINOR COURSES

APPLIED ZOOLOGY

BASICS IN ENTOMOLOGICAL, POULTRY SCIENCE AND DAIRY SCIENCE APPLICATIONS

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or the following online courses 1.https://onlinecourses.swayam2.ac.in/cec20_ge23/preview 2.https://asutoshcollege.in/new-web/six-months-certificate-course-in-apiculture-and-sericulture.html				
Course objectives	The course is designed to develop an understanding in overall aspects of Sericulture, Apiculture, Dairy and Poultry Science and enable the student to do simple experiments regarding these.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the process of Apiculture; different species of Honey Bees; the importance of health and hygiene in Beekeeping; the economic importance of Apiculture	U	F&C	Short answer, Paragraph, Essay type questions
CO2	Describe various stages of Sericulture; different species of Silk moths; the importance of health and hygiene in Sericulture; the economic importance of Sericulture	U	F&C	Short answer, Paragraph, Essay type questions
CO3	Enlist various traps and other physical means to control insect pests	U	F&C	Short answer, Paragraph type questions
CO4	Identify and describe different breeds of cattle and fowls for various purposes, different appliances and parts of cattle and poultry rearing houses	R& U	F& C	Short answer, Paragraph type questions
CO5	Acquire the skills to maintain Bee hives, Silk worm rearing houses and insect traps in a scientific way.	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Compare different species of honey bees and silkworms for their rearing characteristics	U	F&C	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Apiculture (12Hrs) (Out of 70: 18 marks)
Unit 1: Introduction to Apiculture: (2hrs)-Brief history, Apiculture worldwide and in India and its Scope; Traditional, Modern and Urban or Backyard Beekeeping; species of Honey Bees used in Bee-keeping; Role of Central Honey Bee Research and Training Institute.
Unit 2: Biology of Honey bees (2 hrs)- Morphology, Life History and Social Behaviour of Honey Bees of Honey Bees.
Unit 3: Rearing of Honey Bees (5hrs) -: Standard tools used in Apiculture, types of bee hives; Basic requirements for Beekeeping. Honey Bee Enemies and Diseases, Management, Preventive and control measures of diseases.
Unit 4: Economy and Entrepreneurship (3hrs)- Bee products; Composition and uses of honey; Honey extraction and handling; Economic importance and marketing aspects of bee products; Role of Govt. and Non-Govt. agencies in promoting apiculture in Kerala; Present status and scope of apiculture in Kerala.

Module 2: Sericulture and Lac culture(14hrs) (20 marks)
Unit 1: Introduction to Sericulture (2hrs) - Origin and history of Sericulture. Sericulture in India and other countries. Present status of sericulture. Scope of sericulture. Types of silkworms and their distribution. Mulberry and non-mulberry sericulture.
Unit 2: Silkworm Biology and Rearing (6hrs)- A brief introduction to mulberry cultivation and mulberry varieties. Commercial varieties of mulberry, Mulberry plantation establishment and cultivation practices. Life cycle of *Bombyx mori*. Structure of silk gland and secretion of silk. Rearing house and rearing appliances. Disinfectants. Silkworm rearing technology: Early age and Late age rearing. Types of mountages. Spinning, harvesting and storage of cocoons.
Unit 3: Diseases of silkworms (1hr)– Viral, Bacterial, Fungal and Protozoan; Control measures.
Unit 4: Entrepreneurship in Sericulture (2hrs)-: Prospects of Sericulture in Kerala, potential in mulberry and non-mulberry sericulture. Employment in Sericulture and Govt. Schemes for financial Assistance.
Unit 5 Lac culture (3hrs)- Morphology and life cycle of Lac insect lac host plants, different strains of lac insects, cultivation, inoculation, harvesting and propagation of lac, composition and uses of lac.; Enemies of lac insect and their control. Scope for cultivating lac in Kerala. Recent advances in lac culture research.

Module 3: Traps and other physical methods to control insect pests (6 hrs) (13 marks)
Unit 1: Insect traps (5hrs) – Passive traps: Window flight trap, barrier trap, Malaise trap, cone trap, pan trap, bucket trap, Aquatic arthropod trap: Aquatic interception traps, Aquatic emergence trap; Aerial rotary and suction traps; coloured trap, USB based traps: Active traps: Light traps- different types, parts of a light trap, sticky traps, pheromone trap, bait traps.
Unit 2: Other methods(1hr): Sweeping: aerial nets, sweep nets; beating cards and sheets; netting, sieving.

Module:4 Dairy Science and Poultry production(13hrs) (19 marks)
Unit 1: Dairy cattle breeding (3hrs)- Different breeds of cattle grown for different purposes; Inbreeding, Outbreeding, Cross breeding, Grading up. Breeding systems suitable to enhance milk production in India (Cross breeding of cattle and Grading up of buffaloes).Multi-ovulation and Embryo transfer technique. Cloning and Transgenic animals

Unit 2: Dairy processing (3hrs)– Milk collection, transportation & Grading of milk – Standardization – Pasteurization – Homogenisation of milk - packaging of milk- Common adulterants in milk and their detection techniques- Nutritive value of milk ICMR recommendation of nutrients.

Unit 3: Current status of Indian poultry industry (3hrs)- avian biology and welfare; breeds and varieties of poultry, poultry breeding and genetics.
Unit 4: Physical requirements of incubation and hatchery management(4hrs)- summer and winter management of poultry; artificial insemination; Common poultry diseases and management; Management of hatchery and poultry waste; economics of poultry production.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS
1.To study the different species and castes of Honey Bees.
2.Familiarise Bee keeping instruments and Bee hives.
3.Familiarise Silkworm rearing appliances.
4.Construction of any two types of insect traps: light trap/ sticky trap/ pan trap/ malaise trap

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.
5. Identification of different species of Silkworms and their life cycles.
6. To test the quality of milk
7. Structure of Honey comb – Different types of cells for Queen, Workers and Drones.
8. Morphological peculiarities of Worker bees – Honey and pollen storage structures.
9. Construction of mini egg incubators using suitable materials.
10. Construction of bee hives (if original hive making is not possible, make miniature models using cardboards or other suitable materials)

Field Study: a) Visit to an apiary to study the bee keeping methods /b) Visit to Silk worm rearing centers to find the silk worm rearing/ c) Visit to Dairy and Poultry farms/.d Visit to insect pest control device – making units or industries. Prepare a detailed report based on the field visit, which is to be submitted at the time of end semester exam.

Virtual Labs (Suggestive sites)

1.https://agritech.tnau.ac.in/farm_enterprises/fe_api_castesofhoneybee.html#:~:text=Queen%20is%20a%20fertile%2C%20functional,drone%20is%20a%20male%20insect.&text=Queen%20and%20worker%20develop%20from,the%20queen%20or%20worker%20larvae.
2.https://agritech.tnau.ac.in/farm_enterprises/fe_api_beekeepingaccessories.html
3.https://agritech.tnau.ac.in/sericulture/seri_silkworm%20types.html
4.https://agritech.tnau.ac.in/sericulture/seri_silkworm1_rearing%20house.html
5.https://www.beemaniacs.com/2015/04/18/cells-cells-and-cells/
6.https://ir.library.oregonstate.edu/downloads/m613n331f
7.https://agritech.tnau.ac.in/farm_enterprises/fe_api_typesofhoneybee.html#:~:text=The%20Indian%20hive%20bee%2C%20Apis,%2C%20Melipona%20irridipennis%20(Meliporidae).
8.https://pureshmilk.com/blog/2019/06/21/simple-tests-at-home-to-check-the-purity-of-the-milk-you-consume/

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- Arora, R. and Dhaliwal, G. S. 2001. integrated Pest Management Concepts and Approaches – Kalyani Publishers ISBN 81-7663-904-4
- B David and T Ananthakrishnan. 2003. General and applied Entomology. 2nd Edition.ISBN: 9780070434356, 0070434352, Tata McGraw Hill. 1200 pages.
- B. V. David and V.V. Ramamurthy. 2016. Elements of Economic Entomology. 8th Edition. ISBN: 9780994869104, 099486910X, Brillion Publishing. 400 pages.
- G.C. Banerjee. 2019. Text Book of Animal Husbandry, 8th Edition. ISBN: 9788120412606. Oxford & IBH Publishing, New Delhi. 552 pages.
- Gursharan Singh, K.P. Srivastava, G.S. Dhaliwal. 2021. A Textbook of Applied Entomology – II Insects of Economic Importance. 4th Edition.ISBN :9788127267520, Kalyani Publishers.
- Hand Book of Animal Husbandry – ICAR Edition. ISBN -13 - 978-8171640867 1234pages
- Mahanta, D. K., Komal, J. and Sai Teja, K. S. 2022 Different Types of Insect Traps for Different Insects- Agriculture & Food E newsletter Volume 4(4)
- Omkar. 2017. Industrial Entomology. ISBN 978-981-10-3303-2, Springer Nature Singapore Pte Ltd. 469 pages
- Petersen. W.E. 2017. Dairy Science: Its Principles and Practice. 2nd Edition. Publisher – Lippincott & Company
- Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi

Online Sources

1.https://www.vedantu.com/biology/apiculture-and-sericulture

2.https://elearning.icar.gov.in/eLearning_ContentDisplayUG.aspx?Course-Code=7UV3MOEAK1USxrGrYOy7VQ==&CourseName=AabP6XqFFfb5/FvzYT1aG-GZAlW05pNbzZ1x4ZpuEo2OXSkGj/DaCsEk/HLGqrq6CbisPvpLgM4vZ7EWBwZLl-Pjc1awujk2II9I0w21IPwEM=

3.https://agritech.tnau.ac.in/animal_husbandry/animhus_index.html

4.https://vetstudy.journeywithasr.com/p/bvsc-and-ah-1st-year-notes_2.html

5.https://www.vedantu.com/biology/poultry-farming

6.https://www.drprofessionals.in/2021/05/livestock-production-management.html#google_vignette

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3					3						
CO 4	3						3						
CO 5				3					3				
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

AQUACULTURE AND FISHERY SCIENCE PRACTICES

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or the following online courses 5. https://elearning.fao.org/course/view.php?id=579 6. https://www.classcentral.com/classroom/youtube-aquaculture-types-of-culture-systems-179652 7. https://fisheries.tamu.edu/training-online-courses/				
Course objectives	The student develops understanding and knowledge about different aquatic culture species, culture methods and aquaculture systems.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify and describe major commercially important aquaculture species of India and the basic principles of aquaculture and culture methodologies of fishes and shellfishes.	U	F&C	Short answer, Paragraph, questions
CO2	Describe the concepts of pond culture, pen culture, cage culture and other advanced culture systems	U	F&C	Short answer, Paragraph, questions
CO3	Explain different types of tools used in fishing and resource utilization.	U	F&C	Short answer, Paragraph, Essay questions
CO4	Develop expertise in setting up and maintenance of different types of aquaculture systems in commercial level.	Ap	C&P	Short answer, Paragraph, Essay questions
CO5	Prepare field reports on visiting aquaculture systems, fish processing centers and fish landing centers	C	M&P	Practical lab exams, Viva- voce, report writing
CO6	Recognize different disease or malnourishment conditions of culture fishes in real life and imaginary situations	Ap	M	Short answer, Paragraph questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Unit 1: Introduction to Aquaculture (6hrs) (Out of 70: 6 marks)

Unit 1. Aquaculture – Definition. Criteria for selection of species for aquaculture. Commercially important aquaculture species in India. Freshwater, Brackish and Marine finfish and shellfish species. Brief account of classification of aquaculture based on: Environment – Freshwater, brackish water and mariculture.

Module 2: Culture Techniques and breeding(12hrs) (20 marks)
Unit 1: Culture techniques (3 hrs): Cage culture, pen culture, raft culture, pole culture, rack culture and long line culture. Number of species – Mono culture and poly culture.
Unit 2: Type of culture and breeding (9 hrs): Brief account on prawn culture, mussel culture, pearl culture and pisciculture. Important cultivable species in India, seed collection, spawning and larval rearing, induced breeding. Mudbanks of Kerala coast.

Module 3: Aquaculture systems(17hrs) (22 marks)
Unit 1: Aquaculture (8 hrs): Principles of Aquaculture, Site selection, Surveying, Pond preparation-Layout of a farm. Weed eradication, Water quality requirements, Selection of candidate species (indigenous/exotic).
Unit 2: Culture and breeding of finfishes (9 hrs): Carps, Catfishes, *Tilapia*, *Etroplus*. Broodstock management, seed production, larval rearing, growout technology, types of hatcheries, feed management, harvesting and marketing.

Module4: Fishing resources and management (10hrs) (22 marks)
Unit 1: Fishing crafts and gears (4 hrs): Mention Catamaran, Canoes and dug-out-canoes. Gillnet/drift gillnet, purse-seines, harpoon, Chinese dipnets, echo sounders, sonar, remote sensing. Prohibited fishing practices, trawl ban, impacts of trawling.
Unit 2: Fish diseases, spoilage and preservation (6 hrs): Biochemical changes, spoilage, use of ice, freezing, canning, dehydration, salting and smoking. Fish and Shell fish diseases (Bacterial, fungal, viral; 2 each). Cryopreservation of fish germplasm, semen bank and preservation media.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS
1.Identification of culturable species.
2.Feed formulation and preparation for cyprinids, catfishes, prawns, etc.
3.Preparation of field study report after visiting, hatchery and farm/ fish processing plants,/ice plant and fish landing centre/ institutes like CMFRI/ CIFNET/ KUFOS (Maximum **TWO** days)
4.Collection and preservation of crustaceans, molluscs, fishes and other aquatic organisms
From the remaining 6, four experiments can be selected by the teacher; Two more experiments (not included in the list) are to be designed by the teacher.
5.Identification of aquatic weeds, pests and predators.
6.Water quality analysis of aquaculture systems
7.Culturing of any commonly available culture fishes in synthetic tanks, ponds etc.
8.Making of culture devices: rafts for mussel culture, happa for fish culture etc.
9.Identification of culture fish diseases.
10.Identification of preserved fish products
Virtual lab:
1.https://blue-cloud.d4science.org/web/aquacultureatlasgeneration
2.https://www.aquaexcel2020.eu/virtual-laboratory
3.https://www.aquafeed.com/regions/europe/new-virtual-fish-laboratory-open-for-use/

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- Kurian C.V., Sebastian C.V(1986): Prawn and Prawn fisheries in India, Hindustan Publishing Corporation. 297 pages.
- V. B. Upadhyay and G. S. Shukla (2007): Applied and Economic Zoology; Rastogi Publications. 496 pages
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- Fisheries and Aquatic Resources of India. Daya Publ. Hse., Delhi. FAO. 2019.
- The State of World Fisheries and Aquaculture. FAO Fisheries and Aquaculture Department, FAO, Rome Gillett, R. 2008.
- Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.
- Jhingran, V.G. 2007. Fish and Fisheries of India. 3rd ed. Hindusthan Publ. Corpn., New Delhi, 727 pp.
- Jyoti, M.K. & Arti Sharma 2006. Fishes - Aid to Collection, Preservation and Identification. Daya Publ. Hse., Delhi.
- Kurian CV and V.O Sebastian VO. 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corp.
- An Aid to Identification of the Common Commercial Fishes of India and Pakistan. Narendra Publ. Hse., New Delhi, pp. Modayil, M.J. & N.G.K. Pillai. 2007.
- Status & Perspective in Marine Fisheries in India. CMFRI, Kochi, 404pp.
- Pillai, NGK. 2011. Marine Fisheries and Mariculture in India. Narendra Publishing House, Delhi.
- Rounstill, G.A. 1985. Fishery Science. Methods and Application. Internat. Books Periodicals Suppl.

Online Sources

1.https://www.tandfonline.com/journals/brfs21

2.https://www.fisheries.noaa.gov/topic/aquaculture/science-&-technology

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

FOUNDATIONS OF BIOSTATISTICS AND BIOTECHNIQUES

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop an understanding in the procedures of data collection, analysis, centrifugation, electrophoresis, chromatography, DNA extraction, histochemical tissue preparation etc.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various data collection and presentation methods	U	F&C	Short answer, Paragraph, type questions
CO2	Perform various data analysis procedure using the given data	Ap	C&P	Short answer, Paragraph and Essay type questions
CO3	Describe the procedures for centrifugation, electrophoresis, chromatography etc.	U	F&C	Short answer, Paragraph, Essay type questions
CO4	Explain DNA extraction and purification and histochemical tissue preparation methods	U	F&C	Short answer, Paragraph type questions
CO5	Perform experiments related to biostatistics and tissue processing techniques	Ap	C&P	Practical lab exams, Viva- voce, report writing
CO6	Compare the merits and demerits of different techniques for molecular, cytological and histological studies	U	F&C	Short answer, Paragraph type questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1 Data – Collection and Presentation (9Hrs) (Out of 70: 14 marks)

Unit 1: Introduction (1hr) - Definition; Applications; Terminology, variables. Limitations of statistical methods.

Unit 2: . Methods of Collection (2hrs)- a) census method, Advantages, disadvantages b) Sampling methods: Random: Advantages and Disadvantages; Non-random: Advantages and Disadvantages; Sample size, Collection and processing of data, Classification of data.

Unit 3: Presentation of data (6hrs) - a) Tabular: class intervals, preparation of class intervals, tally marks b) Graphical : Line graph, histogram, frequency polygon and frequency curve: types, kurtosis, cumulative frequency curves (ogive), scatter or dot diagram c) Diagrammatic: bar diagram: simple, multiple, component, percentage and pie diagram).

MODULE 2 Data Analysis **(13 Hrs) (20marks)**

Unit 1: Measures of central tendency and Dispersion (8hrs)-: (raw data, discrete series data, continuous series data- problems are to be discussed) i) Mean, ii) Median and iii) Mode. Measures of Dispersion: (raw data, discrete series data, continuous series data - problems to be discussed) i) Range, ii) Mean deviation, iii) Standard deviation, iv) Standard error (problems are to be discussed)

Unit 2: Hypothesis testing and Interpretation of results(5hrs)-: a) i)'t' test, ii) F-test (ANOVA) (problems are to be discussed) b) Statistics-based acceptance or rejection of hypothesis (5Hrs).

MODULE 3 (12 Hrs) (20marks)

Unit 1: Basic Methods to study Biomolecules (9hrs) - Basic principle, procedure and application of Cell fractionation; Centrifugation-Differential, Density Gradient and Ultracentrifugation; Electrophoresis- Agarose Gel Electrophoresis and SDS-PAGE (Mention 2D-PAGE); Chromatography: Paper and Thin Layer Chromatography (Other types of Chromatography Mention only); Blotting techniques: Northern, Southern, Western Blots; Dot Blots (Brief)

Unit 2: Colourimetry, Spectroscopy and spectrometry(3hrs)-: Working and application (Mention the application of Mass spectrometry, LC-MS, GC-MS also). Autoradiography.

MODULE 4 (11 Hrs) (16 marks)

Unit 1: DNA Extraction and Purification(6hrs)- Basic methods for isolating and purifying DNA. Polymerase Chain Reaction (PCR): Basic principle and working of PCR, Mention Different types of PCR; Application. Overview of DNA microarray. Emerging Trends in Biotechnology - Overview of CRISPR-Cas9 technology and synthetic biology (Brief note only).

Unit 2: Biotechniques to study tissues and organs(5hrs) - Basic procedure and application of Histology and Histochemical Techniques- Introduction, whole mount, serial section, microtomy, basic steps in histology -Fixation, Dehydration, Embedding, sectioning, staining and mounting Karyotyping: Procedure and Application

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Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

13. Calculate the mean, median and mode (raw data, discrete series & continuous series) for the given data
14. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.
15. Demonstration of Paper Chromtography/Centrifugation- Pipetting and dilution technique
16. Staining any tissue sample (serial sectioning) and whole mount preparation

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students

17. Measure the size of given shells / any sample of data and represent it in a graphical form and interpret it.
18. Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical form. Compare by t-test.
19. Construct a frequency curve and frequency polygon with mean ± SD using suitable data.
20. Draw a bar diagram with mean ± SD employing suitable data. Construct a histogram with mean ± SD utilizing suitable data.
21. Draw a pie diagram using suitable data.
22. Demonstration of PCR set up and optimization
23. Demonstration of any one type of Electrophoresis
24. Karyotyping of the given sample.

Field study: A) Visit to Molecular Biology/ Biotechnology Laboratory, and submission of detailed field study report at the time of semester end practical examination.

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Mcgiffen, Steven P. Biotechnology. USA: Pluto Press, 2005.

Mahesh, S. Biotechnology IV. India: New Age International, 2006.

Nicholl, Desmond, S.T.: An Introduction to Genetic Engineering. UK: Cambridge University Press, 2002.

Sathyanarayana, U. Biotechnology. Books and Allied, 2008..

Young, Lisa. Biotechnology and Genetic Engineering. Facts on Files, 2004

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2				3	3				3				
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO6		3				3	2						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
C05			✓	✓
CO6	✓			✓

COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATONS

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	VIII				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop a thorough knowledge in computational biology, its tools, its applications and IT tools in biostatistics				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the historical context and importance of computational biology in contemporary biological research.	U	F&C	Short answer, Paragraph, questions
CO2	Explain diverse biological databases and their retrieval systems, their role in phylogenetic studies, drug design, the use of various software such as Phylip, PAUP, RAxML, MrBayes, and Mauve in phylogenetic study as well as different computational methods in drug design including QSAR techniques, and software tools like Autodock and Gold.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe IT tools like spreadsheets and databases for efficient biostatistical data management, apply statistical analysis methods with software such as R, SAS, and SPSS, and utilize visualization techniques like ggplot2 and matplotlib for clear communication of biostatistical findings and retrieve and analyse data from these databases through online tools and resources	U	F&C	Short answer, Paragraph, questions
CO4	Apply Bayesian methods and Markov Chain Monte Carlo (MCMC) algorithms using software tools like Stan and JAGS for Bayesian inference and interpret the results in the context of biostatistics research	Ap	F&C	Short answer, Paragraph, Essay questions
CO5	Perform experiments using biological databases, Biostatistical tools	Ap	C&P	Laboratory experiments, exams

CO6	Explain the use of machine learning methods like decision trees and support vector machines through software packages like scikit-learn in Python and caret in R for predictive modeling and also interpret high-throughput data from next-generation sequencing and microarrays using bioinformatics tools such as Bio conductor in R and Galaxy	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1: Fundamentals of Computational Biology (12hrs) (Out of 70: 15 marks)

Unit 1 Introduction to Computational Biology (1hr): Overview of computational biology, significance in modern biological research; Historical background and milestones,

Unit 2 Biological Databases and Data Retrieval (5Hrs): Overview of biological databases, Scope and applications Sequence, structural, literature, gene expression and metabolic pathway databases, Small molecule databases: Pubchem, drug bank, zinc database and cambridge structure database. Data types in biological databases: Primary, secondary and tertiary databases, data formats: text, sequence data, protein structure and links. Data retrieval and analysis using online databases and tools

Unit 3: Introduction to Algorithms in Computational Biology (3Hrs): Definition and importance of algorithms in computational biology, Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, sorting. Algorithm types in computational biology.

Unit 4: Programming languages (3hrs): Introduction to programming languages, installation and setup of development environments: Python, R, Java Matlab, Perl; Programming Fundamentals: Variables, data types, and operators, Control structures: loops and conditional statements, Functions and modules; Data Structures and File Handling: Lists, tuples, dictionaries, reading from and writing to files

Module II Tools in computational biology (12hrs) (20 marks)

Unit 1: Genomics and proteomics(3hrs): Pairwise and multiple sequence alignment methods: BLAST, ClustalW, : Protein identification and quantification methods (MS/MS, label-free quantification), Protein structure prediction methods (homology modeling, ab initio modeling), visualization and modeling software (e.g., PyMOL, Swiss-PdbViewer) , Construction and analysis of biological networks (protein-protein interaction, metabolic networks), network visualization and analysis using software tools Cytoscape, Genome assembly and annotation methods, Transcriptomics data analysis (RNA-Seq, differential gene expression analysis) data analysis using HISAT2, DESeq2

Unit 2: Metabolomics in computational biology (3hrs): Overview of metabolite identification, quantification, and profiling techniques. Preprocessing steps for raw metabolomic data (e.g., normalization, peak detection, alignment). Computational methods for metabolite annotation and identification (e.g., MS/MS spectral matching, database searching). Computational approaches for biomarker discovery in metabolomic data. Reconstruction of metabolic networks from metabolomic data.MetabolicFluxomics: Computational modeling of metabolic flux distributions. Visualization techniques for exploring and interpreting metabolomic data: heatmaps, pathway analysis approach. Overview of software tools and databases for metabolomic data analysis MetaboAnalyst, XCMS, MetFrag.

Unit 3: Phylogeny (3hrs): Definition and significance of phylogenetic analysis in computational biology, Phylogenetic Reconstruction Methods: Distance-based methods (e.g., neighbor-joining, UPGMA), Character-based methods (e.g., maximum parsimony), Likelihood-based methods (e.g.,

maximum likelihood), Bayesian inference methods. Introduction to commonly used software for phylogenetic analysis: Phylip, PAUP, RAxML, MrBayes, Mauve.
Unit 4: Computational Methods in Drug Design(3hrs): Identification of lead compounds: structure-based and ligand-based approaches; Molecular docking techniques including algorithms and scoring functions; Virtual screening through combinatorial chemistry and databases of ligands; Designing ligands for established target sites using de novo techniques. Application of pharmacophore models based on ligands and targets. Implementation of Quantitative Structure-Activity Relationship (QSAR) techniques for predicting bioactivity. Introduction to software tools such as Autodock, Gold, and others.

Module III: Introduction to IT Tools in Biostatistics (10hrs) (15 marks)
Unit 1: Basics of Biostatistics and Data Management (3hrs): Introduction to biostatistics and its importance in life science. Overview of data types, data sources, and data collection methods in biostatistics. Introduction to data management techniques including data cleaning, data transformation, and data integration. Utilization of IT tools such as spreadsheets and databases for data management in biostatistics.
Unit 2: Statistical Analysis Using Software Packages(3hrs): Introduction to statistical software packages commonly used in biostatistics - R, SAS, SPSS. Basics of data analysis including descriptive statistics, hypothesis testing, and regression analysis.
Unit 3: Visualization and Presentation of Biostatistical Data(2hrs): Importance of data visualization in biostatistics for communicating results effectively. Types of data visualization techniques - histograms, boxplots, scatter plots. Utilization of IT tools for creating visualizations and graphs - ggplot2 in R, matplotlib in Python.
Unit 4: Data Sharing and Reproducibility(2hrs): Importance of data sharing and reproducibility in biostatistical research. Introduction to version control systems for tracking changes in data and analysis scripts-Git. Documenting and organizing data and analysis workflows. Ethical considerations and guidelines for data sharing and reproducibility in biostatistics research.

Module IV: Advanced Topics in IT Tools for Biostatistics (11 hrs) (20 marks)
Unit 1: Bayesian Methods and Markov Chain Monte Carlo (MCMC)(3hrs): Introduction to Bayesian statistics and its applications in biostatistics. Overview of Markov Chain Monte Carlo (MCMC) algorithms for Bayesian inference. Bayesian data analysis using software tools- Stan, JAGS. Interpretation and communication of results from Bayesian analysis in biostatistics.
Unit 2: Machine Learning in Biostatistics(2hrs): Introduction to machine learning techniques and algorithms - decision trees, random forests, support vector machines in biostatistics. Applications of machine learning in predictive modeling, classification, and clustering of biomedical data. machine learning using software packages- scikit-learn in Python, caret in R. Evaluation and interpretation of machine learning models in biostatistics research.
Unit 3: High-Throughput Data Analysis(3hrs): Introduction to high-throughput technologies in biostatistics - next-generation sequencing, microarrays . Overview of bioinformatics tools and pipelines for processing and analyzing high-throughput data. Analyzing high-throughput data using bioinformatics software tools - Bioconductor in R, Galaxy. Challenges and considerations in analyzing and interpreting high-throughput data in biostatistics.
Unit 4: Big Data Analytics in Biostatistics(3hrs): Introduction to big data analytics and its applications in biostatistics. Overview of tools and techniques for handling and analyzing large-scale biomedical datasets. big data analytics using distributed computing frameworks - Hadoop, Spark. Ethical and privacy considerations in big data analytics for biostatistics research.

Module V: Practicals* Credit 1, 30hrs)

1. Sequence data retrival from different database such as GenBank
2. Aligning of DNA/amino acid sequences with BLAST to understand relationships.
3. Protein structures prediction using software PyMOL and interpretation of results to predict function.
4. Metabolomic raw data processing using XCMS and application of statistical methods for biomarker discovery, and visualization of results with heatmaps.
5. Phylogenetic Tree Construction using software PAUP, and analysis of evolutionary relationships.
6. Molecular docking interactions between ligands and receptors and predicting binding affinities using Autodock
7. Hypothesis testing and regression analysis of biological datasets utilizing R
8. Genomic data analysis using hadoop

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3. Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.
4. Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.
5. Propst, C. L., & Perun, T. (1989). Computer-aided drug design: methods and applications. Marcel Dekker, Inc.
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ONLINE SOURCE

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3								3
CO6		3					3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
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Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓	✓		✓
CO3	✓	✓		✓
CO4	✓	✓		✓
CO5			✓	
CO6	✓			✓

SKILL ZOOLOGY

ECOLOGICAL TOOLS AND TECHNIQUES

Programme	B. Sc. Zoology				
Type of Course	Vocational Minor				
Semester	I				
Academic Level	100 -199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Plus two/ VHSE or equivalent online courses				
Course summary	Objective of this course is to pay awareness to the most important aspect of Ecological research i.e. Research Methodology. It will enable the students to build up the most suitable methodology for their research. The mission of the course is to teach research skills to the beginners and assist to improve the quality of Research by the existing researchers by and large.				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the characteristics of environment and its biotic and abiotic factors,	U	F&C	Short answer, Paragraph, questions
CO2	Explain various terms and population estimation methods.	U	F&C	Short answer, Paragraph, Essay questions
CO3	Describe process of data analysis and interpretation	U	F&C	Short answer, Paragraph, Essay questions
CO4	Explain various steps of scientific writing	U	F&C	Short answer, Paragraph, questions
CO5	Conduct direct surveys which gives first-hand observations of animals or other living organisms under laboratory or real-world conditions. Develop skills in applying statistical and ecological tools in practical life.	An	F&C	Assignments, seminars, Lab experiments, Viva-voce.
CO6	Explain the process of research design, importance of literature review.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module I: Introduction to Ecological Research (9 hours) (Out of 70: 15 marks)

Unit 1: Concepts and principles(4hours): Definition and scope of ecology, ecological levels of organization, populations, communities, ecosystems, biomes, ecological interactions, abiotic and biotic factors, energy flow, nutrient cycling, ecological succession.

Unit 2: Research design(3hours): Formulating research questions, hypotheses, null hypotheses, types of research (observational, experimental, manipulative), study design considerations (replication, randomization, controls), ethical considerations in ecological research.

Unit 3: Literature review(2hours): Importance of literature review, accessing scientific databases, critical evaluation of scientific articles.

Module II: Field Sampling and Collection Techniques (12 hours) (19 marks)
Unit 1: Vegetation sampling(1hours): Quadrat methods transect methods, line intercept methods, importance value index, species diversity indices.
Unit 2: Trapping collection and marking of Animals (5hours): Collection of - flying insects, birds, mammals, aquatic animals, soil organisms; marking methods; age determination techniques.
Unit 3: Animal sampling (2hours): Capture-mark-recapture methods, line transects, point counts, camera traps, environmental DNA (eDNA) sampling.
Unit 4: Soil sampling (2hours): Soil core collection, soil profile description, analysis of physical and chemical properties (pH, moisture content, and organic matter content), soil invertebrates sampling.
Unit 5: Field equipment and instrumentation (2hours): GPS, compass, clinometer, thermometers, data loggers, field notebooks, proper handling and maintenance of equipment.

Module III: Data Analysis and Interpretation (12 hours) (21 marks)
Unit 1: Descriptive statistics (4hours): Measures of central tendency (mean, median, and mode), measures of dispersion (range, variance, and standard deviation), frequency distributions, histograms, boxplots.
Unit 2: Inferential statistics (4hours): Hypothesis testing, t-tests, ANOVA, chi-square tests, correlation analysis, regression analysis.
Unit 3: **Data visualization (2hours):** Creating graphs and charts (bar charts, line graphs, scatter plots), using data visualization software, interpreting ecological patterns from data.
Unit 4: Modeling in ecology (2hours): Introduction to different types of ecological models (conceptual models, statistical models, simulation, models), limitations and applications of models.

Module IV: Communication and Presentation (12 hours) (15 marks)
Unit 1: Scientific writing(4hours): Writing research reports, scientific papers, and abstracts, proper citation styles, effective communication of scientific findings**.**
Unit 2: Oral presentations(3hours): Preparing and delivering scientific presentations, using visual aids effectively, answering questions from the audience.
Unit 3: Data sharing and scientific collaboration(2hours): Importance of data sharing, online repositories for ecological data, collaboration with other researchers**.**
Unit 4: Scientific ethics and integrity(3hours): Plagiarism, data fabrication, research misconduct, importance of responsible scientific conduct.

Module V: Practicals (Credit 1; 30 hours)

Mandatory experiments:

1. Preparation of field note book on any local ecologically important parameter (physical, chemical or faunal).
2. Population estimation using quadrat methods, transect methods, line intercept methods/capture, mark, release, and recapture methods in the field or by using relevant pictures.
3. Measure the size of given leaves / any sample of data and calculate the mean, median and mode (raw data, discrete series & continuous series).
4. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). Enter the data in Excel, calculate SD and record the screen shots of steps and results.

(Of the remaining experiments any 4 can be selected by the institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students).

5. Calculate diversity and richness indices of any local ecosystems', and interpret ecological significance.
6. Preparation of food chains and food web of any one ecosystems (Pond/marine/terrestrial)
7. Calculate population size using
8. Extraction of soil organism by hand picking, floatation and Berleese funnel method.
9. Analysis of physical and chemical properties of soil- pH, moisture content, and organic matter content.
10. Design an experiment to prove a hypothesis by testing the specificity of the enzyme salivary amylase on starch.
11. Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical form. Compare by t-test.
12. Prepare a Frequency curve/Frequency polygon/Bar diagram/Histogram/pie diagram with mean ± SD utilizing appropriate data.

References:

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- Ecology and Field Biology, Robert L Smith, Harper CollinsPub, New York.
- Ecology. Gary Miller, Robert, E. Riclefs. W.H. Freeman, USA.
- Elements of Ecology, 5 Ed Robert Leo Smith et al. Harper Collins.
- Environmental Biology (Cambridge Advanced Sciences) Michael Reiss.
- Fundamentals of ecology; Odum, E.P.; W.B.Saunders, New Delhi.
- Textbook of Ecology, G.T. Miller and S. Spoolman, Brookes Cole, England.
- The Encyclopedia of Animal Ecology, P.D. Moore (Ed), Equinox (Oxford) Ltd., England.
- Methods in Ecology: Field and Laboratory Manual. Michael P. Steinberg.
- Ecology & Environment P.D. Sharma, Rastogi Publications.

Online resources

https://onlinecourses.swayam2.ac.in/nou22_cm14/preview
https://onlinecourses.nptel.ac.in/noc22_ge08/preview
https://www.shutterstock.com/image-photo/aerial-view-coconut-farm-green-trees-1693195624
https://www.nyikasilika.org/riparain-zones-crucial-yet-an-overlooked-ecosystem/

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

FOOD PROCESSING AND QUALITY CONTROL

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or equivalent online courses 1 Food Safety and Quality ControlCECand English and Foreign Languages University via Swayam 2 Online Food Processing & Technology courses eLearning Zone - LMS By FICSI (Food Industry Capacity and Skill Initiative) 3 Food is Made. Understanding Food Processingwww.shiksha.com/online-courses				
Course objectives	The course aims to develop an understanding on the need of food preservation and processing and the methods various quality control procedures and to develop a skill to perform those techniques.				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain nutrient components of food and sensory evaluation methods of food.	U	F&C	Short answer, paragraph, essay questions
CO2	Compare the efficiencies of various food preservation and infestation control methods	U	F&C	Short answer, paragraph, questions
CO3	Describe various food processing methods	U	F&C	Short answer, paragraph, questions
CO4	Explain various causes of food damage, Food hygiene and safety practices	U	F&C	Short answer, paragraph, essay questions
CO5	Perform experiments to detect the quality of food materials, various processing and preservation techniques	Ap	C&P	Practical lab exams, Viva- voce
CO6	Identify the causes of food spoilage in real life or imaginary situations and suggest the remedies for it	Ap	M	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Food and its constituents (6hrs) (Out of 70: 11 marks)

Unit 1: Food and Nutrients (2hrs)- Definition, Classification, and Functions; Role of Water in Food and Human Health; Pigments, Phytonutrients, Antioxidants, Flavour Components – Definition, Classification, and Functions; Anti-nutritional Factors in Foods

Unit 2 Composition & Nutritive value of plant& animal food (2hrs)-. - Cereals and Millets Pulses & Legumes. Nuts & Oilseeds: Fruits & Vegetables Sugar, Fat 3 Composition and Nutritive Value of Animal Foods-. Eggs: Structure, Composition, Nutritive value, Grading Changes during storage. Fish: Composition, Nutritive value 3. Meat: Structure, Composition, Nutritive value
Unit 3 Healthy Foods (2hrs) Health foods: Functional foods, Prebiotics, Probiotics, Nutraceuticals, Organic foods, GM foods, Novel foods. Spices: Definition, Classification, Chemical composition, use of spices Plantation Crops

Module 2: Food Preservation-(15 hrs) (21 marks)
Unit 1:-Preservation by using preservative (2 Hrs) 1. Food preservation: Definition, principles, importance of food preservation, traditional and modern methods of food preservation. Food additives – definition, types, Class I and Class II preservatives.
Unit 2: Preservation by use of high temperature (3 Hrs) 1. Pasteurization: Definition, types, Sterilization, Canning - history and steps involved, spoilage encountered in canned foods, types of containers used for canning foods. 2. Food irradiation – Principles, merits and demerits, effects of irradiation and photochemical methods.
Unit 3.: Preservation by use of low temperature (3 Hrs) 1. Refrigeration - advantages and disadvantages, freezing: Types of freezing, common spoilages occurring during freezing, difference between refrigeration and freezing.
Unit 4: Preservation by removal of moisture (2Hrs) 1. Drying and dehydration - merits and demerits, factors affecting, 2. Different types of drying, Concentration: principles and types of concentrated foods. 3. Preservation by Fermentation
Unit 5: Recent Methods in Food Preservation (1 Hr) 1. Pulsed electric field processing, High Pressure Processing, Processing using Ultra Sound, Dielectric, Ohmic and Infrared Heat.
Unit 6: Non-thermal preservation(4 Hours) Microwave Processing, Hurdle Technology, Irradiation, Pulsed Electric Field Electroporation; Modified Atmosphere, Biopreservation, High-Pressure Food Preservation, Membrane Technology, Cold Plasma Technology; Enzymes and Microbes in Food Preservation (Brief account only)

Module 3: Food processing (6 hrs) (18 marks)
Unit 1: Introduction (1hr)- Definition and Difference between Food Processing and Food Preservation; Functions, Benefits and Drawbacks of Food Processing
Unit 2: Primary Processing Techniques (1hrs) – dicing, slicing, mincing, macerating, liquefaction, emulsification
Unit 3: Novel Food Processing (2hrs)– mushrooms, algae, leaf protein concentrates, protein from petroleum yeast, food analogues, edible insects
Unit 4: Performance Parameters for Food Processing (1hr)– hygiene, energy efficiency, minimization of waste, labour
Unit 5: Overview of the types of food processing industries(1hr)

Module:4 Food safety and quality (18 hrs) (20 marks)
Unit 1: Food Spoilage (2hrs) - Definition, types of spoilage - physical, enzymatic, chemical and biological spoilage. Mechanism of spoilage and its end products, shelf-life determination Factors affecting the storage commodity (temperature, moisture, oxygen, light, duration). source of infestation, cross, horizontal, vertical, latent infestation.
Unit 2: Sanitation and Health (4 Hrs). Definition, importance of sanitation, application of sanitation to food industry and food service establishments. Purchasing and receiving safe food, food storage, sanitary procedures in food preparation, serving and displaying of food, special food operations, Environmental Sanitation. Location and layout of premises, constructional details, sanitary requirements

for equipments, guidelines for cleaning equipments, cleaning procedures, pest control, water supply, storage and waste disposal, environmental pollution.

Unit 3:- Hygiene Practices in Food Industry (4Hrs) Introduction, necessity, personnel hygiene, sanitary practices, management and sanitation- safety at work place. Sanitation regulations and Standards- Introduction, regulatory agencies, control of food quality, local health authority. Food sanitation check lists.

Unit 4: Quality Control & Assurance (2hrs) – Objectives; Functions; GMP, GHP, GLP, GAP, HACCP; Indian and International Quality Systems and Standards (BIS, ISO, Codex Alimentarius, Codex India, etc.); CEDAC; Food Adulteration

Unit 5: Quality Analysis (4 hrs)- Food Sampling Techniques; Rapid Detection Methods of Microorganisms, Separation techniques – Ultrafiltration, Ultracentifugation, Sedimentation, Solid Phase Extraction, Supercritical Fluid Extraction, Chromatography, Electrophoresis; Analytical Techniques – Spectroscopy, Microscopy, Immunoassays, Isotopic techniques, Nanotechnology, Thermal Methods

Unit 6: Food Laws and Standards (2 H

rs) Introduction and need of food laws. Mandatory food laws; The food safety and standards Act 2006,. Indian food regulations –FSSAI 2006 – export and import laws and regulations – International food laws- CAC – WTO implications - national and international agencies for implementation . Recommended international code of hygiene for various products.(Brief account only)

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

1. Identification of stored food infestation by insect pests, microbes etc.
2. Estimation of Salt content in pickle
3. Detection of Adulterants in Foods

4 Determination of Nutrient Levels in Foods and Comparisons to Standards

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

Virtual Labs (Suggestive sites)

5 Estimation of crude fat

6 Estimation of plant pigments by Spectrophotometric method

7 Stages of Preparation and Observation of Sugar Syrup

8 Dehydration & Evaporation – *Preparation of Condensed Milk & Salted Dry Fish*

9 Fruit juice powder preparation

10 Wax emulsion treatment

Field study: A) Visit to Food processing or Food analysis center, and submission of detailed field study report at the time of semester end practical examination

References

- Agarwal A and Udipi SA. 2014. *Textbook of Human Nutrition*. Jaypee Brothers Medical Publishers (P) Ltd.
- Bamji MS, Krishnaswamy K, and Brahmam GNV. 2009. *Textbook of Human Nutrition*. Third Edition. Oxford and IBH Publishing Co. Pvt. Ltd
- Dennis. S. Hill Pest and stored foods stuff
- Vijaya Kadar Food storage and preservation
- Central warehouse corporation, New Delhi Manual of storage practices
- Manual of pest management in processed foods and food industries – CFTRI, Mysore
- Kadar AA . 1992. Post Harvest Technology of Horticultural crops University of California

●Satish Kumar Sharma Post harvest Management and processing of fruit and vegetables-Instant notes
●Pandey PH Principle of Practices of post harvest Technology Kalyani publication
●Cruess WV., 1997. Commercial fruit and vegetables Products. Anees offset press, New delhi.
●Lal,G Siddappa S and Tandon GL. Presrvation of fruit and vegetables. ICAR
●Bhat R, Alias AK, and Paliyath G. 2012. *Progress in Food Preservation.* First Edition. Wiley-Blackwell.
●Fellows PJ. 2016. *Food Processing Technology Principles and Practice*. Fourth Edition. Woodhead Publishing
●Ramaswamy HS and Marcotte M. 2005. *Food Processing: Principles and Applications*. Taylor & Francis
●Shapton DA and Shapton NF. 1998. *Principles and Practices for the Safe Processing of Foods*. Butterworth-Heinemann
●Sivasankar B. 2009. *Food Processing and Preservation*. First Edition. PHI Learning
●Early R. 2012. *Guide to Quality Management Systems for the Food Industry*. Blackie Academic & Professional
●Raj D, Sharma R, and Joshi VK. 2011. *Quality Control for Value Addition in Food Processing*. New India Publishing Agency.
●Steinkraus KS.1996. *Handbook of Indigenous Fermented Foods*. Marcel Dekker.
●Civille GV and Carr BT. 2016. *Sensory Evaluation Techniques*. Fifth Edition. CRC Press.
●Damodaran S and Parkin K. 2017. *Fennema's Food Chemistry*. Fifth Edition. CRC Press.
●Lawless HT and Heymann H. 2010. *Sensory Evaluation of Food*. Second Edition. Springer

Online Sources

1Professional Certificate in Essential Concepts in Food Safety and Hygiene
2Professional Certificates in Introduction to Food Safety Standards
3Food Safety and Nutrition A Global Approach to Public Health
4Food Safety and Nutrition A Global Approach to Public Health

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

LIFE SKILL TECHNIQUES

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	75
Pre-requisites	+2 /VHSC or the following online courses 1 https://www.redcross.org/take-a-class/first-aid/first-aid-training/first-aid-online· 2 https://www.firstaidforfree.com 3 https://www.coursera.org/learn/psychological-first-aid 4 https://www.coursera.org/learn/mental-health				
Course objectives	The course develop an understanding in the role and responsibilities of the First Aides, at various situations of causalities, impart knowledge of how to provide first aid to a casualty who is suspected of a major illness such as Heart Attack, Stroke, Asthma, Diabetes or Epilepsy				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the need of first aid and appropriate assistance at the time of causalities, until professional helps arrives.	U	F&C	Short answer, paragraph, essay questions
CO2	Explain different types of common injuries, the first aids provided for them,	U	F&C	Short answer, paragraph, questions
CO3	Explain the need of sex education and sex and reproductive health issues	U	F&C	Short answer, paragraph, questions
CO4	Explain the first aids to be given to mental health issues and at the time of stress and depression, the ill effects of self medication and over medication	U	F&C	Short answer, paragraph, essay questions
CO5	Practice various first aid methods	Ap	P	Practical lab exams, Viva- voce
CO6	Provide first aid for the needy person in real life situations	Ap	P	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Basics of First Aid (15 hrs) (Out of 70: 21 marks)

Unit 1 Basic First Aid (2 hrs) - Aims of first aid & importance of first aid, first aider, laws of first aid. Emergency response: CPR, steps for performing CPR, CPR for newborns and infants, recovery

position, Initial top to toe assessment. Hand washing and Hygiene Types and Content of an ideal first aid kit, dealing with an emergency

Unit 2 : First AID Technique (4 hrs) - Dressings and Bandages. Fast evacuation techniques (single rescuer). Transport techniques. First aid related with Bones, Joints Muscle related injuries -- Basics of The skeleton, Joints and Muscles Fractures (injuries to bones).

Unit 3: First aid related with respiratory system (2 hrs) -- Basics of Respiration. No breathing or difficult breathing, Drowning, Choking, Strangulation and hanging, swelling within the throat, Suffocation by smoke or gases and Asthma.

Unit 4: First aid related with Heart, Blood and Circulation (3 hrs) - Basics of The heart and the blood circulation. Chest discomfort, bleeding Head injury- nose bleed, bleeding gums, bleeding from varicose veins, Shocks- causes of shock and its first aid First aid related with Wounds and Injuries -- Type of wounds, Small cuts and abrasions Chest, Abdominal injuries Amputation, Crush injuries

Unit 5 First aid related with Nervous system and Unconsciousness (2 hrs) - Basics of the nervous system. First aid for: Unconsciousness, Stroke, Fits – convulsions – seizures, Epilepsy

Unit 6 First aid related with Gastrointestinal Tract (2 hrs) - Basics of The gastrointestinal system. Diarrhea, Food poisoning

Module 2: -First aid in burns, poisoning, Road and traffic accidents Disasters (10 hrs) (15 marks)

Unit 1First aid related with, Burns(3hrs) Danger of burns, types of Burn wounds, Dry burns and scald, (burns from fire, heat and steam). Electrical and Chemical burns, Sun burns, heat and heat stroke. Frost bites (cold burns), Prevention of burns, Fever and Hypothermia

Unit 2 First aid related with Poisoning (2 hrs) Poisoning by swallowing, Gases, Injection, First aid related with Bites and Stings Animal bites, Snake bites, Insect stings and bites

Unit 3 First aid related with Sense organs (2 hrs) Basic of Sense organ. Foreign objects in the eye, ear, nose. Swallowed foreign objects.

Unit 4 Road and traffic accidents (3 hrs) Emergencies in rural areas. Specific emergency satiation and disaster management Disasters and multiple casualty accidents. Triage. Emergencies at educational institutes and work place

Module 3: Sex education (12 hrs) (16 marks)

Unit 1 Basic Sex Education (3 hrs) -- Overview, ground rules, Basics of Urinary system and Reproductive system. Male puberty - physical and emotional changes Female puberty — physical and emotional changes

Unit 2 Sexual and reproductive health issues and associated factors (4hrs)

Male-female similarities and differences, Healthy relationship with opposite sex; role of counseling; gender discrimination; sexual consent; sexual hygiene, Sexual intercourse, pregnancy, and childbirth Birth control and abortion Sex without love — harassment, sexual abuse, and rape Prevention of sexually transmitted diseases.

Unit 3- Sexual orientation, sexual abuse and myths (5 hrs)

Homosexuality and bisexuality (mention LGBT); sexual identity- transgender; oral sex; animal sex; cybersex; sexual abuse and harassment; premarital and extramarital sex; sexual perversions; paraphilia; child abuse; prostitution; sexual awareness and policies- legal aspects, protection of children from sexual offences (POCSO) Act 2012 (brief account only); sexual myths.

Module:4 Mental Health and Psychological First Aid (8hrs) (18 marks)

Unit 1 First Aid for Mental Health (2 hrs)

Mental Health Problems in the India The Mental Health First Aid Action Plan, Depression and Anxiety Disorders, Crisis First Aid for Suicidal Behavior & Depressive symptoms, What is Non-Suicidal Self-Injury?

Unit 2 Non-crisis First Aid for Depression and Anxiety Crisis (4 hrs) First Aid for Panic Attacks, Traumatic events, Disorders in Which Psychosis may Occur, Crisis First Aid for Acute Psychosis Substance Use Disorder Crisis First Aid for Overdose, Withdrawal Using Mental Health First Aid
Unit 3 Self medication and over medication (2hrs)
Self medication and its impacts over medication and its impacts

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)
MANDATORY EXPERIMENTS
1 Prepare a first aid kit
2 Cardio pulmonary Resuscitation (CPR)
3 Airway management – Heimlich Maneuver
4 Setting a splint for broken bones

Of the remaining experiments any 4 can be selected by the Institution from the following list. Two experiments other than the listed should be selected by the Supervising teacher and introduced to the students.

6 Choking First Aid Toddlers
7 Practice of AED
8 How to stop excessive bleeding
9 How to identify a concussion and do the its first aid management
10 How to handle trauma other emergency medical conditions

References

1. Indian First Aid Mannual-https://www.indianredcross.org/publications/FA-manual.pdf
2. Red Cross First Aid/CPR/AED Instructor Manual
3. Finkelhor, D. (2009). The prevention of childhood sexual abuse. Durham, NH: Crimes Against Children Research Center. www.unh.edu/ccrc/pdf/CV192. pdf
4. Kantor L. & Levitz N. (2017). Parents' views on sex education in schools: How much do Democrats and Republicans agree? PLoS ONE, 12 (7): e0180250.
5. Orenstein, P. (2016). Girls and sex: Navigating the complicated new landscape. New York, NY: Harper.
6. Schwiegershausen, E. (2015, May 28). The Cut• Wiggins, G. & McTighe, J. (2008). Understanding by design. Alexandra, VA: ASCD.

Online Sourses
1 https://mhfa.com.au/courses/public/types/youthedition4
2 .www.thecut.com/2015/05/most-women-are-catcalled-before-they-turn-17.html

3 https://marshallmemo.com/marshall-publications.php

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5			✓	
CO6	✓			✓

ADVANCES IN BIOTECHNOLOGY AND MICROBIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Vocational Minor				
Semester	VIII				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	4		0	60
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop understanding in gene cloning, biotechnological techniques like FISC, McFISH, GISH, construction of genomic library, Chromosome walking etc., Intellectual property rights, Ethics in genetic engineering; Bioprocesses and microbial use in industry, and bioprocess technology				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the features of various types of cloning vectors and explore different steps involved in molecular cloning	U	F&C	Short answer, Paragraph, Essay questions
CO2	Describe the techniques involved in the production of molecular probes, Genomic and cDNA library, analyse techniques involved in isolation, sequencing and synthesis of genes, and get familial with the biotechnological techniques like antisense RNA and their applications	U & An	F&C	Short answer, Paragraph, questions
CO3	Describe the basic principles of bioprocess, types of fermentation, upstream processing	U	F&C	Short answer, Paragraph, questions
CO4	Describe role of microbes in Industry, the functioning of Bioreactors, and downstream processing	U	F&C	Short answer, Paragraph, Essay questions
CO5	Conduct seminars, submit assignments,	An	F&C	Assignments, seminars
CO6	Explain various aspects of IPR, the ethical issues in cloning, GM food crops and social implications of biotechnology in the body.	U	F&C	Short answer, Paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

PART A BIOTECHNOLOGY

MODULE 1. Introduction to gene cloning methods (13hrs) (Out of 70: 21 marks)

Unit 1. Cloning vectors(4hrs)–Plasmids: pBR322 and pUC; Phages: λgt10 and M13vector; Cosmids: general features; Phagemids: general features; Viruses: SV40 and CaMV; **Transposones**; Ac transposon and Ds transposon of Maize, P-element of *Drosophila;* **Artificial chromosomes**: BAC, YAC and MAC.; Shuttle vectors: applications and example; **Expression vectors**: mention commonly used promoters in expression vectors (Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter of CaMV, Polyhedrin promoter from Baculovirus

Unit 2. Construction of chimeric DNA (3Hrs)- (Blunt end ligation, cohesive end ligation, homo-polymer tailing, use of linkers) Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization; Amplification – Multiplication, Expression, and integration of the DNA insert in host genome.

Unit 3. Molecular probes and Applications (2hrs) - FISH, McFISH and GISH

Unit 4. Construction of Genomic library.(4hrs) -Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity; **Chromosome walking**

MODULE 2. Advanced techniques in Biotechnology and Intellectual property rights (15hr) (15 marks)

Unit 1: PCR methods(3hrs)- Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR, Applications of PCR in Biotechnology and genetic engineering

Unit 2: DNA sequencing and gene synthesis(3hrs) – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide synthetic method, NGS.; Gene synthesis machines

Unit 3: Anti-sence Technology(2Hrs): Antisense RNA and its applications in biomedical and agriculture fields, RNA interference, Gene knockouts and Knock-out mouse

Unit 4: Cloning procedures(2hrs):(adult DNA cloning, Therapeutic cloning, Embryo cloning)–Advantages and disadvantages of cloning

Unit 5. Intellectual property rights and ethical and social implications of Biotechnology (3hrs)

Intellectual property protection, Patents, copy right, trade secrets, trademarks, GATT and TRIPS, patenting of biological materials, International co-operation, obligation with patent applications, implications of patenting- current issues, Social acceptance of medical biotechnology- Various cloning procedures,

Unit 6: Ethics of Genetic engineering (2hrs) - Social impacts - Human safety-Virus resistant plants-Animals and ethics- Release of GEOs-Use of herbicide resistant plants-Human genome alterations by biotechnology, Social acceptance of biotechnology-Transgenic crops - Acceptance of GM crops for food and pharmaceutical production, Social acceptance of Industrial biotechnology

MODULE 3: Introduction to Bioprocess & Microbes in Industry (9hrs) (14 marks)

Unit 1. Introduction to bioprocess engineering(6Hrs) : Basic principles of bioprocess. Types of fermentation: batch, fed batch and continuous fermentation systems. Microbes in industrial process: Isolation, screening and maintenance of microbes for industrial processes. Strain improvement. Microbial growth kinetics.

Unit 2. Upstream processing(3hrs): Microbial Nutrition, Media formulation for industrial fermentation. Development of inocula for the industrial fermentations. Scale up.

MODULE 4: Bioprocess Technology (11hrs) (20 marks)

Unit 1. Bioreactors (4Hrs) : batch, fed –batch and continuous bioreactors, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.

Unit 2. Industrial production of chemicals(3hrs): alcohol(ethanol), acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol, antibiotics (pencilliin, streptomycin, tetracycline), amino-acids (lysine, glutamic acid), single cell protein. Enzyme and whole cell immobilization and their industrial applications.

Unit 3. Downstream processing(4hrs): Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid – liquid extraction chromatography, Membrane process. drying and crystallization. Effluent treatment D.O.C. and C.O.D. treatment and disposal of effluents.

MODULE 5: Open ended (12hrs)

The teacher can design student activities related to Module 2 and 3

References

Part- A- Biotechnology

1. Alphey - DNA sequencing-Bios Scientific publishers-
2. Bernard R. Glick and Jack J. Pasternak-Molecular Biotechnology-Principles and aplications of recombinant DNA- ASM press Washington D.C.
3. Charles Hardin (2008): Cloning, Gene expression, and Protein purification- Experi mental procedures and process rationale - Oxford UniversityPress.
4. Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall ofIndia

Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge Universitypress.

2. Dale. J.W. and Malcom von Scantz. From genes to genome- Concepts and Applications of DNA Technology. Dominic, W.C. Wong-The ABCs of gene cloning-Springer internationaledition
3. Dubey, R.C. -A text book of biotechnology-S. Chand &Co.
4. Emmanuel. C., Rev. Fr. Ignacimuthu. S. and Vincent. S. Applied Genetics: Recent Trends and Techniques, MJP Publishers,Chennai
5. Gupta. P.K. -Elements of biotechnology-Rastogipublications.
6. Singh, B.D.(2002).Biotechnology-Kalyanipublishers.
7. Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt.Ltd.
8. Wilson and Walker (2008): Principles and techniques of Biochemistry and Molecular biology- Cambridge low priceeditions.
9. Ausubel, F.M., Brebt,R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith,J.A. and Struht,K.(2002). Short Protocols in Molecular Biology. John Wiley and Sons,Inc.
10. Alberts,B., Bray, D., Lewis, J., Raff., M, Roberts, K. And Watson, J.D. (2000). Molecular Biology of the cell. Garland Science, NewYork.
11. Brown .T.A. (2002).Genomes II ed. John Wiley and Sons, NewYork.
12. Freshney, Ian R.(2006). Culture of Animal Cell. 5thed. Wiley-LissPublications.
13. Glick, B. R. and Pasternak, J.J.(1998). Molecular Biotechnology-Principles and Applications of Recombinant DNA.

BIOPROCESSING

1. Reference Books: 1. Biochemical Engineering, Aiba,S., Humprey,A.E., and Millis,N.F., Unty. of Tokyo Press, Tokyo.
2. 2. Biochemical Reactors. Atkinson,B., Pion, Ltd., London.

3. 3. Biochemical Engineering Fundamentals. Baily,J.E., and Ollis,D.F., McGraw – Hill Book Co. New York.
4. 4. Bioprocess Technology: Fundamentals and applications, KTH, Stockholm. 5. Process Engineering in Biotechnology, Jackson,A.T., Prentice Hall, Engelwood Cliffs.
5. 6. Bioprocess engineering: Basic Concepts, Shuler,M.L., and Kargi,F., Prentice Hall, Engelwood Cliffs.
6. 7. Principles of Fermentation Technology. Stanbury,P.F., and Whitaker,A., Pergamann Press, Oxford.
7. 8. Bioreaction Engineering Principles ,Neilson,J., and Villadsen,J. Plenum Press.
8. 9. Chemical Engineering Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE. 30
9. 10. Biochemical Engineering, Lee,J.M., Prentice hall Inc.
10. 11. Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression, Vieth, W.F., John Wiley and Sons, Inc.
ONLINE SOURCE

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

GENERAL FOUNDATION COURSES

MULTI DISCIPLINARY COURSES

NUTRITION, HEALTH AND HYGIENE

Programme	B.Sc. Zoology				
Type of Course	MDC				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		-	45
Pre-requisites	+2 /VHSC or equivalent online courses: https://www.coursera.org/browse/health/nutrition https://www.oxfordhomestudy.com/courses/nutrition-certificate-programs-online/free-online-nutrition-courses https://www.udemy.com/topic/nutrition https://www.schoolofhealth.com https://thehealthsciencesacademy.org/registration-free-starter-nutrition-course/ https://www.open.edu/openlearn/health-sports-psychology/health/the-science-nutrition-and-healthy-eating/content-section-overview				
Course objectives	The course is designed to develop awareness in the need of good dietary practices, ill effects of smoking and other abuses, causes of various diseases, and to develop skill in first aid management				

Course Outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts in nutrition	U	F&C	Short answer, paragraph, questions
CO2	Enlist the vitamins and minerals and describe their roles in human nutrition	U	F	Short answer, paragraph, essay questions
CO3	Describe the importance of hygienic and body fitness paractises and ill effects of smoking and other abuses	U	F&C	Short answer, paragraph, questions
CO4	Illustrate diet therapy and dietary management of various conditions [	U	F&C	Short answer, paragraph, essay questions
CO5	Perform first aid management in emergency situations	Ap	C&P	Assignments, seminars
CO6	Describe the major communicable, non-communicable, congenital and sexually transmitted human diseases	U	F&C	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Basics of Nutrition (6hrs) (Out of 50: 7 marks)
Unit 1: Introduction to Nutrition science (1hr) : Basic concepts in food and nutrition,
Unit 2: Food and Diet (5hr)- Basic terms used in study of food and nutrition Understanding relationship between food, nutrition and health, Functions of food-Physiological, psychological and social; Basic five food groups: Cereals and grains, pulses and legumes, milk and meat products, Fruits and vegetables, Fats and sugars. Definition of RDA, factors affecting RDA and uses of RDA, Energy: Concept of energy and its balance, basal metabolism, BMR affecting factors, Requirement determination, Energy sources.

Module 2: Macro and Micro-nutrients (14 hrs) (20 marks)
Unit 1: Carbohydrate (2hrs)- Introduction, functions, classification, sources, RDA, Types of Fibres – crude fibre and dietary fibres – soluble and insoluble, Functions of dietary fibre, recommended intake for different age groups
Unit 2: Proteins (2hrs)- Introduction, composition, classification, RDA, functions, food sources, essential and nonessential amino acids, protein deficiency and excess, protein quality
Unit 3: Fat (1hr)- Introduction- Lipids, Fats and oils, Composition, Classification, RDA, food sources, essential and non-essential fatty acids- deficiency.
Unit 4: Water (1hr)- Water as nutrient, components of body fluids, function. Dehydration, requirements, structure, water balance,
Unit 5: Vitamins (2hrs)- Introduction of vitamins. Classification, water soluble vitamins (Vit-B1, B2, B3, B5, B6, B7, B9, B12 &Vitamin -C). Fat soluble vitamins (Vitamin -A,D,E and K).Function, RDA, food sources. Deficiency and toxicity of vitamins.
Unit 6: Minerals (2hrs)- Macro minerals – Calcium, Phosphorus, Magnesium, Sodium, Potassium and Chloride. Micro minerals – Iron, Zinc, Iodine, Fluorine Functions of macro and micro minerals, food sources, RDA, deficiency and toxicity.
Unit 7: Phytochemicals & Antioxidants(1hr)- Definition, mode of action Classification of Phytochemicals: brief account only); Antioxidants: Definition and Mechanism of action Classification Of antioxidants
Unit 8: Functional foods (3hrs) - Definition, Health benefits of functional foods; Probiotics and prebiotics – definition, types, Health benefits; Nutraceuticals –Definition, concept, , Classification of nutraceuticals based on chemical nature and mechanism of action ,Significance and relevance of nutraceuticals in the management of diseases and disorders.

Module 3: Health and Hygiene (5 hrs) (7 marks)
Unit 1: Body fitness(1hr)- Principles of exercise programming, Exercise, Yoga, cycling & walking.
Unit 2: Hygiene(2hrs)- Definition, Personal hygiene, Oral Hygiene and Sexual Hygiene. feminine hygiene, sleep hygiene, hand washing, toiletry. Social hygiene – clean living movements, occupational hygiene, food and cooking hygiene, medical hygiene,
Unit 3: Smoking and abuses (2hrs)- Smoking habits, Active and passive smoking, composition and effects of tobacco smoke. **Alcohol Use**: Alcoholism, Physiological effects of alcohol and abuse of alcohol. **ill effects of drug abuse** (emphasis should be given to pan masala, amphetamines, hashish, opium, brown sugar, pethedine).

Module 4: Human disease & First Aid (11 hrs) (16 marks)
Unit 1: Communicable diseases and its diet therapy (3hrs) - Bacterial (and Typhoid), Viral (Measles and Poliomyelitis), Fungal (Candidiasis), Protozoan (Amoebiasis and Malaria), Helminth (Ascariasis and Taeniasis).
Unit 2: Non-Communicable diseases and its diet therapy(2hrs) – Life style diseases-Blood pressure (Hypertension and Hypotension); Cerebral hemorrhage and stroke; Coronary thrombosis,

Atherosclerosis and Arteriosclerosis; Diabetes: Type I and Type II; Kidney failure; Cancer: Thyroid cancer and Breast cancer; Congenital diseases: Autism, Dyslexia, Downs and Foetal alcoholic Syndrome;

Unit 3: Sexually transmitted diseases (STD) and its diet therapy(1hr)- Syphilis and Gonorrhea

Unit 4: Vectors and diseases: and its diet therapy(2hrs)- *Anopheles*, *Aedes*, *Culex* and *Xenopsylla*

Unit 5: First aid management in emergency situation: (3hrs)

Dog bite; Insect sting: scorpion, Bee and wasp; Snake bite: Poisonous and Non poisonous snakes; Haemotoxic Venom and Neurotoxic Venom; Antivenom and Polyvalent snake antivenom; First aid for Road accidents and drowning; Risks of self-medication practices, first aid for burns.

Module 5. Open ended (9 hours)

Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 4, organize sessions to practice first aid techniques, etc.

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Online Sourses

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar

Exam

Project/Practical

Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

REPRODUCTIVE HEALTH & SEX EDUCATION

Programme	B.Sc. Zoology			
Type of Course	MDC			
Semester	I			
Academic Level	100-199			
Course Details	Credits	Lecture per week	Practical per week	Total hours
	3	3	0	45
Pre-requisites	+2/VHSC Course; Equivalent Online courses			
Course objectives	The course is designed to develop awareness in the need of sex education sexual hygiene, causes of infertility problems, different ARTs, prenatal diagnostic techniques, fertility control methods etc.			

Course Outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the rationale and background in terms of reproductive rights, problems and strategies, different ethical aspects in sex; different sexual orientations, perversions, paraphilias, abuses and myths with awareness on legal aspects	U	F&C	Short answer, Paragraph, questions
CO2	Explain the anatomy and physiology of male and female reproductive system and associated structures, production of gametes, female reproductive cycle, events of fertilization, implantation, gestation, parturition & lactation, role of hormones, importance of placenta	U	F&C	Short answer, Paragraph, Essay questions
CO3	Recognize the causes and problems in male and female infertility; different infertility management techniques- steps & pros and cons, test tube babies, surrogacy	U	F&C	Short answer, Paragraph, questions
CO4	Analyze different prenatal diagnostic techniques- procedure and advantages and disadvantages of each, female feticide and legal implications; Evaluate different fertility control methods, termination of pregnancy	U	F&C	Short answer, Paragraph, Essay questions
CO5	Explain the importance of sex education, various fertility control methods and important sexually transmitted diseases	An	F&C	Assignments, seminars

CO6	Manage to conduct awareness programmes on the need of sex education	U	F&C	Short answer, Paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Introduction, Ethical aspects, Sexual orientation, abuse & myths (9hours) (Out of 50: 13 marks)

Unit 1- Introduction (2 hours) : Definition; Reproductive health- problems and strategies; reproductive rights; importance of sex education for teen and youth- adolescence and senescence, adolescent sexual activity, teenage pregnancy

Unit 2- Ethical aspects of sex (2 hours)

Healthy relationship with opposite sex; role of counseling; gender discrimination; sexual consent; sexual hygeine

Unit 3- Sexual orientation, sexual abuse and myths (5 hrs)

Homosexuality and bisexuality (mention LGBT); sexual identity- transgender; oral sex; animal sex; cyber sex; sexual abuse and harassment; premarital and extramarital sex; sexual perversions; paraphilia; child abuse; prostitution; sexual awareness and policies- legal aspects, protection of children from sexual offences (POCSO) Act 2012 (brief account only); sexual myths.

Module 2. Sex determination, Human reproduction (13 hours) (17 marks)

Unit 1- Sex determination (3 hours)

Mechanism of sex determination- chromosomal, environmental and hormonal; Barr body; sex mosaicm; sex reversal; Sex chromosomal anomalies: Turner's syndrome and Klinefilter's syndrome (mention only).

Unit 2- Human reproduction (10 hours)

Male reproductive system: Structure of testis, male accessory organs; Semen production and composition; ejaculation; spermatogenesis (mention the role o hormones)

Female reproductive system: Structure of human ovary; development of primary follicle; structure of grafian follicle; fallopian tubes; uterus; external genitalia; mammary glands; oogenesis.

Menstrual cycle and hormonal control; brief account of fertilization, implantation, pregnancy, gestation, placenta, parturition and lactation (Brief account on hormonal control of parturition and lactation)

Module 3. Infertility and Assisted Reproductive Techniques (8 hrs) (10 marks)

Unit 1 Infertility: Causes and problems in male and female; Infertility management: collection, preservation and storage of semen and ova, artificial insemination; Cryopreservation and embryo transfer: Collection, care and preservation of embryos; In vitro fertilization (IVF) and embryo transfer: Major steps; Test tube babies; Assisted Reproductive Techniques (ART): GIFT, ZIFT, ICSI, oocyte donation and embryo donation; surrogacy

Module 4. Prenatal Diagnosis, Fertility control and Sexually transmitted diseases (7 hrs) (10 marks)

Unit 1- Prenatal diagnosis (2 hours)

Different methods: Ultrasonography, amniocentesis, chorionic villus sampling and alpha-foetoprotein estimation; female foeticide: ethical issues and laws (Mention PNDT Act)

Unit 2- Fertility control (3 hours)

Natural methods; artificial methods; chemical methods; hormonal methods; contraceptive devices; surgical contraception; abortion, legal termination of pregnancy (brief account).

Unit 3- Sexually transmitted diseases (2 hours)

Symptoms, mode of transmission, diagnosis, treatment and prophylaxis of AIDS, syphilis, gonorrhea, herpes (genital), human papilloma virus and genital warts, hepatitis, gonococcal vulvo vaginitis, Trichomonal vaginitis (short account for each). Mention the term venereal disease. Socio economic dimensions of STD

Module 5. Open ended (8 hours)

Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 1, organizing mass education programmes by the students for the school students and general public of their locality through offline or online modes etc.

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

AQUACULTURE AND ORNAMENTAL FISH FARMING

Programme	B.Sc. Zoology				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3			45
Pre-requisites	+2 /VHSC or the following online courses 8. https://courseware.cutm.ac.in/courses/ornamental-aquaculture/ 9. http://ecoursesonline.iasri.res.in/course/view.php?id=297 10. https://www.classcentral.com/classroom/youtube-aquaculture-types-of-culture-systems-179652				
Course objectives	The student develops understanding and knowledge about different aquatic culture species and aquaculture systems. Student develops skill in setting up of ornamental fish aquariums				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify and describe major commercially important aquaculture species of India and the basic principles of aquaculture and culture methodologies of fishes and shellfishes.	U	F&C	Short answer, paragraph, questions
CO2	Describe the different types of tools used in aquariums	U	F&C	Short answer, paragraph, essay questions
CO3	Identify the diversity of ornamental fishes and develop skills in aquarium fabrication and maintenance.	Ap	C&P	Short answer, paragraph, questions
CO4	Develop skills in culture and breeding of freshwater and marine ornamental fish varieties.	Ap	C&P	Short answer, paragraph, essay questions
CO5	Develop expertise in setting up and maintenance of freshwater and marine aquariums as hobby and also in commercial level.	Ap	C&P	Practical lab exams, Viva- voce
CO6	Employment and Entrepreneurship skill development in the field of ornamental fish industry.	Ap	M&P	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Introduction to Aquaculture (9hrs) (Out of 50: 13 marks)
Unit 1: Aquaculture(3hrs) – Definition. Commercially important aquaculture species in India. Freshwater, Brackish and Marine finfish and shellfish species. Brief account of classification of aquaculture based on: Environment – Freshwater, brackish water and mariculture.
Unit2: Culture techniques (6hrs)– pond aquaculture, cage culture, pen culture, raft culture, pole culture, rack culture and long line culture. Number of species – Mono culture and poly culture. Type of organism – prawn culture, shrimp culture, edible oyster culture, lobster culture, Pearl culture, Pisciculture etc.

Module 2: Ornamental fish farming (10 hrs) (12 marks)
Unit 1: Introduction to Ornamental fish as a hobby(4hrs)- Role of public aquaria, design, shape, types of aquaria, accessories, setting up of aquaria. Physicochemical parameters of water and their maintenance in aquaria and ornamental fish ponds.
Unit 2: Ornamental fishes (6 hrs): Identification of commercially important fresh water ornamental fishes: exotic species: Goldfish, Koi carp, Silver shark, Cardinal Tetra, Kissing gourami, Angel fish etc.(Egg layers), Guppy, Molly, Sword tail, Platy etc. (Live bearers); Indigenous species: Deninson, S barb, Rosy barb, Honey gourami, Zebra fish, Glass fish etc.

Module 3: Aquarium Setting (8 hrs) (11marks)
Unit 1: Introduction (2hrs)- Farm design, quarantine facility, transportation of fishes, Government programs and institutions facilitating the ornamental fish production.
Unit 2: Aquarium construction (6hrs) -Types of aquaria- Biotope aquarium. Vivarium, insectarium, terrarium, paludarium, oceanarium, dolphinarium. Reef aquarium. Nano aquariums. Principles of setting up and maintenance of aquaria: Construction of fresh water aquarium. Aquarium accessories-aerators, filters, skimmers, chillers, lighting, decorates, etc.

Module4: Aquarium Maintenance (9 hrs) (14marks)
Unit 1: Feeding and nutrition(5hrs)- Breeding of ornamental fishes (One each for live bearer and egg layer). Live feed culture. Formulated feeds. Preparation of aquarium fish food. Colour enhancement techniques. Feed preparation and coloration, Formulate feed with thrust on coloration. Aquatic plants, ornamental plants.
Unit 2: Fish trading (2hrs)- Packaging, transportation and marketing of aquarium fishes. Anaesthetics used in the trade.
Unit 3: Health care (2hrs)- Common diseases and parasites of ornamental fish. Health management of aquarium fishes. Cleaning the aquarium –Siphoning, Water exchange.

Module 5: Open ended (9 hrs)
Practise sessions for fabrication and setting up of a fresh water aquarium and its maintenance can be conducted. Field visits can be conducted to nearest marine aquarium.

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3. http://aquaculturetraining.com.au/pdf/ornamental-fish-culture-practices.pdf
4. https://www.proquest.com/openview/1739d1a26c3a75fee7599ca1828d23e3/1?pq-origsite=gscholar&cbl=237326

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6					3					2		2	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

APICULTURE AND SERICULTURE

Programme	B.Sc. Zoology				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		0	45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The student get an acquaintance with the Apiculture and Sericulture practices				

Course outcome	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts of Apiculture & Sericulture.	U	F&C	Short answer, paragraph, essay questions
CO2	Explain different species and races of Honey Bees & Silk Insect.	U	F&C	Short answer, paragraph, questions
CO3	Describe the importance of health and hygiene in Beekeeping & Sericulture.	U	F&C	Short answer, paragraph, essay questions
CO4	Analyse the possibilities of entrepreneurship in apiculture and sericulture	An	C&P	Short answer, paragraph, questions
CO5	Describe the economic importance of Apiculture and Sericulture.	U	F&C	Practical lab exams, Viva-voce
CO6	Maintain Bee hives and Silk worm rearing houses in a scientific way	Ap	P	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
\# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Apiculture (9hrs) (Out of 50: 9 marks)

Unit 1: Introduction to Apiculture (2hrs)- History: Apiculture worldwide and in India and its Scope; Traditional Beekeeping, Modern Beekeeping; Urban or Backyard Beekeeping; Different species of Honey Bees used in Beekeeping; Role of Central Honey Bee Research and Training Institute

Unit 2: Morphology and Life History of Honey Bees (2 hrs)-: Castes and Social organisation of Honey Bees; Morphological and communicative adaptations; Life History of Honey Bees

Unit 3: Social Behaviour of Honey Bees (2hrs)- Behaviour of Queen, Drones and Workers, Swarming Behaviour, Absconding and migration, Supersedure, Emergency Queen, Communication of Honey Bees

Unit 4: Honey Bee Enemies and Diseases (3hrs)- Management, Preventive and control measures of diseases
Enemies: Wax moth, Hawk moth, Wax Beetle, Ants, Wasps, Termites, Mites, Lizards, Birds.
Diseases, Management, Preventive and control measures.
Adult diseases – Nosemosia, Amoebic disease, Acarine disease, Septicaemia, Fungal Disease
Brood Disease – Foul-brood Disease (American foul-brood and European foul-brood), Chalk brood disease, Stone brood disease and Sac brood disease.

Module 2: Rearing of Honey Bees and Entrepreneurship in Apiculture -(9 hrs) (11 marks)
Unit 1: Rearing of Honey Bees(5hrs) –Structure of beehive, Standard tools used in Apiculture; Basic requirements for Beekeeping
Unit 2: Entrepreneurship in Apiculture(4hrs)- Bee products; Composition and uses of honey; Honey extraction and handling; Economic importance and marketing aspects of bee products; Role of Govt. and Non-Govt. agencies in promoting apiculture in Kerala; Present status and scope of apiculture in Kerala.

Module 3: Sericulture (9 hrs) (19 marks)
Unit 1: Introduction to Sericulture: (2hrs)- Definition, origin and history of Sericulture. Sericulture in India and other countries. Present status of sericulture. Silk route and scope of sericulture. Types of silkworms and their distribution. Mulberry and non-mulberry sericulture.
Unit 2: Silkworm Biology (3hrs) - Life cycle of *Bombyx mori*. Structure of silk gland and secretion of silk; other species of silk worms
Unit 3: Rearing (4hrs)- A brief introduction to mulberry cultivation and mulberry varieties. Commercial varieties of mulberry, Mulberry plantation establishment and cultivation practices. Rearing house and rearing appliances. Disinfectants: Formalin, bleaching powder, Resham Keet Oushadh (RKO). Silkworm rearing technology: Early age and Late age rearing. Types of mountages. Spinning, harvesting and storage of cocoons.

Module:4 Silkworm diseases and Entrepreneurship in Sericulture (9hrs) (11 marks)
Unit 1: Diseases of silkworms & Control measures (4hrs)- Diseases – Viral (Grasserie & Cytoplasmic polyhedrosis), Bacterial (Flacherie, Septicaemia, Scotto disease, Court disease), Fungal (White, Black and Brown muscardines) and Protozoan (Pebrine)
Unit 2: Entrepreneurship in Sericulture (5hrs) - Prospects of Sericulture in Kerala, potential in mulberry and non-mulberry sericulture. Employment in Sericulture and Govt. Schemes for financial Assistance: Present status and scope of sericulture in Kerala

Module 5: Open Ended (9hrs)
The teacher can conduct student activities related toTraditional methods and Recent Developments in Apiculture and Sericulture; practice sessions to construct beehives; a field visit to an apiary or sericulture centers
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Online Sources
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2
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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

BIOLOGY FOR COMPETITIVE EXAMS

Programme	B.Sc. Zoology				
Type of Course	MDC				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		0	45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop a foundation in Biological science, especially Zoology for those students who prepare for undergraduate level competitive exams,				

Course outcome (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify various names, functions and structural parts of the cell.	R	F&C	Short answer, paragraph, questions
CO2	Describe the various theories of evolution, the importance of Ecological study, components of ecosystem, different kinds of population interactions.	U	F&C	Short answer, paragraph, essay questions
CO3	Correlate the structure and functions of various organ system in human body.	Ap	C	Short answer, paragraph, essay questions
CO4	Describe the symptoms and causes of various human diseases.	U	F&C	Short answer, paragraph, questions
CO5	Organize model competitive tests based on the course content.	C	M	Practical lab exams, Viva- voce
CO6	Make comparison with the course content and questions in the recent competitive exams and suggest modifications for the course content.	An	M	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Introduction to the course and Cell organization (7hrs) (Out of 50: 7 marks)

Unit 1: Introduction (1hrs)- General pattern of Competitive exams

Unit 2: Cell organelles (2hrs)– Brief description of shape, structural components and functions of: plasma membrane, Cell wall, mitochondria, Golgi bodies, ribosomes, lysosomes, endoplasmic reticulum, cytoskeleton and nucleus, and chromosomes

Unit 3: Cell division (2hrs) - Cell cycle**:** G1, S, G2 and M phases, G0 phase; Phases of mitosis and meiosis

Unit 4: Chromosome (2hrs) - Normal human karyotype Autosomes, sex chromosomes, mention Barr body and its significance. Brief note on chromosomal anomalies and disorders Chromosomal mechanism of sex determination: hormonal influence of sex determination; sex mosaics; Gynandromorphism. Genetic counseling

Module 2: Evolutionary and ecological principles-(11hrs) (18 marks)
Unit 1: Evolutionary theories (3hrs)- Lamarck's theory, Darwin's theory, Weismann's germplasm theory, Theory of punctuated equilibrium, Mutation theory of *De*Vries, Brief note on evolution of man; **Geological time scale:** Mention Cambrian explosion, fossilization, living fossils
Unit 2: Ecology(2hrs)- Scope, definition, types; Ecosystem: Concept of biome, types: marine, freshwater, terrestrial; Energy flow in ecosystem: Food chain, food web, laws of thermodynamics, kinds of productivity; Biogeochemical cycles: types. examples
Unit 3: Population ecology(3hrs) Properties of population, carrying capacity, growth forms (J-, S-shaped curves); Community ecology: characteristics of a community, ecotone and edge effect.; Population interactions: (a) Intraspecific, (b) Inter specific – (i). Positive interactions (mutualism, commensalism, proto-cooperation), (ii). Negative interactions (competition, predation and parasitism). Give examples
Unit 4: Biodiversity(3hrs)- Definition, significance, uses; Threats to biodiversity, extinction of species, concept of threatened species; Biodiversity hot spots examples; Conservation acts : wildlife protection act(1972), Brief account on Red Data Book, IUCN, and WWF; Conservation strategies: Ex-situ (seed banks, zoo, botanical gardens); In-situ (wildlife sanctuaries, national parks, biosphere reserves). Sustainable development (concept), Global warming and Ozone depletion

Module 3: Human Body (7 hrs) (18 marks)
Unit 1: (a). Digestion & absorption; (b). Breathing & exchange of gases; (c). Body fluids & circulation; (d). Excretory products & their elimination; (e). Locomotion & movement; (f). Neural control & coordination; (g). Chemical control & coordination.

Module:4 Human health(11hrs) (7 marks)
Unit 1: Disease (3hrs)- Definition, factors affecting health, common terms related to diseases (pathogen, host & parasites, vector/carrier, reservoir, inoculation, epidemic, endemic, pandemic, etc.) Mode of transmission: Direct and indirect (air-borne, water-borne, food-borne, etc.).
Unit 2: Types of causative agents (3hrs)-Bacteria, viruses, animal bite, pollen, parasites, mutagens, etc.. Classification: (i). Congenital, (ii). Acquired [communicable & non-communicable]; Types of non-communicable diseases (degenerative, deficiency, allergy, cancer, others); Cancer: Characteristics of cancer cells; causes of transformation; proto-oncogenes, tumour suppressor genes and their role in transformation
Unit 3: Common diseases of man (3hrs)- Common cold, typhoid, TB, cholera, dysentery, diarrhoea, leprosy, chicken pox, mumps, measles, polio, rabies, tetanus. Brief note on diseases caused by vectors (mosquito, ticks, rat, pets, etc.).
Unit 4: STDs (2hrs) Definition, common causes, prevention & cure. **Examples:** HIV-AIDS, syphilis, gonorrhoea, hepatitis, genital warts, genital herpes, etc.

Module 5: Open ended: (9 Hrs)
Teacher can design student activities like assignments, seminars, collection of notes/reference materials related to the topics related to any module, can conduct student organized model competitive exams etc.
References

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- ChakrabortyP.A.(2009) Text Book of Microbiology, ISBN-10: 8173810818 New Central Book Agency, 1026 pages.
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- ttp://www.biologydiscussion.com/essay/reproductive-health-in-human-problemsand-strategies/5167

Online Sourses

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics:

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

VALUE ADDED COURSES

HEALTH – A HOLISTIC APPROACH

Programme	B.Sc. Zoology				
Type of Course	VAC				
Semester	III				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		0	45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course develops understanding in the importance of holistic approach of health, the methods for stress management, different kinds of mental health problems etc.				

Course outcome (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Define holistic health including various compounds that come together to support the well-being of the mind, body and sprit	U	F&C	Short answer, paragraph, essay questions
CO2	Explain various ways for stress management	U	F&C	Short answer, paragraph, questions
CO3	Explain different kinds of mental health problems, and way to improve mental health	U	F&C	Short answer, paragraph, essay questions
CO4	Describe need of self-empowerment, different empowerment exercises	U	F&C	Short answer, paragraph, questions
CO5	Practice various exercises for a holistic health	Ap	C&P	Assignments, seminars
CO6	Describe the importance of healthy diet for the development of holistic health	U	F&C	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: 1 Holistic health –Basic Aspects(12hrs) (Out of 50: 16 marks)

Unit 1: Introduction (1hr) - Scope, definition and history, holistic approach to health and its importance

Unit 2: Principle and Life style tips (5hrs) - Common principles of holistic health and pillars of holistic health; Different types of holistic approaches and treatments (Brief account only); Overall healthy life style tips.

Unit 3: holistic medicine (2hrs) - Health vs conventional medicine; Benefits and disadvantages of holistic medicine pros and cones.

Unit 4: Holistic health and nutrition(4hrs) Holistic nutrition definition, scope and its importance; common myths regarding holistic nutrition; Macronutrients and Micronutrients in holistic nutrition; Preparation of a healthy diets and meal planning and meal timing

Module :2 Stress Management and Life Style Transformation (9hrs) (10 marks)
Unit 1: Stress(3hrs) –Definition, signs of stress; Impact of stress on personal life and social life; Major steps to create a holistic stress management plan;
Unit 2: Ways to meet stress (6 hrs) -Yoga and meditation Importance of exercise; Science backed ways to deal with stress; Holistic approach to healthy life style and its importance.

Module 3: Emotional Wellness and Mental health support(10hrs) (17 marks)
Unit 1: Emotional wellness (4hrs)- Definition, key components, concept goals, signs, benefits, importance; Ways to improve emotional well-being, factors which destroy emotional wellness: stress, alcoholic and other drug abuse, influence of media; Relation between emotional well-being and overall health
Unit 2: Mental health (6hrs):- Definition, concept goals, signs, importance; things to know about mental wellness; Common mental illness and its causes (brief account only); Major activities to improve mental health; Impact of mental health for overall health

Module 4: Self empowerment coaching (5hrs) (7marks)
Unit 1: Characteristics of self empowered people. Ways to achieve self empowerment, Personal empowerment exercise; importance, dimensions, self analysis; Tracks to empower self
Module 5: Open ended (9hrs)
Teacher can design student activities like assignments, seminars, collection of notes/ reference materials related to the topics of module 5, organize practicing sessions for empowerment exercise, stress releasing exercise etc.

Reference
James Clear Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones (2018)The #1 New York Times bestseller.
Stephen R. Covey The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change Paperback – Special Edition, (2013)
Travis Bradberry (2023) Emotional Intelligence Habits Hardcover
Michael Greger, Gene Stone (2015) How Not to Die: Discover the Foods Scientifically Proven to Prevent and Reverse Disease - Flatiron Books ISBN 9781250066114 (ISBN10: 1250066115)
Louise L. Hay (1984) You Can Heal Your Life 253 pages, Unknown Binding Full Circle ISBN 9788176210775 (ISBN10: 8176210773
Lissa Rankin, Kris Carr (2013) Mind over Medicine: Scientific Proof That You Can Heal Yourself 259 pages, Hay House Inc ISBN 9781401939984 (ISBN10: 1401939988)
Lise Bourbeau (2002) Heal Your Wounds & Find Your True Self 232 pages, Lotus Press (WI) ISBN 9782920932210 (ISBN10: 2920932217)
Gabor Maté (2004) When the Body Says No: The Cost of Hidden Stress 320 pages, Published , by Vintage Canada ISBN 9780676973129 (ISBN10: 0676973124)
Louise L. Hay (1984) Heal Your Body: The Mental Causes for Physical Illness and the Metaphysical Way to Overcome Them- 96 pages, Hay House ISBN 9780937611357 (ISBN10: 0937611352)
Bruce H. Lipton(2005) The Biology Of Belief: Unleashing The Power Of Consciousness, Matter And Miracles 205 pages –Authors Pub Corp ISBN 9780975991473 (ISBN10: 0975991477)

Online Sources
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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

ECOLOGICAL ECONOMICS AND SUSTAINABLE LIFE

Programme	B.Sc. Zoology				
Type of Course	VAC				
Semester	IV				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		0	45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The course aims to develop understanding in the relationship between environment and economic activity, the application of economic principles to solve environmental issues.				

Course outcome (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the relationship between environment and economic activity.	U	F&C	Short answer, paragraph, essay questions
CO2	Apply economic principles to analyze environmental issues.	An	F&C	Short answer, paragraph, questions
CO3	Enumerate the costs and benefits of environmental policies.	Ap	F&C	Short answer, paragraph, questions
CO4	Analyze the role of markets and institutions in environmental decision-making.	An	F&C	Short answer, paragraph, essay questions
CO5	Analyse the arguments for and against sustainable development	An	F&C	Assignments, seminars, debates
CO6	Make reports after analysing the functioning of different sustainable development and ecotourism projects	Ap	M&P	Short answer, paragraph, questions

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Module 1: Introduction to Ecological Economics and Sustainable Development (7hrs) (Out of 50: 8 marks)

Unit 1: Foundations of ecological economics(2hrs): History of ecological economics; Core principles and concepts (entropy, ecological footprints, carrying capacity); Relationship between economic systems and the environment

Unit 2: Defining sustainable development(3hrs): Brundtland Commission report; Different approaches and perspectives; SDGs (Sustainable Development Goals) and their importance.

Unit 3: **Challenges to sustainable development(2hrs):** Climate change; Biodiversity loss; Resource depletion; Pollution and environmental degradation.

Module :2 Resource Management and Environmental Degradation (7hrs) (15 marks)
Unit 1: Renewable Resources(3hrs): Renewable energy sources and technologies. Sustainable forest management and biodiversity conservation. Water resource management and water scarcity
Case studies of Germany's transition to renewable energy
Unit 2: Non-Renewable Resources(2hrs): Fossil fuels and climate change. Peak oil and resource depletion. Resource curse and economic development.
Unit 3: Pollution and Waste Management(2hrs): Air pollution and its control. Water pollution and treatment. Solid waste management and recycling.

Module 3: Sustainable Development in Practice (10hrs) (15 marks)
Unit 1: Green economy and circular economy(3hrs): Principles and key features; Decoupling economic growth from resource use; Examples of green businesses and circular economy practices
Unit 2 Social dimensions of sustainable development(2hrs): Equity, justice, and intergenerational responsibility; Poverty and environmental degradation; Role of communities and civil society in sustainable development.
Unit 3: Sustainable agriculture and food systems(5hrs) Renewable energy and energy efficiency, Green infrastructure and urban planning, Ecosystem restoration and conservation, Governance and policy frameworks for sustainable development, Role of businesses, NGOs, and individuals in promoting sustainability

Module 4: Future of Ecological Economics and Sustainable Development (12hrs) (12 marks)
Unit1: Emerging issues in ecological economics and sustainable development(3hrs): Technological innovations for sustainability; Climate change adaptation and mitigation strategies; Building resilience to environmental shocks
Unit 2: Climate change mitigation and adaptation strategies(4hrs): Circular economy and resource efficiency, The role of technology in achieving sustainability, Social and cultural dimensions of sustainability, Future scenarios: different pathways to a sustainable future.
Unit 3: Biodiversity Loss and Ecosystem Services(5hrs): Valuation of ecosystem services. Payment for ecosystem services programs. REDD+ and conservation incentives. Emerging Issues in Environmental Economics: Green jobs and the transition to a sustainable economy.
Module 5: Open ended (9hrs)
Teacher candesign student activities like Field trip or online tour of a local sustainable development project. OR Calculation of ecological footprints of your campus
University Footprint Calculator: https://www.eusteps.eu/resources/university-footprint-calculator/
Global Footprint Network: https://www.footprintnetwork.org/
Ecological Footprint Standard: https://www.footprintnetwork.org/resources/data/

REFERENCES

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4. Oates, W. E. (2008). The economics of environment: Pollution, regulation, and development. Edward Elgar Publishing.
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6. Arrow, K. J., Dasgupta, P., Mäler, K.-G., & Munasinghe, M. (1996). Sustainable development and cost-benefit analysis. Edward Elgar Publishing.
7. Stern, N. (2007). The economics of climate change: The Stern review. Cambridge University Press.
8. Dasgupta, P. (2021). The economics of biodiversity: The value of the natural world. Oxford University Press.
9. Hanemann, M. W. (1992). Contingent valuation and environmental damage: A critical assessment. Edward Elgar Publishing.
10. Turner, R. K., & Bateman, I. J. (2001). The economics of environment and development. Edward Elgar Publishing.

Online Sources

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Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Quiz / Assignment/ Discussion / Seminar
Exam
Project/Practical
Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

SKILL ENHANCEMENT COURSES

LABORATORY EQUIPMENT MAINTENANCE & MUSEUM CURATION

Programme	B.Sc. Zoology				
Type of Course	SEC				
Semester	V				
Academic Level	100-199				
Course Details	Credits	Lecture per week	Tutorial per week	Practical per week	Total hours
	3	3		0	45
Pre-requisites	+2/VHSC Course; or Equivalent Online courses				
Course objectives	The course is designed to develop an understanding in the need of caring and maintenance of laboratory equipments, its methods, and various techniques for curation of museum specimens.				

Course Outcomes (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various care and maintenance methods for laboratory equipments	U	F&C	Short answer, paragraph, questions
CO2	Describe the methods for preparation of biological museum specimens	U	F&C	Short answer, paragraph, essay questions
CO3	Expain the process of taxidermy	U	F&C	Short answer, paragraph, questions
CO4	Describe preservation techniques for biological specimens	U	F&C	Short answer, paragraph, essay questions
CO5	Develop skill in performing taxidermy and other preservation techniques.	Ap	C&P	Assignments, seminars, Viva- voce
CO6	Maintain an own collection of biological specimens.	Ap	C&P	Short answer, paragraph, questions
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Module 1. Laboratory equipment maintenance (10hrs) (Out of 50: 12 marks)

Unit 1: Maintenance of Laboratory glassware (1hr) – Cleaning the glassware- normal cleaning, chemical cleaning, cleaning with chromic acid, cleaning of greasy and Tarry material, cleaning of microslides,

Unit 2: Sterilization of Laboratory materials (1hr) – Glassware, metal wares, cotton, rubber

Unit 3: Maintenance of Microscope (2hrs) – Proper handling of microscopes; Cleaning dirts and debris, optical surfaces, cleaning agents; Removal of immersion oil, avoidance of contamination

Unit 4: Maintenance of Centrifuge (1hr) –General and scheduled maintenance; cleaning, autoclaving and sterilization, working safely

Unit 5: Maintenance of other equipments (3hrs) – colorimeter, spectrophotometer, electrophoretic apparatus; balances- common and electronic; pH meters, PCR machine, hot air oven, incubators, microtome
Unit 6: First aid cabinet for laboratories and first aid for lab accidents (1hr) – Inclusions in a first aid cabinet; first aid for, cuts; burns; fainting; poisoning by acids, alkalies, mercuric chloride etc.

Module 2: Biological collections and their preparation (10hrs) (14 marks)
Unit 1: Microscopic slides (3hrs): (Whole mounts (larvae & parasites), body parts, wings, scales, hairs, antennae, legs, L.S & C.S of tissues/organs.
Unit 2: Formalin specimens (1hr): Vertebrates and invertebrates, internal organs, developmental stages/ embryos.
Unit 3: Dry specimens (4hrs): insects, eggs, bones- separate bones, complete skeleton, in situ skeleton; feathers, scats, antlers etc.
Unit 4: Replicas (1hr): molds, models, charts
Unit 5: Value of Biological collections. (1 hr)

Module 3: Taxidermy (7hrs) (7 marks)
Unit 1: Fish mountings(1hr): methods and precautions.
Unit 2: Bird mountings(2hrs): Preparation, preservation and mounting.
Unit 3: Mammals mountings (3hrs): Whole mounting; trophy mounting, skin preparations
Unit 4: Equipments (1hr) Tools, instruments, display boxes

Module 4: Preservation of biological collections (10hrs) (17 marks)
Unit 1: Stabilization (3hrs): documentation during stabilization (ecological information, field conditions, observations about the specimen and its habitat, accurate locality data, field notes, field tags applied to the specimen, photographs, digital images, sound or video recordings), health and safety concerns during stabilization.
Unit 2: Processing (2 hrs): preparation; accessioning; cataloguing; labeling materials used to label specimens; handling of biological specimens during processing, health and safety concerns during processing.

Unit 3: Storage (2hrs): Storage vessels and equipments; security of biological collections, control of access and use, physical security, arrangement during storage, storage material (Can be used/ cannot be used.

Unit 4: Maintenance (3hrs) : updating information, housekeeping in storage and exhibit areas, emergency preparedness, specimen cleaning, specimen treatment, agents that deteriorate collections, pest management.

Module 5. Open ended (8 hours)

Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module.

REFERENCES
Paul N. Hasluck 2019 Traditional Taxidermy methods and Equipment –Hasluck's Traditional Skills Library
Swarup, N, Arora, S. and Pathak,S. C. 2004. Laboratory techniques in Modern Biology – Kalyani Publishers
Vodopich, D.S. and Moore, R. 2011 Selected exercises from Biology Laboratory Manual – University of North Texas , McGraw-Hill Learning Solutions

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3		2			3						
CO 2		3		2			3						
CO 3		3					3						
CO 4		2		3			3						
CO 5					3					2		2	3
CO6		3		2			3						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6	✓			✓

IT SKILLS IN BIOSTATISTICS & BIOINFORMATICS

Programme	B.Sc. Zoology			
Type of Course	SEC			
Semester	VI			
Academic Level	100-199			
Course Details	Credits	Lecture per week	Practical per week	Total hours
	3	3	0	45
Pre-requisites	+2/VHSC Course; or Equivalent Online courses			
Course objectives	The course aims to develop skill in the use of IT tools in Biostatistics and Bioinformatics,			

Course Outcomes (CO)

	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Basic understanding and application of tools in biostatistics and Appreciation in various biostatistics methods and its applications	U	F&C	Short answer, Paragraph, questions
CO2	Explain the methods of ANOVA, Correlation and regression	U	F&C	Short answer, Paragraph, Essay questions
CO3	Application of biostatistical tools in different in different Research problems in Biology	U	F&C	Short answer, Paragraph, Essay questions
CO4	Deep understanding and applications of Free software related to biostatistics	U	F&C	Short answer, Paragraph, questions
CO5	Basic practical understanding of Various biological databases and data retrieval methods	An	F&C	Assignments, seminars
CO6	Practical experience in molecular docking, including ligand selection, homology modelling of protein, drug binding /docking stability analyses and visualizations	U	F&C	Assignments, seminars, practical sessions, viva-voce

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)
# - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

BIOSTATISTICS (18 HRS)

MODULE 1 Data presentation and visualization (10 Hrs) (Out of 50: 11 marks)

Unit 1. Data presentation(3hrs): Use of Ms Excel or LibreOffice Calc functions for data visualization, construction of line chart, column chart, pie chart, scatter chart, bar chart, changing chart type, **etc.**

Unit 2: Data analysis(7hrs): calculation of frequency, Mean, Median, Mode, standard deviation, Regression Analysis, sampling, hypothesis testing, ANOVA

Module 2: Data analysis by PAST /R software (8hrs) (16 marks)
Unit 1: Introduction to PAST/ R softwares; Installation and applications (1hr)
Unit 2: t-test (2hrs): Types,* (problems to be discussed)*
Paired t-test
Unpaired t-test
Unit 3: chi-square test(3hrs)- (problems to be discussed)*
1. Goodness of fit
2. Contingency Chi-square
3. Homogeneity Chi-square
Unit 4: **F-test, ANOVA(2hrs) -(problems to be discussed)***
One –way
Two- way classification

Section B: BIOINFORMATICS (18 hours)

MODULE 3 (9 Hrs) (14 marks)

Unit1. Biological Databanks (3hrs) Sequence Databases, Structure Databases, Specialized Databases; Make list of Biological databases for DNA and protein by browsing search engines; Visit NCBI, EMBL, and DDBJ. Explore them, List out the salient features of these databases.

Unit 2. Data Retrieval tools and file formats (2hrs): Retrieve the gene sequences by exploring and querying the nucleic acid databases

Unit 3. Sequence Similarity searching (3hrs) -NCBI, BLAST; Multiple Sequence Alignment CLUSTAL W;

Unit 4. Molecular Phylogeny(1hr) (PHYLIP)- Construction of phylogenetic tree

MODULE 4 (9 Hrs) (9marks)

Unit 1. Familiarize Databases (3hrs) PDB, SCOP, CATH, Pfam etc.; Protein sequence analysis (expasy proteomics tools) and secondary structure prediction using various tools available such as SOPMA, GOR, NN predict, etc.

Unit 2. Retrieval of protein sequences and homology modelling(3hrs): Molecular visualization of the 3D structure of any desired protein using the Molecular modeling tool (PyMol); Drawing Small Drug /ligand Molecules Using Chemsketch

Unit 3: Selection of ligands and structure verification for docking(3hrs); Molecular Docking of Modeled Protein With Ligands using swissdock; Visualization of Docked Molecule Using Rasmol

Module 5. Open ended (9 hours)

Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 1&3.

REFERENCES

1. Bioinformatics: Concepts, Skills and applications-Rastogi, S.C., et.al., -CBS Publishers, New Delhi

2. Bioiformatics: A Practical Approach- K.Mani& N. Vijayaraj-Aparna Publishers NewDelhi

3. Thomas J. Perun and C. L. Propst, “Computer-Aided Drug Design: Methods and

Applications”, Marcel Dekker.

4. Rastogi et. al., “Bioinformatics: Methods and Applications”, Prentice Hall of India.

BIOSTATISTICS

1. Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
2. Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
3. Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
4. Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ikas Publishing House, New Delhi.
5. Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition New Delhi
6. Magurran AE. 2004. Measuring Biological Diversity. Blackwell Publishing
7. Stephen W,Looney(2008) Methods in Molecular Biology-Biostatistical Methods-Springer International Edition
8. Zar, J.H.(2003) Biostatistical Analysis - Fourth edition. Pearson Education. Delhi

5. Claverie &Notredame, “Bioinformatics - A Beginners Guide”, Wiley-Dreamtech India Ltd

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3		3	3		3		3				
CO 3		3					3						
CO 4		3					3						
CO 5					3				3				
CO6					3				3				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Exam
- Project/Practical
- Final Exam

Mapping of COs to Assessment Rubrics :

	Internal exam	Assignment	Practical exam	End semester exam
CO1	✓			✓
CO2	✓			✓
CO3	✓			✓
CO4	✓			✓
CO5		✓		
CO6		✓		

MODEL QUESTION PAPERS

FIRST SEMESTER

I Semester B. Sc. (CUFYUGP) Degree Examinations November2024
ZOO1CJ101: AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAINING SYSTEMS
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

) **[Answer All. Each question carries 3marks] (Ceiling:24 Marks**

1. What is BMI, write its significance.
2. Distinguish between vital capacity and tidal volume
3. What is Haemoglobinopathies?
4. Explain Saltatory conduction with suitable diagram.
5. What is Physical ergonomics? Write any four benefits of physical exercise.
6. Distinguish between Bulimia Nervosa & Anorexia nervosa
7. Fill the column **B** appropriately:

Sl no	A. Diseases	B. causes and symptoms
1	Tingling	
2	Cachexia	
3	Pyuria	

8.Sliding filament theory suitable for muscle contraction, why?
9. What is ESR? Write its clinical significance.
10. Write the function of Juxta glomerulus apparatus

Section B

[Answer All. Each question carries 6 marks] (Ceiling:36Marks)

11. Explain the Ultra structure of skeletal muscle
12.Writean account on Ornithine cycle
13.With appropriate diagram describe the structure and types of neurons
14.What is synapsis? Write an account on neurotransmitters.
15. Explain the structure of hemoglobin.
16. Briefly describe Hormonal control of digestion
17. Comment on the respiratory problems in new born babies
18.Write an account on intrinsic pathway of blood coagulation

Section C

[Answer any one. Each question carries10 marks (1x10=10marks)

19.Describe various mode of carbon dioxide transport
20. With appropriate illustration describe the propagation of nerve impulse

I Semester B. Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1MN101: FOUNDATIONS OF ENVIRONMENTAL BIOLOGY AND ANIMAL BEHAVIOUR
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks] (Ceiling:24 Marks)`

1. How does ecology functions aas an interdisciplinary science?
2. Explain energy transfer and transformation in an ecosystem.
3. What are the roles of biogeochemical cycles in sustaining an ecosystem?
4. What are the key characteristics of the alpine biome?
5. Describe how animals are adapted to live in abyssal habitats.
6. Outline the key features of the National Environmental Policy, 2006.
7. Explain biotic potential and its significance in population ecology.
8. Discuss orientation in animal behaviour.
9. List three scientists who were awarded the Nobel Prize in 1972-73 for their contributions to the study of animal behaviour.
10. Write on social organization of elephants.

Section B

All questions can be answered. Each question carries 6 marks] (Ceiling:36 Marks)

11. Describe the food chain in a marine ecosystem.
12. Describe the fauna of intertidal muddy shores and their adaptations.
13. What are the characteristic of freshwater habitats, and how do they differ from marine habitats?
14. Elaborate on the significance of parasitism and predation as species interactions found in biological communities with suitable examples.
15. Discuss the solid waste Management Rules, 2016 in India and assess their effectiveness in addressing solid waste pollution.
16. Compare different types of population growth curves and their effects on population size sustainability.
17. How can conditioned reflexes be used to train domestic animals? Provide two specific examples.
18. 'Fixed action patterns are elicited by sign stimuli' Substantiate the statement giving examples.

Section C

Answer anyone. Each question carries10 marks (1x10=10marks)

19. Explain the major steps involved in the nitrogen cycle and include a note on impact of human activities on it.
20. Elaborate on the social organization of termites and elephants.

I Semester B.Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1MN102: BASICS IN CELLULAR PHYSIOLOGY
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3marks. (Ceiling:24 Marks)

1. List three postulates of the cell theory.
2. Explain the statement "the cell membrane id protein iceberg in a sea of lipids".
3. Draw and label any two stages of mitosis.
4. Differentiate between 70s and 80s ribosomes.
5. Highlight the significance of mitosis.
6. What is meant by Okazaki fragments?
7. What is termination codon?
8. What is test cross?
9. Differentiate between dominant and recessive mutations.
10. Explain multiple allelism and provide an example.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Briefly describe the structure and functions of the Golgi bodies.
12. Describe the phases of interphase in the cell cycle.
13. Explain the structure of DNA.
14. Outline the key steps involved in DNA replication.
15. Explain Mendel's law of inheritance.
16. What is co-dominance? Give an example.
17. Briefly describe sex chromosomal anomalies.
18. Explain how chromosomes are classified based on the position of the centromere.

Section C

Answer anyone. Each question carries 10 marks (1x10=10marks)

19. Describe the structure and functions of mitochondria.
20. Discuss any four disorders caused by gene mutations.

I Semester B.Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1VN101: BASICS IN ENTOMOLOGICAL, POULTRY SCIENCE AND DAIRY SCIENCE APPLICATIONS
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. What is royal jelly? What are its importance?
2. Enlist the functions of Drones in a colony.
3. Explain the causes and symptoms of any one of the bee disease.
4. Describe the types of mountages.
5. Enlist the types of silkworms.
6. Describe the making of bait trap for insects.
7. Describe the working of aerial rotary and suction traps.
8. List out cattle breeds grown for milk production.
9. Discuss the symptoms and causes of any one of the viral disease of poultry.
10. What is the nutritional value of egg?

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Enumerate the composition of honey, and its uses.
12. Describe the stages of mulberry cultivation
13. What are the different strains of Lac?
14. Enumerate the types of traps and nets for aquatic insect collection.
15. Discuss the merits and demerits of pheromone traps.
16. Describe the hatchery management system.
17. Describe pasteurization methods.
18. Explain the advancements in cattle breeding practices.

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Describe the structure of bee hive.
20. Describe the life cycle of *Bombyx mori.*

I Semester B. Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1VN102: ECOLOGICAL TOOLS AND TECCHNIQUES
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Explain biomes. What are the different types?
2. Enlist the ecological study design considerations.
3. Describe the importance of literature review.
4. Describe DNA sampling.
5. Explain the procedure of soil core collection.
6. Describe the GPS.
7. What is boxplot?
8. What is mean deviation?
9. Brief regression analysis
10. Enumerate the qualities of a literature abstract.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Describe the ethical considerations of ecological research.
12. Describe the importance of nutrient cycling.
13. Describe species diversity index.
14. Describe the process of Hypothesis testing
15. What are the different types of measures of central tendency.
16. What are the important things to consider in an oral presentation.
17. Describe online repositories of ecological data.
18. What are the plagiarism prevention methods?

Section C

Answer anyone. Each question carries 10 marks (1x10=10marks)

19. Describe different collection and trapping methods for insects.
20. Describe various data visualization procedures

I Semester B. Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1FM105(1): NUTRITION, HEALTH AND HYGIENE
(Credits:3)

Maximum Time: 1½ hours **Maximum Mark:50**

Section A

All questions can be answered. Each question carries 2 marks. (Ceiling:16 Marks)

1. What is RDA?
2. Define nutrition
3. What is water balance?
4. What is scurvy?
5. Explain the nutritional role of calcium.
6. What are the ill effects of pan masala use?
7. Explain social hygiene.
8. What is Hypertension?
9. What is Dyslaxia?
10. Explain Arteriosclerosis.

Section B

All questions can be answered. Each question carries 6marks. (Ceiling:24 Marks)

11. Describe any five food groups.
12. Describe the classification and functions of carbohydrates.
13. Describe essential and non-essential fatty acids.
14. Explain the ill effects of drug abuse.
15. Describe the risks of self-medication.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

16. Discuss the composition, classification and functions of proteins.
17. Explain the first aid given in snake bite, burns and road accidents.

I Semester B. Sc. (CUFYUGP) Degree Examinations November 2024
ZOO1FM105(2): REPRODUCTIVE HEALTH AND SEX EDUCATION
(Credits:3)

Maximum Time: 1½ hours **Maximum Mark:50**

Section A

All questions can be answered. Each question carries 2 marks. (Ceiling:16 Marks)

1. Enlist any four female reproductive rights
2. Comment on gender discrimination
3. Give short account on POCSO act
4. What is barr body?
5. Comment on artificial insemination
6. Write notes on ICSI
7. What are test tube babies?
8. How surrogacy helps to manage infertility?
9. Briefly discuss human papillomavirus
10. What is chorionic villi sampling?

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:24 Marks)

11. Explain the importance of sex education for teenage people
12. What is cyber sex? What is its impact on an individual?
13. Write a brief account on human spermatogenesis
14. Elaborate the events of menstrual cycle in human female. Mention its hormonal control
15. List out the causes of infertility in males and females

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

16. Discuss various mechanisms of sex determination
17. Write an essay on various fertility control methods

SECOND SEMESTER

II SEMESTER B. Sc. ZOOLOGY DEGREE EXAMINATION MARCH 2025
ZOO2CJ102 ENVIRONMENTAL AND CONSERVATION BIOLOGY

Time: Two Hours **Total marks : 70**

Section A

I. Short answer questions. Each question carries 3 marks

1. Differentiate between autecology and synecology (M1,CO1,U,F)
2. Give brief account of food chain (M1,CO1,U,C)
3. Discuss Ecological pyramids (M1,CO1,U,F)
4. Briefly describe the importance of Tropical rainforest (M2,CO1,U,F&C)
5. Explain the significance of Mangrove ecosystem (M2,CO1,U,C)
6. Describe carrying capacity and biotic potential (M3,CO2 ,U,F)
7. Give e-waste management rules 2016 (M3,CO2,U,C)
8. Briefly discuss imprinting(M4,CO3,U,C)
9. Distinguish between taxes and kinesis (M4,CO3,U,C)
10. Comment on habituation (M4,CO3,U,C)

(Ceiling 24 marks)

Section B

II. Paragraph questions. Each question carries 6 marks.

11 With an example explain conditioned reflex (M4,CO3,U,F&C)
12. Explain different types of population growth curves (M3,CO3,U,F&C)
13. Discuss negative interactions of the community (M3,CO2,U,F&C)
14. With an example give notes on keystone species (M3,CO2,U,F&C)
15. Compare the adaptations of animals on sandy, rocky and muddy shores (M2,CO1,U,C)
16. Discuss the importance of wetland ecosystem (M2,CO1,U,C)
17.Give an account on the productivity of ecosystem (M1,CO1,U,C)
18. Discuss briefly on the social life of elephants(M4,CO3,U,C)

(Ceiling 36 marks)

Section C

III. Essay question. Answer any one.

19. Explain the Nitrogen Cycle with the help of a diagram (M1,CO1,U,C)
20. Describe different types of communication with suitable examples (M4,CO3,U,F&C)

(1 x 10 = 10 marks)

II Semester B. Sc. (CUFYUGP) Degree Examination
ZOO2MN101-INTRODUCTORY HUMAN PHYSIOLOGY

Time : 2 hours Maximum Marks : 70

SECTION A

1. Answer the following. Each question carries 3 marks. (Ceiling 24 marks)

1. Explain homeostasis and mention its importance in the human body. (M1/CO1/U)
2. Summarize how apheresis can be used in the treatment of blood disorders.. (M2/CO3/U)
3. Apply your knowledge to explain how an ECG can help diagnose a heart attack. (M2/CO3/A)
4. Explain the differences between systole and diastole in the cardiac cycle. (M2/CO3/U)
5. Neurotransmitters are inherently neither excitatory nor inhibitory. Examine the statement. (M3/CO4/A)
6. Discuss the different types of muscles. (M3/CO4/U)
7. Elaborate the structure of multipolar neuron. (M3/CO4/U)
8. Describe the physiological changes which lead to flatulence. (M4/CO6/U)
9. Clarify the role of pancreas in maintaining blood glucose level. (M4/CO6/U)
10. Give the experimental procedure involved in dialysis. (M4/CO6/U)

SECTION B

II Answer the following. Each question carries 6 marks. (Ceiling 36 marks)

11. Briefly describe the main branches of human physiology. (M1/CO1/U)
12 Illustrate the sequence of events that occur during the clotting of blood and how different clotting factors contribute to this process. (M2/CO3/A)
13. Discuss the respiratory problems in new born babies and old age people. (M2/CO2/U)
14. Distinguish a chemical synapse from an electrical synapse in terms of structure and function. (M3/CO4/U)
15. A person is diagnosed with multiple sclerosis. Figure out the complications. (M3/CO4/A)
16. Explain the structural organization of gastrointestinal tract with the help of a neat and labelled diagram. (M4/CO6/U)
17. Discuss the significance of abnormal constituents of human urine. (M4/CO6/U)
18. Give a detailed account on ornithine cycle. (M4/CO6/U)

SECTION C

III Answer ANY ONE. Each question carries 10 marks (1 x10 = 10MARKS)

19. Summarize the process of Oxygen and Carbon dioxide transport in the blood. (M2/CO2/U)
20. Explain the physiology and biochemistry of muscle contraction. (M3/CO4/U)

II Semester B. Sc. (CUFYUGP) Degree Examination
ZOO2MN102-(CREDITS 4)-NUEROPHYSIOLOGY-

Time – 2 hrs Max. Marks: 70

SECTION – A

All questions can be answered. Each question carries 3 marks. Ceiling -24 Marks

1. Describe the structure and function of neuron. (Module1, U, CO1)
2. Explain the concept of dominant hemisphere. (M4, U, CO4)
3. Elaborate on the structural organization of spinal cord. (M2, U, CO2)
4. Discuss the role of neurotransmitters in nerve impulse transmission (M1, U, CO1)
5. Elaborate on the mechanisms, types and applications of electrical stimulation of brain. (M4, U, CO4)
6. Describe the distinct layers of the cerebellar cortex and their cellular composition (M3, U, CO3)
7. Classify the different types of neuroglia. (M1, U, CO1)
8. Summarize the motor functions of basal ganglia (M3, U, CO3)
9. Explain the structure of muscles spindle with a labelled diagram (M2, U, CO2)
10. Differentiate reflex action from voluntary action (M2, U, CO2)

SECTION – B

All questions can be attended. Each question carries six marks. Ceiling -36 Marks

11. Explain various sleep theories. (M4, U, CO4)
12. Explain the mechanism of neural control of muscle tone and posture. (M2, U, CO2)
13. A 52-year-old man suffered a stroke affecting his left frontal lobe. Following the stroke, he could understand spoken and written language but had significant difficulty in speaking fluently. His speech was slow, effortful and limited to a few words, often missing proper grammar.
    a) Predict which area of the brain is likely to be damaged in the above-mentioned patient? Provide a detailed account on the role of this area in language process
    b) Explore the possible rehabilitation measures. (M4, Ap, CO4)
14. Describe different types of reflexes with examples. (M2, U, CO2)
15. Summarize the motor functions of Cerebellum. (M3, U, CO3)
16. Elaborate on the motor aspects of communication. (M4, U, CO4)
17. Summarize the process of nerve impulse transmission. (M1, U, CO1)
18. Describe the principle, procedure and applications of PET. (M4, U, CO4)

PART - C

Answer any ***one*** question. Each question carries **10** marks.

19. Describe the structure of the human brain with a labeled diagram. (M2, U, CO2)
20. Explain the role of basal ganglia for cognitive control. (M3, U, CO3)

II Semester B.Sc. (CUFYUGP) Degree Examinations March 2025
ZOO2VN101: AQUA CULTURE AND FISHERY SCIENCE PRACTICES
(Credits:4)

Maximum Time: 2 hours **Maximum Marks :70**

Section A

[**Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)**

1. Describe any four criteria for selecting species for aquaculture. (M1- CO1-U)
2. Discuss the importance of mariculture? Give examples (M1-CO1-U)
3. Discuss the advantages of selecting native species for aquaculture.(M1-CO1-U)
4. Describe cage culture? (M2-CO2-U)
5. Explain how pen culture differs from other aquaculture systems (M2-CO2-U)
6. Summarize the process of species selection in raft culture (M2- CO2-U)
7. Differentiate between pole culture and rack culture.(M2-CO2-U)
8. Discuss the principles of aquaculture (M3-CO1-U)
9. Demonstrate the principal behind echosounder in fishing (M4-CO3-A)
10. Describe the environmental impacts of trawling (M4-CO3-U)

Section B

[Answer All. Each question carries 6 marks](Ceiling: 36 Marks)

11. Compare cage culture and pen culture. Discuss their advantages and limitations.(M2-CO2-U)
12. What are the differences between monoculture and polyculture? Discuss the advantages and challenges of each. (M2-CO2-U)
13. Describe the steps involved in surveying and pond preparation for aquaculture and the layout of a typical aquaculture farm (M3-CO4-U)
14. Describe the culture and breeding practices of carps in India. Give examples of species and their economic importance.(M3-CO4-U)
15. Describe the different types of aquaculture hatcheries. What are their functions and importance.(M3-CO4-U)
16. Explain the methods of dehydration, salting, and smoking in fish preservation. Discuss their effectiveness and applications. (M4-CO5-U)
17. Explain the structure and use of different fishing crafts used in India.(M4-CO3-U)
18. Describe the working principles and applications of gillnets and purse seines in fishing.(M4-CO3-U)

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10 marks)

19. Discuss the culture and breeding of *Etroplus* species. Highlight their ecological and economic significance in Indian aquaculture. (M3-CO4-U)
20. Explain the various shell fish diseases in detail.(M4-CO6-U)

II Semester B.Sc. (CUFYUGP) Degree Examinations March 2025

ZOO2VN102: FOOD PROCESSING AND QUALITY CONTROL

(Credits: 4)

Maximum Time: 2 hours Maximum Marks: 70

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Distinguish between prebiotics and probiotics (M1, CO1, U)
2. Describe the role of water in human food (M1, CO1, U)
3. Summarize the advantages of GM food (M1, CO1, U)
4. Clarify the concept of food preservation (M2, CO2, U)
5. Give notes on food additives (M2, CO2, U)
6. Investigate the role of cold plasma technology in preserving the food (M2, CO2, Ap)
7. Distinguish between processing and preservation of food materials (M3, CO3, U)
8. Explain emulsification as a food processing technique (M3, CO3, U)
9. Elaborate the purpose and features of FSSAI 2006 (M4, CO4, U)
10. Explore the applications of chromatography in quality analysis of food (M4, CO4, Ap)

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Classify food based on their nutrient properties (M1, CO1, U)
12. Differentiate between refrigeration and freezing of food (M2, CO2, U)
13. Highlight the merits and demerits of food irradiation (M2, CO2, U)
14. Summarize the performance parameters used in food processing (M3, CO3, U)
15. Provide a detailed account of different types of food processing industries (M3, CO3, U)
16. Discuss the processing involved in mushroom and leaf protein concentrates (M3, CO3, U)
17. Visualize the objectives and functions of GMP and GHP (M4, CO4, U)
18. Give a note on food adulteration (M4, CO4, U)

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Provide a detailed account on recent methods in food preservation (M2, CO2, U)
20. Define food spoilage. Elaborate the types and mechanisms of spoilage of food (M4, CO4, U)

SECOND SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS MARCH 2025
ZOO2FM106(1): AQUA CULTURE AND ORNAMENTAL FISH FARMING
(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

[Answer All. Each question carries 2 marks] (Ceiling:16 Marks)

1. Differentiate between monoculture and polyculture (M1-CO1-U)
2. Give two examples for brackish water and marine finfishes (M1-CO1-U)
3. Explain raft culture (M1-CO1-U)
4. Give an account on the role of public aquarium (M2-CO1-U)
5. Differentiate between egg layers and live bearers (M2-CO3-U)
6. Give two examples for exotic and indigenous ornamental fishes (M2-CO1-U)
7. Explain closed system of fish transportation (M3-CO6-U)
8. Give the name of institutions facilitating ornamental fish production in India (M3-CO6-U)
9. Give any two examples of aquatic plants used in aquarium (M4-CO5-U)
10. Describe live feeds used in ornamental fish culture (M4-CO5-U)

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24marks)

11. Describe pearl culture (M1-CO1-U)
12. Classify aquaculture based on environment (M1-CO1-U)
13. Describe the physicochemical parameters of water and its maintenance in aquarium (M2CO3U)
14. Summarize the accessories used in aquarium setting (M3-CO3-U)
15. Describe the common diseases and parasites of ornamental fishes (M4-CO6-U)

Section C

[Answer any one. Each question carries 10marks] (1x10=10marks)

16. Explain the different types of aquarium (M3-CO3-U)
17. Explore the techniques involved in live and formulated feed preparation (M4-CO-5A)

SECOND SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS
ZOO2FM106 (2) APICULTURE AND SERICULTURE
(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

Answer the following questions each question carries 2 marks

1. Summarize the scope of Apiculture.
2. Describe the economic importance of honey and bee wax.
3. Discuss how the waggle dance enhances the bees' role in pollination.
4. Give the names of different species of silk worms.
5. Explain Pebrine.
6. Give any two natural enemies of honey bees and add note on its control measures.
7.Why is mulberry cultivation important in sericulture?
8. Provide the methodology of honey extraction.
9. Group the following silk worm diseases based on causative agents: Grasserie, Scooto Septicaemia and Brown muscardine.
10. Differentiate early age and late age rearing of silkworm.

(Ceiling 16 marks)

Section B

Answer the following question each question carries 6 marks

11. Elaborate different Government schemes for financial assistance for Sericulture.
12. Explain the morphological adaptations of worker bees.
13. Describe the structure of silk gland.
14. Detail the basic requirements for bee keeping
15. Summarize the prospects of Sericulture in Kerala.

(Ceiling 24 marks)

Section C

Answer any one each question carries 10 marks

16. Elaborate the social organisation of honey bees.
17. Explain the lifecycle of Bombyx mori

(10 x 1 = 10 marks)

SECOND SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS MARCH 2025
ZOO2FM106 (3) BIOLOGY FOR COMPETITIVE EXAMS
(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

I. Answer the following questions each question carries 2 marks

1. Outline the components of human excretory system. (M3, U1, Ap, CO3)
2. Summarise the causes of global warming. (M2, U4, U, CO2)
3. Write the significance of Barr body. (M1, U4, R, CO1)
4. Give two examples of waterborne diseases. (M4, U1,U, CO4)
5. Explain the significance of living fossils in evolution. (M2,U1, U, CO2)
6. Plot the pathway of air from nose to alveoli. (M3, U1, Ap, CO3)
7. Give an account of the characteristics of cancer. (M4, U2, U, CO4)
8. Differentiate between food chain and food web. (M2, U2, U, CO2)
9. Figure out the role of insulin in human body. (M3, U1, Ap, CO3)
10. Describe the structure of Mitochondrion. (M1, U2, R, CO1)

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Discuss on the causes, prevention and cure of any two STDs. (M4, U4, U, CO4)
12. Describe the chromosomal mechanism of sex determination (M1, U4, R, CO1)
13. Elaborate on different conservation strategies. (M2, U4, U, CO2)
14. Describe the stages of mitosis with labelled diagrams. (M1, U3, R, CO1)
15. Prepare a table stating any five endocrine glands, hormones and their functions. (M3, U1, Ap, CO3)

Section C

[Answer anyone. Each question carries 10 marks] [1x10 = 10 marks]

16. Discuss the various interspecific population interactions with examples. (M2, U3, U, CO2)
17. Investigate the role of any three digestive glands in man. (M3, U1, Ap, CO3)

(10 x 1 = 10 marks)

THIRD SEMESTER

III SEMESTER B. Sc. (CUFYUGP) DEGREE EXAMINATION NOVEMBER 2025
ZOO3CJ201SYSTEMATICS, EVOLUTION & ZOOGEOGRAPHY

Time: Two Hours **Total marks : 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Describe taxonomic species concept.
2. Explain the concept of cytotaxonomy
3. Brief the contributions of Wallace in evolutionary studies.
4. Explain the mass extinction theory.
5. Describe Neolamarkism
6. Explain Artificial selection
7. Distinguish between continental and oceanic islands.
8. Describe faunal characteristics of Australian realm
9. Explain the origin of Deccan plateau.
10. Describe Weber's line.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe Taxonomic hierarchies.
12. Describe the postulates on Eukaryotic origin
13. Describe Darwinian theories of evolution
14. Describe Morgans theories of evolution
15. Enumerate speciation mechanisms
16. Differentiate subspecies, semi-species, sibling-species
17. Describe the characteristics of Neotropical realm
18. Describe the factors containing animal distribution.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Detail different systems of classification of organisms.
20. Discuss the morphological and physiological evidences of evolution

(1 x 10 = 10 marks)

III Semester B.Sc. (CUFYUGP) Degree Examinations November2025

ZOO3CJ202: PRACTICES IN ENTOMOLOGY, POULTRY SCIENCE AND DAIRY SCIENCE

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3marks. (Ceiling:24 Marks)

1. Describe the features of any two culturable honey bee species.
2. Enlist the morphological adaptations of worker bee.
3. Explain the process of honey extraction.
4. Describe the types of mountages.
5. Enlist the types of silkworms.
6. Describe the making of bait trap for insects.
7. Describe the working of aerial rotary and suction traps.
8. List out cattle breeds grown for milk production.
9. Discuss the symptoms and causes of any one of the viral disease of poultry.
10. What is the nutritional value of egg?

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Enlist the accessory tools used in apiculture.
12. Describe the stages of mulberry cultivation
13. What are the different strains of Lac?
14. Enumerate the types of traps and nets for aquatic insect collection.
15. Discuss the merits and demerits of pheromone traps.
16. Describe the hatchery management system.
17. Describe pasteurization methods.
18. Explain the advancements in cattle breeding practices.

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Describe the social organisation and communication of honey bee.
20. Describe the sericulture practices upto reeling.

1X10=10marks

III Semester B.Sc. (CUFYUGP) Degree Examinations November2025

ZOO3MN201: ANIMAL DIVERSITY, REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3marks. (Ceiling:24 Marks)

1. Enlist the features of *Leucosolenia.*
2. *Sacculina* possess typical features of a parasite. Justify
3. Explain the special features of *Nasikabatrachus.*
4. Describe the feeding behaviour and adaptations of *Petromyzon.*
5. Explain PNDT act.
6. What is the significance of Corpus luteum.
7. What is meant by potency?
8. What are the different cleavage patterns.
9. What is the importance of yolk.
10. Distinguish between invagination and involution.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain metagenesis, with respect to *Obelia.*
12. Describe the characteristics of Ascaris.
13. Describe the volant adaptations of *Pteropus*
14. With the help of diagram, describe the structure of typical vertebra of *Oryctolagus*
15. Describe the features of *Chamaeleo*
16. Describe any two assisted reproductive technologies.
17. Describe the classification of eggs.
18. Describe the primordial germ layers and their derivatives.

Section C

Answer any one. Each question carries 10 marks (1x10=10marks)

19. Describe the organisation of digestive system of *Oryctolagus*
20. Describe the hormonal regulation of female reproductive cycle. **1X10=10marks**

III Semester B.Sc. (CUFYUGP) Degree Examinations November2025
ZOO3MN202: PHYSIOLOGY OF BEHAVIOUR AND SENSES
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Describe the role of Angiotensin in thurst regulation.
2. Distinguish between Bulimia and Anorexia nervosa.
3. Hypothalamus is a center of behavioural functions- justify.
4. Explain environmental stressors.
5. Explain the significance of Amygdala.
6. What are statoreceptors?
7. Differentiate myopia, hypermetropia and presbyopia.
8. Illustrate the olfactory epithelial structure.
9. Explain the physiological basis of trickling.
10. Clarify the pain suppressive system.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Describe the factors that regulate the quantity of food intake.
12. Explain the mechanical process of food intake and its neuronal control
13. Describe the influence of perinatal hormones on sexual behaviour.
14. Describe the reward and punishment centers of brain.
15. Describe the anatomy of auditory organ.
16. Explain the physiological basis of taste perception.
17. Explain the categories of mechanoreceptive senses.
18. Describe somatosensory cortex.

Section C

Answer any one. Each question carries10 marks (1x10=10marks)

19. Describe the neural mechanism of sexual behaviour.
20. Elaborate the chemistry of vision and visual perception mechanism.

1X10=10marks

III Semester B.Sc. (CUFYUGP) Degree Examinations November2025
ZOO3VN201: FOUNDATIONS OF BIOSTATISTICS AND BIOTECHNIQUES
(Credits:4)

Maximum Time: 2 hour **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Clarify data and variable.
2. Explain kurtosis.
3. Define standard error, and explain its significance.
4. Define Mean deviation. List out its merits and demerits.
5. Describe autoradiography.
6. Differentiate GC-MS and LC-MS.
7. What is karyotype? What is the significance?
8. Brief CRIPR Cas-9 technology
9. Explain cell fractionation technique.
10. What is Vital stain. Give the composition of any one of the vital stains.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain random sampling, its advantages and disadvantages.
12. Describe the construction of piediagram.
13. Illustrate the F test.
14. Explain statistical based rejection and acceptance of hypothesis.
15. Describe different centrifugation methods
16. Explain SDS PAGE.
17. Explain different PCR techniques.
18. What are the qualities of a good fixative. Give the composition of any two common fixatives.

Section C

Answer any one. Each question carries 10 marks (1x10=10marks)

19. Explain different measures of central tendency.
20. Explain different blotting techniques.

1X10=10marks

III Semester B.Sc. (CUFYUGP) Degree Examinations November2025
ZOO3VN202: LIFE SKILL TECHNIQUES
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3marks. (Ceiling:24 Marks)

1. Describe the first aid for small cuts.
2. List the inclusions of a first aid kit.
3. Describe the proper hand washing and hygiene protocol.
4. What are the precautionary measures to be taken in educational institutions to meet emergency situations.
5. What is triage?
6. What is the first aid for insect bite.
7. List out the features of POCSO act 2012.
8. What is the significance of sex education?
9. What are the ill effects of self medication and over medication.
10. What is meant by psychosis?

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. What is CPR? Describe its procedure.
12. Describe firs aid related to different bone injuries.
13. Explain first aid for different kinds of burns.
14. Brief disaster management methods.
15. Describe birth control techniques
16. Describe first aid for suicidal tendency
17. What is meant by panic attack? What is its first aid?
18. Describe Mental health first aid action plan.

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Describe first aids to be provided with various respiratory problems.
20. Describe different altered sexual orientation behaviour.

1X10=10marks

III SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS NOVEMBER 2025
ZOO3FV 108 HEALTH – A HOLISTIC APPROACH

(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

I. Answer the following questions each question carries 2 marks

1.Outline the concept of holistic health.
2. What are the thinks to remember during a healthy diet preparation.
3. What are the conflicts between conventional medicine and holistic health approach
4. List out the signs of stress.
5. Explain the importance of exercise.
6. Point out the thinks to remember about meditation
7. Detail the importance of emotional wellness.
8. List out the ways to improve emotional wellness.
9. Explain self empowerment excersice.
10. Describe the self analysis method.

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. List out overall healthy life style tips.
12. Discuss the pros and cons of holistic medicine.
13. Discuss the scientific ways to reduce stress.
14. List out the key characteristics of emotional wellness
15. List out the characteristics of self empowered people.

Section C

[Answer anyone. Each question carries 10 marks] [1x10 = 10 marks]

16.Discuss the concept of holistic nutrition
17. Elaborate the concept of Mental health. **(10 x 1 = 10 marks)**

FOURTH SEMESTER

IV Semester B. Sc. (CUFYUGP) Degree Examinations March 2026
ZOO4CJ203: ANIMAL DIVERSITY-I- NON-CHORDATA
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3marks. (Ceiling:24 Marks)

1. Distinguish between Protostomia and Deuterostomia
2. Write notes on the symbiotic life of *Trychonympha*
3. Provide a brief account on eight kingdom classification
4. Comment on sexual dimorphism in *Ascaris*
5. Enumerate the parasitic adaptations of *Hirudinaria*
6. Write short notes on *Sacculina*
7. Enlist the distinguishing features of class Cephalapoda
8. Comment on the evolutionary significance of *Limulus*
9. Write short notes on Glochidium larva
10. Briefly discuss about molluscs as a source of food

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Briefly explain the characteristic features of phylum Apicomplexa
12. Briefly discuss nutrition in *Paramecium*
13. Explain polymorphism in Cnidaria
14. Describe the salient features of phylum Platyhelminthes
15. Discuss in brief the affinities of *Peripatus*
16. With suitable diagrams, briefly explain the following appendages of *Penaeus*
    a) Antenna b) Second maxilliped c) Uropod
17. Briefly discuss parasitic adaptations in helminthes
18. Briefly discuss the role of insects as pollinators

Section C

Answer anyone. Each question carries10 marks (1x10=10marks)

19. With suitable diagrams, explain canal system in sponges
20. With suitable diagrams, describe water vascular system in starfish

1X10=10marks

IV Semester B.Sc. (CUFYUGP)Degree Examinations March 2026
ZOO4CJ204: CELL BIOLOGY &GENETICS
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Briefly explain fluid mosaic model
2. Differentiate between incomplete dominance and co-dominance
3. What is multifactorial inheritance?
4. Summarise centrosome cycle
5. Define nucleo-cytoplasmic index
6. Explain pleiotropy
7. Explain mitochondrial biogenesis
8. Differentiate between euchromatin and heterochromatin
9. Define linkage. Which are the different types of linkages?
10. Comment on cell theory

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Comment on the organization and functions of microfilaments.
12. Briefly explain the molecular events occurring in recombination
13. Differentiate between gap junctions and tight junctions
14. Write notes on chromosome structural mutations
15. Explain complementary genes with a suitable examples.
16. Explain the different types of cancer
17. Differentiate between sex influenced and sex limited characters with examples
18. Elaborate on the ultrastructure of nuclear pore complex with the help of a diagram

Section C

Answer anyone. Each question carries10 marks (1x10=10marks)

19. Explain the various stages of meiosis
20. Explain various non allelic interactions with suitable examples. **1X10=10marks**

IV Semester B. Sc. (CUFYUGP) Degree Examinations March 2026
ZOO4CJ205: BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTICES
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Write down the criteria for selection of aquaculture species
2. Classify aquaculture based on environment
3. Which are the important cultivable species in India?
4. Describe different types of hatcheries
5. Write a note on prohibited fishing practices
6. Explain the process of fish spoilage
7. Write a note on cryopreservation
8. What is trawl ban?
9. What are mudbanks?
10. Explain the aquaculture based on number of species

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain different culture techniques
12. Briefly explain prawn culture
13. Describe the technique of induced breeding in fishes and prawns
14. Explain the procedure of live feed culture and feed formulation
15. Briefly describe the culture and breeding of carps and tilapia
16. Explain the harvesting and marketing of cultured species
17. Write a note on different types of fishing gears
18. Explain the fish preservation methods.

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Write an essay on bacterial, fungal and viral diseases in fishes and prawns
20. Write an essay on developing an aquaculture pond system

1X10=10marks

IV SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS MARCH 2026
ZOO4FV110 -ECOLOGICAL ECONOMICS AND SUSTAINABLE LIFE

(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

I. Answer the following questions each question carries 2 marks

1.What are the key milestones in the development of ecological economics as a distinct field of study?
2.Explain the significance of the SDGs in achieving sustainable development globally.
3.Discuss the role of conservation efforts, such as protected areas and sustainable forest management, in preserving biodiversity.
4. What are the main types of renewable energy sources, and how do they contribute to sustainable development
5. Explain the concept of water footprint and its significance in understanding water usage patterns.
6. Explain the concept of decoupling economic growth from resource use.
7. Discuss the importance of renewable energy and energy
8. What role can technological innovations play in promoting sustainable development and reducing environmental impacts?
9. Discuss the importance of community engagement and participation in promoting sustainable development.
10. Explain the concept of conservation incentives.

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11.What are the main causes and consequences of resource depletion, including water, land, and minerals?
12.Discuss the role of water conservation measures, such as efficient irrigation systems, in reducing water scarcity.
13. What are the benefits of agroecological practices, such as permaculture and regenerative agriculture, in promoting sustainable agriculture
14.What are the key principles of a circular economy, and how can they contribute to resource efficiency and sustainability?
15.What are the key design elements of payment for ecosystem services (PES) programs, and how can they be effective?

Section C

III. [Answer anyone. Each question carries 10 marks] [1x10 = 10 marks]

16. Discuss the key principles of sustainable forest management, and how do they contribute to biodiversity conservation.
17. Discuss the social dimensions of sustainable development.

(10 x 1 = 10 marks)

FIFTH SEMESTER

V Semester B. Sc. (CUFYUGP) Degree Examinations November 2026
ZOO5CJ301: ANIMAL DIVERSITY-II-CHORDATA
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Explain the defining characteristics that all chordates share.
2. Enumerate the distinguishing traits of Ascidiacea, highlighting their ecological relevance.
3. Analyze the distinctive adaptations of lung fishes, emphasizing their survival strategies in diverse environments.
4. Identify Indian sanctuaries where amphibians serve as flagship species, illustrating their role in conservation efforts.
5. Evaluate the significant contributions of Padmashree Rhomulus Whitaker in the realm of Reptile Conservation, emphasizing their impact on biodiversity preservation.
6. Evaluate the effectiveness of software applications in bird identification, considering their utility and accuracy in species recognition.
7. Explain the defining characteristics of the super order Palaeognathae,
8. .Explain the characters of the Order Bucerotiformes, elucidating their ecological niche.
9. Analyse the adaptations of Cetacea to their peculiar mode of life
10. Compare and contrast the excretory systems of Pisces and Amphibia, emphasizing their structural and functional adaptations to aquatic and terrestrial environments.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain the morphological features and functional significance of the Ammocoetes larva
12. Discuss the structure and function of the lateral line system in superclass Pisces
13. Investigate the adaptations of subterranean fishes in Kerala, highlighting their specialized morphological and behavioral traits for survival in underground habitats.
14. With the aid of labeled diagrams, compare and contrast the structure of a typical vertebra, the eighth vertebra, and the ninth vertebra in a frog.
15. Critically evaluate birding as a recreational activity, discussing its societal, ecological, and conservation implications.
16. Analyze the unique biodiversity of endemic birds in the Western Ghats, emphasizing their ecological significance and conservation challenges.
17. Discuss the anatomical and physiological adaptations for flight in birds, Include examples.
18. Analyze the principles of biomimetics in Vertebrates, exploring how biological principles inspire technological advancements and innovation.

Section C

Answer anyone. Each question carries10 marks (1x10=10marks)

19. Construct a key for identifying venomous and non-venomous snakes native to Kerala. Additionally, explain the significance of Polyvalent Anti-Snake Venom (ASV) in snakebite treatment its implications for public health.
20. Write an essay on the characteristic features of the class Mammalia. Compare and contrast the the salient traits of order Monotremata and Marsupialia within this class.

1X10=10marks

V Semester B. Sc. (CUFYUGP) Degree Examinations November 2026
ZOO5CJ302: BIOSTATISTICS AND BIOTECHNIQUES
(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. What are the limitations of statistical methods, and how can they be addressed
2. Discuss the importance of sample size and how it is determined
3. Define standard error, and explain its significance.
4. Define Mean deviation. List out its merits and demerits.
5. Describe autoradiography.
6. Differentiate GC-MS and LC-MS.
7. What is karyotype? What is the significance?
8. Brief CRIPR Cas-9 technology
9. Explain cell fractionation technique.
10. What is Vital stain. Give the composition of any one of the vital stains.

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain random sampling, its advantages and disadvantages.
12. What is the purpose of graphical presentation, and what are the different types of graphs
13. Illustrate the F test.
14. Arithmetic mean is good measure of central tendency. Justify
15. Describe different centrifugation methods
16. Explain SDS PAGE.
17. Explain different PCR techniques.
18. What are the qualities of a good fixative. Give the composition of any two common fixatives.

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. What is hypothesis testing, and what are the different types of hypothesis tests?
20. Explain different blotting techniques..

1X10=10marks

V Semester B. Sc. (CUFYUGP) Degree Examinations November 2026
ZOO5CJ303:FOUNDATIONS OF MOLECULAR BIOLOGY & BIOINFORMATICS

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1. Differentiate between inducible and repressible operon.
2. Explain the role of sigma factor in transcription
3. What are pseudogenes?
4. Comment on BLAST
5. Comment on the applications of MALDI-TOF.
6. What is PubMed? Explain its scope in biological research.
7. Differentiate between A, B and Z forms of DNA
8. Explain cheminformatics
9. Comment on Wobble hypothesis
10. Explain DDBJ

Section B

All questions can be answered. Each question carries 6 marks. (Ceiling:36 Marks)

11. Explain the function of tryptophan operon
12. Briefly explain various methods used for phylogenetic tree construction in bioinformatics
13. Explain the different multiple sequence alignment tools.
14. Elaborate Watson and Crick model of DNA
15. Discuss the significance of machine learning in bioinformatics
16. Define genetic code. Explain the various properties of genetic code.
17. Briefly explain the different metabolic databases
18. Briefly explain Hershey and Chase experiment

Section C

Answer anyone. Each question carries 10 marks (1x10=10marks)

19. Discuss the scope and applications of bioinformatics
20. Explain the machinery and mechanism of protein synthesis in prokaryotes

1X10=10marks

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ301(1)-ENTOMOLOGY I: STRUCTURE, ADAPTATIONS AND CLASSIFICATION OF INSECTS

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

I [Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Discuss the importance of understanding insect diversity and abundance
2. Explain the structure and function of the insect cuticle, sclerites, and external processes
3. Explain different types of antennae.
4. Discuss the features of piercing type mouthparts.
5. Describe the segmentation structure of insect thorax.
6. Explain the importance of proper curation and storage of insect specimens.
7. Describe the limitations of using taxonomic tools.
8. Brief the history of insect classification.
9. Explain the importance of Coleoptera in the agriculture field.
10. Enlist the features of Noctuidae family.

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. What are the key factors contributing to the success and diversity of insects?
12. Describe the three main body divisions of an insect.
13. Discuss the application of understanding insect morphology in various fields.
14. Explain the structure of compound eye.
15. Discuss the adaptations of larval and pupal stages to different environments and lifestyles.
16. Explain the characteristics and classification of Class Insecta up to Orders.
17. Describe the economic importance of Diptera.
18. Describe the features of Coleoptera.

Section C

III. [Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Detail the insect head modifications.
20. Give an overview of the order Hemiptera.

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ302(1)-ENTOMOLOGY II: AGRICULTURAL ENTOMOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

I [Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. With suitable examples write short notes on major pests
2. Provide a brief account on pest surveillance
3. Write short notes on any one pest of coffee
4. Briefly discuss the damages caused by *Leptocorisa acuta*
5. Explain the control measures of *Neoplocaederus ferrugineus*
6. Write short notes on *Hyblaeapurea*
7. Briefly discuss about pest of Oak.
8. Give an account on *Odoiporus longicollis*
9. Briefly discuss about any one pest of cardamom
10. Write short notes on any one pest of pepper

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly discuss the classification of pests based on levels of infestation
12. Explain the reasons for pest outbreak
13. Describe the symptoms of damage and management strategies of *Spodoptera*
14. Give an account on damage caused by *Saissetia nigra* and its control measures
15. Explain the characteristic features of any two pests of stored products
16. Discuss about polyphagous pests
17. Explain damage caused by *Batocera rufomaculata* and its control measures
18. Briefly describe the features of pest of ginger and its control measures

Section C

III. [Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss the biology, nature and symptoms of damage and management strategies of any two coconut pests.
20. Explain the damages caused by any 4 pests of vegetables and their control measures

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ303(2)-FISHERY SCIENCE I: FUNDAMENTALS OF FISHERY SCIENCE

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

I [Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Describe the role of fisheries in aquatic biodiversity maintenance.
2. Explain subsistence fisheries
3. Distinguish between lentic and lotic systems
4. Describe the tide prediction principle.
5. Describe the importance of coral reefs
6. Which are the sites of fisheries, vulnerable for risks.
7. Describe the role of NGOs in disaster management.
8. Explain various warning systems disaster management.
9. Explain co-operative marketing in fisheries.
10. Explain the role of environmental economics in fishery sector

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe the role of fisheries in National Income generation.
12. Describe features of any two fresh water fish of commercial importance.
13. Describe the chemistry of sea water, and preparation of artificial sea water.
14. Describe the role of marine parks and sanctuaries.
15. Explain community preparedness and awareness programmes for risk management.
16. Explain various aspects of disaster recovery programmes.
17. Describe the features of fishery and aquaculture marketing systems.
18. What are the interventions of Government in fishery marketing?

Section C

III. [Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss the role of Fishery Institutions in India.
20. Describe the disasters associated with fisheries.

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ 304(2) - FISHERY SCIENCE II: FISH TAXONOMY, FISH BIOLOGY AND FISH PHYSIOLOGY
(Credits: 4)

Maximum Time: 2 hours Maximum Marks: 70

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain the importance of dichotomous keys in fish classification.
2. What is DNA barcoding, and how does it aid in fish taxonomy?
3. Describe the role of chromatophores in fish colouration and their biological significance.
4. What are the key anatomical and physiological adaptations of deep-sea fishes?
5. What are the different types of fish scales, and how do they function?
6. How do freshwater and marine fishes regulate osmoregulation?
7. What is the Gonadosomatic Index (GSI), and why is it important in fish reproduction?
8. How do freshwater and marine fishes regulate osmoregulation
9. Define gynogenesis and androgenesis in fish chromosome manipulation.
10. How is transgenesis used to improve fish species?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain the hierarchical levels of classification in biological taxonomy and their significance in identifying fish species.
12. Discuss the role of molecular taxonomy and DNA barcoding in modern fish taxonomy.
13. Explain the different sensory adaptations in fishes, including the lateral line system, electroreception, and enhanced vision, and their significance in survival.
14. Discuss the different types of fish fins, their structure, and their role in locomotion, stability, and specialized adaptations
15 Explain the role of endocrine glands in fish physiology, focusing on hormonal regulation of growth and reproduction.
16. Describe the structure and function of the fish heart and explain how blood circulation occurs in fishes.
17. Explain the genetic basis of sex determination in fishes and describe how chromosome manipulation techniques can be used to control fish sex ratios.
18. Discuss the significance of Genetically Improved Farmed Tilapia (GIFT) and how selective breeding has enhanced its aquaculture potential.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss the significance of taxonomic keys in fish classification, including the types of keys, their construction, and the role of modern tools such as molecular taxonomy and digital keys.
20.Explain the anatomical, physiological, and behavioral adaptations of fishes to different aquatic environments, including deep-sea, coral reef, cave-dwelling, hill stream, and air-breathing fishes.

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ305(3)-HUMAN GENETICS I: INTRODUCTION TO HUMAN GENETICS
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

I [Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Mention three great milestones in Genetics
2. Provide a brief account on Fragile X- Syndrome
3. Write short notes on any one autosomal aneuploid syndrome
4. Briefly discuss the features of Philadelphia chromosome
5. Explain the significance of pedigree analysis
6. Write short notes on Alzheimer's disease
7. How does X–SCID affect the immune system.
8. Give an account on epigenetic effects of RNA molecules
9. Briefly discuss about maternal effect genes
10. Write short notes on genomic imprinting

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly discuss the applications of Genetics to human endeavors
12. Explain Denver system of chromosome classification
13. Describe the genetic causes and characteristic features of Klinefelter's and Turner's syndromes
14. Give an account on factors causing aneuploidy
15. Explain the genetic causes and characteristic features of any 2 autosomal recessive disorders
16. Discuss the genetic causes, inheritance pattern and symptoms of Duchenne muscular dystrophy
17. Explain histone modifications in epigenetics
18. Briefly describe the defects of androgen target cells

Section C

III. [Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss different types of structural abnormalities of chromosomes
20. Explain the genetic causes and characteristic features of any 5 autosomal dominant coconut

FIFTH SEMESTER B. Sc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ 306(3) HUMAN GENETICS - II - HUMAN CYTOGENETICS

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

I [Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Write short notes on ideogram
2. Give a brief account on hypotonic treatment in preparation of chromosomes
3. Briefly discuss about contamination in tissue culture
4. Provide a brief account on the genes involved in apoptosis
5. Explain the role of cyclin and cyclin dependent kinases in the regulation of cell cycle
6. Write short notes on the significance of telomerase enzyme
7. Discuss the role of tumour suppressor genes
8. Provide a brief account on microarray
9. Write short notes on Comet assay
10. Briefly discuss the characteristic features of marker chromosomes

Section B

II. [Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly discuss the following banding techniques
    a) G-banding and b) Q-banding
12. Explain different types of sterilization techniques in cell culture
13. Briefly describe different phases of eukaryotic cell cycle
14. Discuss the genetic regulation of cell cycle in *Saccharomyces cerevisiae.*
15. Explain the role of p53 gene as guardian of genome
16. Provide an account on different types of cancers
17. Discuss the principle and applications of FISH
18. Explain the procedure of DNA fingerprinting

Section C

III. [Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain extrinsic and intrinsic pathways of apoptosis
20. Discuss different events in metastasis

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ 307(4)-WILDLIFE BIOLOGY - I- BIODIVERSITY & BIOTA

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Describe about any two insect pest of teak.
2. Describe briefly about biodiversity hotspots in India
3. Discuss the role of 'ban on trolling' in Kerala as a conservation effort
4. Give an account on any three endemic fishes of Western Ghats
5. Explain the concept and types of biodiversity.
6. Define species richness and species abundance. How do they differ?
7. Describe any two measures for the control of forest insects.
8. Differentiate between turtles and tortoises. Give an example for each.
9. Describe the crocodiles of India
10. Discuss about any two endangered Amphibian of western Ghats

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly explain the major groups of fishes found in India with examples.

12. Describe major biodiversity areas of the world.

13. Explain how biodiversity supports various ecosystem functions and provides resources

14. Describe some of the prominent invertebrates found in Kerala, focusing on their ecological roles
15. Explain the concept of faunal zones and describe the major zones of faunal distribution

16. Describe the conservation perspective of fish biodiversity in India

18. Discuss the major conservation problems and issues faced by herpetofauna in the Indian Subcontinent
19. Describe the poisonous and nonpoisonous snakes of India

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the various ecological functions of insects
20. Discuss the endemic amphibians of the Western Ghats, highlighting their unique characteristics, the threats they face, and the importance of conserving these species.

FIFTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO5EJ 308(4) WILDLIFE BIOLOGY - II-ORNITHOLOGY AND MAMMALOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Classify Indian mammals based on their skin and its derivatives with an example.
2. Explain the different mating systems among birds, providing examples of each.
3. Discuss the distribution and feeding habit of lion tailed macaque
4. Describe the different types of territoriality and its primary functions?
5. How do mammals use territorial marking for communication
6. Discuss the key habitat types for birds in India
7. Explain different types of parental care exhibited by birds.
8. Explain the concept of defense and site fidelity among birds
9. Give an account of the breeding and feeding habits of Indian Flying Fox
10. Describe insectivores with an example.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss the endemic mammal species found in the Western Ghats and their ecological significance.
12. Briefly describe the feeding ecology of birds
13. Explain the differences between bird songs and calls, their functions, and how these vocalizations contribute to a bird's survival and behavior
14. Discuss some examples of endemic bird species in India and the significance of Endemic Bird Areas (EBAs)
15 Explain the different communication patterns observed among mammals.
16. "Discuss the useful and harmful roles of birds in ecosystems and human activities, highlighting examples of both positive and negative impacts.
17. Describe the different forms of nests. nest materials and nest building among birds.
18. Discuss about the various threats to the survival of sperm whale.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Briefly describe bird migration. Add a note on its significance
20. Explain the sociobiology of lion

FIFITH SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS NOVEMBER 2027
ZOO5FS 112- LABORATORY EQUIPMENT MAINTENANCE & MUSEUM CURATION
(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

Answer the following questions each question carries 2 marks (Ceiling 16 marks)

1. Enlist the cleaning agents of laboratory glassware, and explain their usage
2. Explain the sterilization procedure for cotton and rubber materials.
3. Explain the method of immersion oil in microscopes, and its benefits.
4. Explain the importance of biological specimens.
5. Describe the method of formalin preservation of biological specimens.
6. Describe the method of fish mounting preparation
7. Explain the chemicals used for taxidermy preparations.
8. Discuss the importance of control of access to biological specimens.
9. Describe the quality of storage vessels for biological specimens.
10. Discuss the materials that deteriorate preserved specimens.

Section B

Answer All. Each question carries 6 marks (Ceiling: 24 Marks)

11. Explain the method of proper use and maintenance of Centrifuge.
12. Explain the inclusions of first-aid kit for laboratories.
13. Describe the method of collection of biological specimens.
14. Describe the procedure for Trophy preparation and its mounting.
15. Discuss the procedure and precautions for safe handling of specimen processing

Section C

[Answer anyone. Each question carries 10 marks] [1x10 = 10 marks]

16. Describe the procedure of permanent slides of whole mounts.
17. Discuss the importance and procedure of documentation of biological collections.

(10 x 1 = 10 marks)

SIXTH SEMESTER

VI Semester B. Sc. (CUFYUGP) Degree Examinations March 2027
ZOO6CJ304: FUNDAMENTALS OF BIOCHEMISTRY& MICROBIOLOGY

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

SectionA

All questions can be answered. Eachquestioncarries3marks. (Ceiling:24 Marks)

1.What are peptide bonds. How are they formed
2. Write notes on hydrogen bonding
3.Biological functions of lipids
4. Oxidative Phosphorylation
5. Differentiate glycogenesis and gluconeogenesis
6.Discuss on base pairing
7. Fate of Pyruvic acid
8.Antiseptics & Disinfectants
9.Gram staining and its application
10.Normal microflora of human body

SectionB

All questions can be answered.Eachquestioncarries6marks. (Ceiling:36 Marks)

11.Beta Oxidation
12.Sterilization methods in Laboratories
13.Hierarchial Levels in Protein structure
14.DNA Structure - Watson Crick model with illustration
15.Production of Lactic Acid
16.Culture preservation techniques
17.Biosynthesis of Pyrimidines
18.Comment on different types of media

SectionC

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19.Discuss on the Krebs cycle. Add a note on its energetics
20. Details on causative agent, symptoms, mode of transmission and treatment of chikugunya & Dengue

1X10=10marks

VI Semester B. Sc. (CUFYUGP) Degree Examinations March 2027
ZOO6CJ305/ZOO8MN305:BASICS OF BIOTECHNOLOGY AND IMMUNOLOGY

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

SectionA

All questions can be answered.Eachquestioncarries3marks. (Ceiling:24 Marks)

1.Explain the scope of biotechnology in the agriculture field.
2. What is linker DNA? Explain its applications.
3. Differentiate between dot blots and slot blot.
4. Explain Bioreactors.
5. Describe the concept of personalized medicines.
6. Explain adjuant.
7. Explain RIA
8. Explain the functions of NK cells.
9. Explain the procedure of bone marrow transplantation
10. Explain SCID

SectionB

All questions can be answered.Eachquestioncarries6marks. (Ceiling:36 Marks)

11. Explain the use of restriction endonuclease enzymes in gene cloning.
12.Explain shot gun method.
13. Explain National Biotechnology Policy of India.
14. Describe DNA fingerprinting.
15. Explain the immunological role of MHCs.
16. Briefly explain different kinds of vaccines.
17. Describe the characteristics of cancer cells.
18. Describe any two organ specific autoimmune diseases

SectionC

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Discuss the production of monoclonal antibodies.
20.Describe the structure of Immunoglobulins and their functions.

1X10=10marks

VI Semester B. Sc. (CUFYUGP) Degree Examinations March 2027

ZOO6CJ306/ZOO8MN306: FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGY & REPRODUCTIVE BIOLOGY

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

SectionA

All questions can be answered.Eachquestioncarries3marks. (Ceiling:24 Marks)

1. What is hypothalamo-hypophyseal axis?
2. Comment on the theory of epigenesis in detail
3. Distinguish between holoblastic and meroblastic cleavage with examples
4. Give a brief account on the structure and functions of human placenta
5. What are teratogens? Give one example for a chemical teratogen and its impact
6. What is meant by fate map?
7. Write notes on Crew's hen
8. What is corpus luteum? Why it is important?
9. Give short notes on ICSI
10. How ultrasonography can be used for prenatal diagnosis

SectionB

All questions can be answered.Eachquestioncarries6marks. (Ceiling:36 Marks)

11. Describe the role of hormones in insect development
12. Explain the structure and functions of thyroid hormones
13. Briefly discuss the development of eye in frog
14. Enlist different categories of egg membranes in detail with their functions
15. What is parthenogenesis? Comment on various types
16. Discuss the role of organizers in amphibian development
17. Elaborate the process of spermatogenesis in humans
18. Write an account on the natural and mechanical methods of fertility control

SectionC

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

19. Describe the mechanism of hormone action at cellular level
20. Discuss the early developmental events in a chick embryo from fertilization to formation of germ layers

1X10=10marks

VI Semester B. Sc. (CUFYUGP) Degree Examinations March 2027

ZOO6EJ301(1) ENTOMOLOGY III: INSECT ECOLOGY

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

a. Describe the historical development of insect ecology.
b. Describe the features of gall forming insects.
c. Describe mutualistic relationship in insects, with example.
d. Describe the importance of predatory insects
e. Explain the role of pathogens on insect communities. Give example.
f. Detail the role of insects in decomposition
g. Explain the ecosystem engineering service by insects giving an example.
h. Describe the use of Wolbachia in pest control.
i. Describe the insect-born diseases which can be controlled through vaccination.
j. Explain the symptoms of yellow fever, and its control measures.

Section B

All questions can be answered. Each question carries 6marks. (Ceiling:36 Marks)

18. Describe the adaptations of parasitic insects
19. Describe intraspecific competition among insects.
20. Describe the features of insect pollinators.
21. Describe the social organization of ants.
22. Explain density- independent factors regulating insect population.
23. Describe different aspects of co-evolution in insect- host relationship.
24. Describe the IPM strategy for vector control.
25. Describe Malaria as a potential vector-born disease.

Section C

Answer any one. Each question carries 10 marks (1x10=10marks)

19. Detail the adaptations shown by insects in hot, salty and aquatic environment.
20. Discuss the influence of abiotic factors on insects.

VI Semester B. Sc. (CUFYUGP) Degree Examinations March 2027

ZOO6EJ302(1) ENTOMOLOGY IV: INSECT PEST MANAGEMENT

(Credits:4)

Maximum Time: 2 hours **Maximum Mark:70**

Section A

All questions can be answered. Each question carries 3 marks. (Ceiling:24 Marks)

1.Differentiate between Prophylactic and curative methods of pest control.
2. Enlist various natural methods for pest control.
3. Describe the term quarantine, in terms of pest control.
4. Describe the ecological basis of biological control.
5. Discuss the role of parasitoids in biological control.
6. Explain the basis of classification of chemical pesticides.
7. What is meant by pesticide residue? How it can be reduced?
8. Describe various types of light traps.
9. Brief the working of Baermann Funnel.
10. Describe the use of aspirator in pest control devices.

Section B

All questions can be answered. Each question carries 6marks. (Ceiling:36 Marks)

11. Brief the history of pest control methods.
12. Describe the stages of biological pest control procedure.
13. Explain disadvantages of biological control methods.
14. Describe Botanical pesticides.
15. Describe the process of environmental degradation of pesticides.
16. Describe autocidal control of pests.
17. Explain trapping methods for stored products pests.
18. Detail IPM

Section C

Answeranyone.Eachquestioncarries10 marks (1x10=10marks)

26. Describe any two case studies of biological control projects in India.
27. Give an overview of chemical pesticides.

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ 303(2) -FISHERY SCIENCE - III - CAPTURE AND CULTURE TECHNIQUES

(Credits: 4)

Maximum Time: 2 hours Maximum Marks: 70

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. What are the major riverine systems in India?
2. List the different types of reservoirs and briefly describe each.
3. Differentiate between pelagic and deep-sea ecosystems.
4. What is bycatch, and why is it a concern in marine fisheries?
5. What are Marine Protected Areas (MPAs)?
6.Describe paddy cum fish culture and its advantage.
7. Differentiate between live feeds and artificial feeds in aquaculture
8. Givethe significance of feeding regimes in aquaculture?
9.How can you use simple methods to monitor water quality in a small fish pond?
10.If overcrowding in a pond is leading to fish stress, how would you adjust the stocking density?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain the origin and classification of estuaries and their significance in fisheries.
12. How does technology assist in data collection and monitoring in fisheries management?
13. Discuss the regulation of fish populations and exploitation in riverine fisheries.
14.Compare the symptoms, causes, and treatments of viral, bacterial, and fungal diseases in fish.
15. Discuss the process of fish transportation and acclimatization in aquaculture.
16. How do wastewater treatment technologies help in sustainable aquaculture?
17. Discuss different methods used to control weeds, pests, and predators in aquaculture.
18. Discuss the role of certification and eco-labeling in promoting sustainable fisheries.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the impact of climate change, ocean acidification, and habitat destruction on marine fisheries.
20.Describe the culture of edible oysters, pearl oysters, and mussels. What are the challenges and benefits of shellfish culture?

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ 304(2) - FISHERY SCIENCE - IV –HARVESTING AND POST - HARVESTING TECHNIQUES

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. What are Fish Aggregating Devices (FAD)?
2. What is the role of an echo-sounder in fishing?
3. How does rigor mortis affect fish muscle quality?
4. What is the role of refrigerated seawater (RSW) in fish handling?
5. Compare microbial and biochemical spoilage in fish.
6. Give the basic requirements for registering a fish processing plant with MPEDA?
7. What is canning?
8. Define surimi and mention its use.
9. Give the importance of HACCP in seafood processing
10. Give the benefits of using UV rays in seafood processing

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Compare and contrast different fishing methods such as fishing with traps, pots and harpoons.
12. Give an account on Indigenous fishing crafts of India
13. Explain the different icing methods used for preserving fresh fish
14. Give the nutritive value of fish muscle and its benefits in human nutrition.
15. Explain the complete process of lobster processing, including grading and packaging.
16. Describe the methods used for processing commercially important fish in India.
17. Give a brief account on fish byproducts
18. Discuss the microbial hazards associated with seafood and the measures taken to prevent contamination.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the facilities available at fish landing sites and their significance in commercial fishing.
20. Discuss the different techniques used in fish processing and preservation

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ305(3)-HUMAN GENETICS III: GENETIC DISEASES AND COUNSELLING

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Discuss the genetic causes of sickle cell anaemia
2. Provide a brief account on IDDM
3. Write short notes on Haemophilia
4. Briefly discuss the features of Tay Sach's disease,
5. Write short notes on Hereditary fructose intolerance
6. Give a brief account on primary gout
7. Discuss the reasons for Spontaneous abortions.
8. Write short notes on Syndromology
9. Briefly discuss chorionic villus sampling
10. Write short notes on population screening

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly discuss any two neuromuscular disorders
12. Explain the features of any two diseases of amino acid metabolism
13. Briefly describe Glycogen storage disorders
14. Give an account on Wilson's disease
15. Discuss any 2 birth defects of human
16. Describe Amniocentesis and its significance
17. Write notes on genetic counselling
18. Briefly describe any two non-invasive techniques for prenatal diagnosis

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Write an essay on thyroid disorders
20. Explain different types of assisted reproductive techniques

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ 306(3) HUMAN GENETICS - IV TECHNIQUES, GENOME AND COMPUTATION

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Write short notes on premature chromosome condensation
2. Give a brief account on Peripheral blood lymphocyte culture
3. Briefly discuss Liposome-based Drug Delivery
4. Provide a brief account on metabolic engineering
5. Give an account on any three applications of Recombinant DNA techniques in Human Diseases
6. Discuss the goals of HGP
7. Comment on the approaches used in HGP
8. Provide a brief account on BankIt
9. Write short notes on PDB
10. Briefly discuss Entrez.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Briefly discuss any two chromosome staining techniques
12. Discuss different types of gene therapy
13. Explain sister chromatid exchange and its significance in genetics
14. Provide an account on medical products developed by using biotechnology tools.
15. Explain physical mapping of human genome
16. Briefly discuss the salient features of human genome as evident from HGP
17. Discuss any two nucleic acid databases
18. Explain the techniques of sequence alignment

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the principle, steps and applications of PCR.
20. Write an essay on any five major rDNA products.

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ 307(4) WILDLIFE BIOLOGY III: FIELD TECHNIQUES IN WILDLIFE STUDIES
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Detail about the safely measures to be taken during capturing and handling of wild animals
2. Describe the age estimation in larger herbivores
3. Discuss about bio-loggers and its application
4. Give any two purposes for capturing and handling of wild animals
5. Explain the role of GIS in wild life conservation
6.Discuss about field kit and its usage in animal research
7. Give an account on the different marking techniques of birds
8. Discuss about behavioral sampling in studying camouflage in animals
9. Discuss about any two-drug delivery equipment used in drug immobilization of animals
10. What is a sonogram? How is it used in wildlife studies?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain the concept of digital tagging and its application in wild life studies
12. Describe about animal capture methods
13. Describe scat analysis of carnivores
14. Explain the purpose of an ethogram in behavioral studies and how it is developed.
15. Discuss about the handling and transport of wild animals
16. Explain Peterson or Lincoln Index method.
17. Explain the determination of age and sex in birds
18. Discuss the impact of wild life photography in conservation goals

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe the various techniques used in managing problem animals
20. Describe briefly about the direct count methods for wildlife population estimation

SIXTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO6EJ 308(4) WILDLIFE BIOLOGY IV: WILDLIFE CONSERVATION & MANAGEMENT

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain about the treaties for wildlife conservation
2. Explain the significance of zoonotic diseases in public health.
3. Describe Indian Forest Act
4. Explain any two essential factors to be considered when developing conservation strategy
5. Describe about any two-case study of human – wildlife conflict
6. Describe the present status of biodiversity in India
7. Describe Joint Forest Management
8. Discuss about the disease and population dynamics
9. Discuss about any two extinct categories of birds listed by IUCN
10. Give an account on the women in conservation

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11.Describe the role of Indian board of wildlife and state wildlife advisory board
12. Describe briefly about the threats and conservation issues.
13. Describe Environmental Impact Assessment (EIA) methods and their role in wildlife conservation.
14. Describe the marine sanctuaries and national parks of India
15 Explain the causes of depletion of wildlife resources
16. Discuss the basic considerations for designing a modern zoo. Comment on the functions of a zoo.
17. Describe different categories of wildlife in IUCN Red list
18. Explain Wild Life Protection Act 1972 and its amendments

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe about any five government and voluntary organization in wild life conservation
20. Explain the concept of Man and biosphere reserves (MAB) and describe the biosphere reserves in India

SIXTH SEMESTER FYUGP HONOURS DEGREE EXAMINATIONS MARCH 2028
ZOO6FS 113- IT SKILS IN BIOSTATISTICS & BIOINFORMATICS
(CREDIT: 3)

Time: 1.5 Hours **Maximum marks: 50**

Section A

I. Answer the following questions each question carries 2 marks (Ceiling 16 marks)

11. Write down the protocol for calculating Arithmetic Mean using Ms Excel.
12. Describe the procedure for changing the chart type using Libre office Calc and Ms Excel
13. Describe the features of PAST software.
14. What are the applications of ANOVA?
15. What is meant by Goodness of fit?
16. Describe data retrieval tools.
17. Describe the features of PHYLIP
18. Describe the features of SOPMA
19. What is meant by molecular docking/
20. What are the features of Chemsketch?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 24 Marks)

11. Discuss the protocol for ANOVA using Ms Excel/ Libre office Calc.
12. Explain the protocol for creating scatter plot using Ms Excel.
13. Explain the protocol for Homogeneity Chi-square test using PAST/ R software.
14. Describe Multiple sequence similarity search.
15. Describe the applications of Rasmol

Section C

[Answer anyone. Each question carries 10 marks] [1x10 = 10 marks]

16. Discuss the protocol of executing t-tests using R software.
17. Describe the features of nucleic acid databases

(10 x 1 = 10 marks)

SEVENTH SEMESTER

SEVENTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS NOVEMBER 2027
ZOO7CJ 401 - PHYSIOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
Answer All. Each question carries 3 marks (Ceiling: 24 Marks)

1. Describe the composition and formation of lymph
2. Distinguish between eustress and distress
3. Describe the importance of meninges.
4. Describe blood-brain barrier
5. Explain polysynaptic reflexes.
6. Describe diabetic retinopathy, and its management.
7. Describe the structure of taste buds.
8. Explain nasal disorders.
9. Describe the structure of organ of Corti.
10. Explain Alzheimer's disease.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe the diseases associated with lymphatic system.
12. Explain the role of endocrine stress axis.
13. Describe the organization of diencephalon.
14. Explain the role of peripheral Nervous system.
15. Describe the neuronal circuitry of retina.
16. Explain the physiology of taste reception
17. Describe the basis of memory
18. Describe the auditory pathway.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain different areas of cerebral cortex and their organization and functions.
20. Elaborate various kinds of receptors on skin.

SEVENTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS NOVEMBER 2027

ZOO7CJ 402–ENZYMOLOGY AND CLINICAL BIOCHEMISTRY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Differentiate between ribozymes and abzymes.
2. Comment on Lesch-Nyhansyndrome
3. Describe lactose intolerance
4. Describe allosteric regulation of enzymes.
5. Explain PT test
6. Elaborate on the causes and clinical manifestation of gout
7. Discuss the key features of an enzyme active site.
8. Write notes on various abnormal constituents of urine
9. Add notes on holoenzymes.
10. Elaborate on dose- response curves of Enzyme inhibition

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Add notes on SCID
12. Explain how blood glucose concentration is regulated in the body.
13. Examine various types of diabetes mellitus.
14. Explain various factors affecting the velocity of enzyme catalyzed reactions.
15. Discuss various renal function tests.
16. Elaborate on classification and nomenclature of enzymes.
17. Describe the role of isoenzymes in enzymatic regulation with reference to Lactate Dehydrogenase (LDH)
18. Explain Michaelis Menten equation. Add notes on Km value and its significance

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss the different Enzyme inhibition mechanisms.
20. Investigate on different disorders of aminoacids metabolism

SEVENTH SEMESTER B.SC. (CUFYUGP) DEGREE EXAMINATIONS, NOVEMBER 2027

ZO07CJ403: ADVANCES IN ECOLOGICAL AND EVOLUTIONARY STUDIES

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

Answer all. Each question carries 3 marks

1.Define the term metapopulation. (a) What are the factors that characterize metapopulations?

2. Differentiate symbiosis and mutualism.

3. Age structure.

4. Factors affecting population growth.

5. Ecosystem modeling.

6. Phenotypic plasticity.

7. Evo-devo.

8. Hot- dilute soup.

9. Paleoecology.

10. Population genomics.

(Ceiling: 24 Marks)

Section B

Answer All. Each question carries 6 marks.

11. Comment on ecological interactions and its significance.

12. Characters affecting population growth.

13. Niche theory.

14. Ecosystem modeling.

15. Comment on applications of evolutionary theory.

16. What are the different interdisciplinary approaches in ecology and evolution?

17. Comment on anthropogenic perturbations of Global carbon cycles.

18. Role of ethical considerations in ecological and evolutionary research.

(Ceiling: 36 Marks)

Section C

Answer any one. Each question carries 10 marks

19. Write an essay on Factors regulating population.

20. Comment on ethical considerations in ecological and evolutionary research.

(1x10=10marks)

SEVENTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO7CJ404- MOLECULAR BIOLOGY AND CYTOGENETICS

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Distinguish between moderately repetitive and highly repetitive DNA
2. Provide a brief account on heat shock proteins
3. Write short notes on pseudogenes
4. Briefly discuss CpG islands
5. Provide a brief account on spliceosomes
6. Write short notes on microRNAs
7. Briefly discuss endomitosis
8. Write short notes on heteroduplex DNA
9. Briefly explain Lyon hypothesis
10. Write short notes on Cri du Chat syndrome

Section B
[**Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)**

11. Briefly discuss any two transposons in bacteria
12. Explain the role and significance of Telomerase enzyme
13. Describe Ubiquitin proteosome pathway.
14. Give an account on translocation of proteins to ER
15. Explain the role of cyclins and cyclin dependent kinases in cell cycle
16. Discuss the role of Rec A protein in genetic recombination
17. Explain different types of Gynandromorphism.
18. Briefly describe the features and causes of any two autosomal trisomies.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Discuss different types of DNA repair mechanisms
20. Explain chromosomal mechanism of sex-determination

SEVENTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO7CJ405: COMPARATIVE ANATOMY & DEVELOPMENTAL BIOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Write short notes on juxta glomerular apparatus
2. Briefly describe the structure of intestinal villus
3. Briefly discuss about homoplasy
4. Write short notes on ocelli
5. Briefly discuss sinus venosus
6. Provide a brief account on lateral line system
7. Explain hox code hypothesis
8. What is meant by cell potency?
9. Comment on hedgehog family proteins
10. What is morphallactic regeneration?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss different types of internal gills
12. Discuss any 6 different types of excretory organs of invertebrates
13. Briefly discuss the evolution of major aortic channels of vertebrates
14. Provide an account on cranial nerves of vertebrates
15. How nieuwkoop centre acts as an organizer?
16. What is genomic imprinting? Comment on its implications in animal development
17. Distinguish between the instructive and permissive modes of interactions during induction
18. Elaborate the role of DNA repair enzymes in ageing process

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe different types of chemoreceptors of insects
20. Discuss the mechanisms of differential gene expression at the level of transcription

EIGHTH SEMESTER

EIGHTH SEMESTER B.Sc. (CUFYUGP) DEGREE EXAMINATIONS
ZOO8CJ406/ZOO8MN406- COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATONS

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1.Differentiate between primary, secondary and tertiary databases.
2. Describe the importance of algorithms in computational biology.
3. Explain control structures.
4. Describe Cytoscape.
5. Explain molecular docking.
6. Brief the IT tools used for data management in biostatistics.
7. Explain the importance of data visualization
8. Brief ethical consideration in data sharing and reproduction.
9. Describe MCMC
10. Brief big data analysis.

Section B
[**Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)**

2. Describe the features of Python language.
3. Describe different types of algorithms.
4. Describe protein structure prediction methods.
5. Give a note on metabolic pathway databases.
6. Describe data collection procedures in biostatistics.
7. Explain documenting and organizing data and analysis workflows.
8. Explain applications of machine learning in classification, and clustering of biomedical data.
9. Explain evaluation and interpretation of machine learning models in biostatistics research.

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Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe Phylogenetic reconstruction methods.
20. Describe high-throughput data analysis

EIGHTH SEMESTER B.Sc. (CUFYUGP) DEGREE EXAMINATIONS
ZOO8CJ407/ZOO8MN407- ADVANCES AND APPLICATIONS OF IMMUNOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Clarify, isotype, allotype and idiotype of antigenic determinants.
2. With suitable example explain the cross reactivity of antibodies.
3. Brief the hematopoietic growth factors.
4. What is BCR? Explain its significance.
5. Explain the role of TH cells.
6. Describe the importance of dietary factors in immune regulation
7. Comment on complement deficiency conditions.
8. Comment on bacterial septic shock.
9. Describe immunological basis of graft rejection
10. Describe DNA vaccines

Section B
[**Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)**

11. Describe the process of hematopoiesis, and cell lineages.
12. Describe immunoglobulin genes, and basis of diversity of immunoglobulins.
13. Describe the features of cytokines.
14. Describe the properties of cytotoxic T cells.
15. Explain complement activation pathways.
16. Explain the interactions between Microbiota an innate lymphoid cells
17. Describe the mechanism of cancer cell detection and clearance.
18. Explain primary immune-deficiency diseases.

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Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Elaborate B cell activation and mechanism of humoral immunity
20. Discuss different types of hypersensitivity reactions.

EIGHTH SEMESTER B.Sc. (CUFYUGP) DEGREE EXAMINATIONS
ZOO8CJ408/ZOO8MN408- ADVANCES IN BIOTECHNOLOGY AND MICROBIAL PROCESSING

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Explain the role of restriction endonuclease enzymes in gene cloning..
2. What are the essentials for expression vectors.
3. Explain the technique of McFISH.
4. Brief the social acceptance of GM plants.
5. Enlist the demerits of Maxam-Gilbert method of DNA synthesis.
6. Brief on GATT.
7. Describe the screening of microbes for industrial purpose.
8. Explain scale up procedures
9. Explain industrial production of acetic acid.
10. Explain the methods of analysis of mixed microbial populations

Section B
[**Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)**

11. What are the applications of molecular probes?
12. Explain the methods for selection of transformed cells
13. Describe the production of Knock out mice.
14. Describe the applications of Anti- sense technology
15. Describe the procedure of inocula preparation for industrial fermentation
16. Describe different media for industrial fermentation.
17. Describe different kinds of bioreactors
18. Describe industrial production of various solvents

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe various kinds of cloning vectors.
20. Discuss various down stream processing in industrial microbiology.

EIGHTH SEMESTER B. Sc. (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ401- ENVIRONMENTAL BIOLOGY I: ENVIRONMENTAL LEGISLATION AND IMPACT ASSESSMENT

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. State three key outcomes of the 1972 Stockholm Declaration on the Human Environment
2. What is the significance of the IUCN Red List?
3. Define the term "Ecological Footprint" and its significance.
4. What is the fundamental purpose of using Cost-Benefit Analysis in environmental decision-making?
5. Explain the "Polluter Pays Principle".
6. Why is the conservation of migratory species important?
7. Briefly explain the concept of "Carbon Credits."
8. What is the primary focus of the ISO 14000 series of standards?
9. Describe three significant contributions of M.C. Mehta to environmental protection in India.
10. What are the key goals of the Mission on Sustainable Habitat within the NAPCC?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss the pivotal role of the United Nations Organization (UNO) in the international development of environmental laws, with specific reference to the significance and impact of the Stockholm Declaration, 1972.
12. Evaluate the significance of the UNFCCC, in addressing climate change. Discuss the successes and limitations of these agreements.
13. Define the term "Carbon diet" and explain how individuals and organizations can implement strategies to reduce their carbon footprint. Provide practical examples.
14. Outline and compare two distinct methodologies used in impact assessment. Discuss the strengths and weaknesses of each method, providing appropriate examples.
15. Detail the functions and powers of the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCB) in India.
16. Discuss the roles and contributions of BNHS and ANERT, providing specific examples.
17. Examine the contributions of Mission on Sustainable Habitat and the Mission for Sustainable Agriculture.
18. Define eco-tourism and discuss its principles. Describe two major eco-tourism projects in India,

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Compare and contrast the provisions of the Air (Prevention and Control of Pollution) Act, 1981, with the Water (Prevention and Control of Pollution) Act, 1974. Discuss how these acts address noise pollution and other forms of pollution.
20. Explain the concept of Life-Cycle Analysis (LCA) and its relevance to environmental management. Discuss how Cost-Benefit Analysis is used in evaluating environmental projects and policies.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ402 - ENVIRONMENTAL BIOLOGY II: ENVIRONMENTAL CHEMISTRY
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define "chemical speciation" and give an example of how it is relevant in atmospheric chemistry.
2. Differentiate between Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD).
3. Explain the concept of a soil profile. List the major horizons typically found in a well-developed soil profile.
4. Give the chemical composition of Portland cement.
5. What is photochemical smog? Enlist the primary pollutants involved.
6. How do radioactive pollutants impact aquatic ecosystems?
7. Explain the significance of the C:N ratio in soil. How does it affect nitrogen availability for plants?
8. What are the limitations of Flame Photometry?
9. What is the difference between PM 10 and PM 2.5, and why are they considered pollutants?
10. Differentiate between saline, acidic, and alkaline soils.

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss the chemical composition of the atmosphere, emphasizing the differences between the troposphere and stratosphere.
12. Compare and contrast the principles and applications of acidimetry, alkalimetry, and iodometry in water quality analysis..
13. Explain the relationship between organic carbon and organic matter in soil. Describe the formation and significance of soil humus.
14. Describe the principle of flame photometry and how it is used for quantitative analysis.
15. Explain the chemistry of acid rain formation. Discuss the environmental impacts of acid rain on terrestrial and aquatic ecosystems.
16. Detail the impacts of heavy metals and metalloids on living systems. Explain the specific toxic effects of heavy metals on human health and aquatic organisms.
17. Discuss the primary types of soil, their origins, and the evolutionary processes that lead to their formation. Explain the role of different particle sizes in determining soil texture and their impact on soil properties.
18. Describe the basic metallurgical operations involved in the extraction of pure Aluminium from its ore.

Section C

[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe the role of chlorofluorocarbons (CFCs) in ozone layer depletion. Explain the chemical mechanisms involved in this process, and discuss the environmental consequences of ozone depletion.
20. Explain the principle of Atomic Absorption Spectrophotometry. Describe the instrumentation involved and the applications of AAS in quantitative analysis.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ403 - ENVIRONMENTAL BIOLOGY III: ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Define GMOs and give an example.
2. Differentiate between bioaugmentation and biostimulation.
3. Define biopolymers. List three types of biopolymers and an application each.
4. Define acid mine drainage and identify the primary microbial group responsible for its formation.
5. List the characteristics of high-quality vermicompost.
6. What is MEOR?
7. List three microbial indicator organisms used to assess the microbiological quality of potable water.
8. Define commensalism and give an example of how it occurs in soil microbial communities.
9. Define environmental biotechnology and state its primary objectives.
10. Describe how the plankton community can be used as an indicator of water pollution.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Classify bio-pesticides. Explain the microbial bio-pesticide production process and their mode of action.
12. Define phytoremediation and discuss the critical factors that affect its efficiency. Elaborate on the different types of phytoremediation and mechanisms involved in each.
13. Describe the applications and advantages of biosensors for environmental monitoring.
14. Describe the composition of sewage and explain the different kinds of sewerage systems. Discuss the diverse groups of microorganisms found in sewage, including their roles and significance in sewage treatment.
15. Explain the purpose and key components of the Cartagena Protocol on Biosafety.
16. Discuss the process of bioleaching for metal recovery and its advantages and disadvantages.
17. Explain how lichens serve as effective bio-indicators of air pollution.
18. Explain the process of bioleaching of metals, highlighting the role of specific microorganisms.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the earthworm life cycle and the operating process of vermicomposting. Discuss the unique characteristics and advantages of vermicompost over traditional compost.
20. Describe in detail the various bacteriological analysis techniques used to assess water quality and the principles of these methods.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ404 - PARASITOLOGY I: GENERAL PARASITOLOGY AND NON-HELMINTH PARASITES

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. What were the major contributions of ancient civilizations to the field of parasitology?.
2. Give any two examples of parasitic diseases that have significant economic and social impacts.
3. Explain morphological adaptations in parasites
4. Explain the role of leaches in transmission of pathogens.
5. Explain the role of arthropods as vectors of parasites.
6. How does Leishmania cause disease in humans?
7. Describe the morphology of Entamoeba.
8. Explain the morphology of Phlebotomus.
9. Describe the life cycle of Tabanus.
10. Explain the medical importance of hemipterans.

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Explain strategies for preventing the transmission of parasites
12. How do social and cultural factors impact the epidemiology of parasitic diseases?
13. Explain the relationship between parasitism and altruism.
14. Describe the life cycle of Toxoplasma.
15. What are the different modes of transmission for parasitic protozoa?
16. Explain mosquitos as potential vectors of parasites.
17. Describe the lice of veterinary importance.
18. What are some common control measures for arthropod vectors?

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the classification of parasitic protozoa.
20. Describe parasite induced modifications of the host.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ405 - PARASITOLOGY II: HELMINTHOLOGY

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. What are the general characteristics of trematodes.
2. Classify Acanthocephala.
3. Explain the key features of Nematodes
4. What is the morphology of Polystoma?
5. How does Stilesia cause disease in animals?
6. Describe the morphology of Enterobius.
7. Describe the prophylaxis of nematode parasites.
8. What are the main characteristics of Bivalvia?
9. Describe the features of Indoplanorbis.
10. How do snails impact ecosystem?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe the parasitic adaptations of Cestoda.
12. Give an outline of Trematode life cycle.
13. What is the life cycle of Fasciola?
14. What are some common methods for diagnosing trematode infections?
15. Describe the morphology of Ascaris.
16. Describe the life cycle of Ancylostoma
17. What are some strategies for controlling snail populations in agricultural settings.
18. Describe the any two marine mollusks which serve as hosts.

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain the life cycle and pathology of any three cestode parasites.
20. Explain the features and life cycle of various filarial worms.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8EJ406 - PARASITOLOGY III: BIOCHEMICAL, MOLECULAR AND IMMUNO-LOGICAL ASPECTS OF PARASITISM

(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. How do intracellular parasites interact with their host cells?
2. How do parasites regulate nitrogen excretion?
3. How do apicomplexans metabolize energy?
4. What are the different phases of parasitism in the vertebrate alimentary canal?
5. Give any two examples of toxins, poisons, and secretions produced by parasites?
6. How do gene structures in protozoa differ from those in other organisms
7. Explain discontinuous transcription of mRNA.
8. What is the purpose of a biopsy in histological diagnosis?
9. How does the Complement fixation test work in diagnosing parasitic infections?
10. What are the advantages and limitations of histological and serological diagnosis?

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. What is the structure and function of the excretory system in parasites?
12. How do parasites regulate their energy sources and respiration?
13. Give any three examples of parasite-induced changes in host behavior
14. How do parasites interact with the mammalian blood system?
15. How does homologous gene recombination occur in parasites?
16. Describe chromosome and gene mapping in parasites.
17. What is the role of rDNA technology in parasitic diagnosis?
18. What are the different types of serological tests used in diagnosing parasitic infections

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Explain hormone interactions between hosts and parasites.
20. Describe the antigenic variation in protozoan parasites. Give treatment strategies against them.

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ407 :Forensic Biology I: Biological evidences and Forensic Biology

(credits:4)

Maximum Time: 2 hours **MaximumMarks:70**

Section A

[**Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)**

1. Sketch & Label the structure hair
2. Distinguish are secretors and non-secretors?
3. What are HLA antigens?
4. Explain different types of body fluids which are of forensic importance?
5. Write short note on blood group antigens?
6. Outline the possible sources of DNA for profiling?
7. Explain Bombay blood group?
8. What are the various types of fibres?
9. How do we infer in ABO blood grouping?
10. Differentiate human and non-human hair?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. Elucidate the forensic aspects of fibre examination?
12. Explain the macroscopic and microscopic features of hair?
13. Summarize on the different stages of hair cycle? Explain?
14. What is absorption elution method?
15. Point out the role of genetic markers in paternity disputes with case studies
16. What is PCR? Explain its types?
17. Show how the blood stains are individualized? Explain
18. Discuss on RNA extraction method from different forensic samples

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Summarize the different types of red cell enzymes – Genetics & Polymorphism? Point out the forensic importance of each one of them giving examples?
20. Explain DNA extraction techniques for different forensic samples with suitable flow diagrams

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ408 :Forensic Biology II: Wild life, Microbial Forensics, Forensic Medicine & Forensic Odontology

(credits:4)

Maximum Time: 2 hours **MaximumMarks:70**

Section A

Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Name some of the protected and endangered species of animals &plants
2. Differentiate cause, manner & mode of death
3. What are different wild life artifacts
4. Write a short note on forensic importance of Clostridium botulinum
5. What is cadaveric spasm
6. Explain thermal injuries
7. Explain the different types of wild life crimes
8. Draw and label the basic structure of human teeth
9. Explain Poaching
10. What are proteomics? Identify its application in bio-forensics?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. What is the forensic significance of pug mark?
12. Brief on wild life protection act 1972 & Point out its importance in forensic biology
13. Define mechanical injuries? Compile and comment the different types of mechanical injuries?
14. Elucidate the medicolegal aspects of death?
15. Explain the forensic importance of bite mark?
16. Explain early post-mortem changes?
17. What is epidemiology? Explain about the dynamics of disease transmission and outbreak investigation?
18. Generalize on the significance of microbes in soil for crime investigation|?

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Summarize the different fungi of forensic importance and also the role of anti-fungal agents?
20. What are the significant clues in investigation of hanging and strangulation death. Infer them in the light of forensic evidences?

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ409 :ForensicBiology III: Forensic Entomology

(credits:4)

Maximum Time: 2 hours **Maximum Marks:70**

Section A

[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

Section A

1. State the general characters of Diptera
2. Differentiate cleridae and carabidae family of insects on taxonomical basis
3. Explain the significance of entomological evidence in Forensic investigation
4. What are different types of ground crawling arthropods
5. Infer on the significance of clown beetles in forensic entomology
6. Paraphrase on the significance of entomological samples in estimating the post mortem interval
7. Paraphrase on larval rearing with models
8. List the factors influencing insect sucession on carrion
9. What is entomotoxicology
10. Brief on the entomological samples obtained from aquatic habitats

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. Infer on the role of aquatic insects in forensic investigations
12. Describe the general characteristics, taxonomy & biology of any 5 family of insects of forensic importance
13. Outline in brief the different stages of decomposition insects succession on carrion and infer on its relationship in determining time since death
14. Paraphrase on laboratory rearing of insects and point out the forensic significance of rearing insects
15. Point out the significance of entomological samples from buried remains of body in enclosed structures
16. Summarize on the various molecular methods in forensic entomology
17. Generalize on the significance of soil environment in forensic entomology
18. Describe the geographical and climatic factors affecting insect succession on carrion

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Explain the method of collection of entomological evidence during death investigations in different regions and comment on how its is taxonomically categorized into groups.
20. What is meant by succession of insects on carrion? Predict the importance of it in death investigations

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ410: MARINE BIOLOGY I: THREATS TO MARINE ECOSYSTEM

(credits:4)

Maximum Time: 2 hours **MaximumMarks:70**

Section A

[**Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)**

1. What were some of the major oceanographic expeditions that shaped our understanding of the ocean?
2. What is the role of plankton in marine ecosystems?
3. How do microplastics affect marine organisms and the marine food web?
4. What are the causes and consequences of coral reef destruction?
5. What is the significance of blue flagging of beaches?
6. What methods can be used to control invasive species in marine ecosystems?
7. What are the key provisions of the Indian Water Pollution Act?
8. Give any three examples of endangered marine organisms?
9. What is the role of marine sanctuaries in conservation efforts?
10. What are Large Marine Ecosystems (LMEs), and why are they important?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. Discuss the contributions of any two scientists for the development of marine biology as a field?
12. How is marine biodiversity distributed across different ecosystems and zones?
13. What are the impacts of organochlorine pesticides (DDTs) on marine ecosystems?
14. What are the ecological and economic importance of coral reefs?
15. How can ecosystem-based conservation and management be applied to restore marine ecosystems?
16. How can international cooperation and policy frameworks support marine ecosystem restoration and conservation?
17. What is the concept of EEZ (Exclusive Economic Zone), and how does it impact marine conservation?
18. What is Integrated Coastal Zone Management, and how does it relate to MPAs?

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Discuss the major threats to marine ecosystem diversity and function
20. Discuss the cause of marine pollution and strategies for reducing it.

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ411: MARINE BIOLOGY II: MARINE RESOURCES AND PLANKTONOLOGY

(credits:4)

Maximum Time: 2 hours **MaximumMarks:70**

Section A

[**Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)**

1. Give any two examples each for antibacterial, antifungal compounds derived from marine organisms?
2. Discuss examples of shellfish poisoning syndromes
3. How are biopolymers and novel enzymes obtained from marine organisms?
4. How are algae used in waste treatment?
5. What are single cell proteins, and how are they produced?
6. What is the definition of plankton, and how are phytoplankton and zooplankton classified?
7. What are some adaptations that enable plankton to thrive in their environments?
8. What preservation techniques are used to maintain the integrity of plankton samples?
9. What are Harmful Algal Blooms, and what are their impacts on marine ecosystems?
10. What are the food and feeding habits of zooplankton?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. What is the purpose of antimitotic assays in screening biomolecules?
12. How do marine toxins affect human health?
13. What are some pharmaceutical applications of algae
14. What are the key components of upstream and downstream processes in bioreactors?
15. What are the culture techniques used for commercially important zooplankton.
16. How do changes in plankton populations affect the marine food chain?
17. How are plankton used as indicator species, and what is their relationship to fisheries productivity?
18. What is diurnal-vertical migration in zooplankton, and what are its ecological implications?

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Discuss the potential applications of genomics in marine toxin research.
20. Discuss the ecological and economic importance of plankton.

VIII Semester B. Sc. (CUFYUGP) Degree Examinations, March 2028

ZOO8EJ412: MARINE BIOLOGY III: ADVANCES IN MARINE BIOLOGY

(credits:4)

Maximum Time: 2 hours **Maximum Marks:70**

Section A

[**Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)**

1. Describe the working of Rosette sampler.
2. How do researchers determine the optimal sampling locations and frequencies for water and sediment parameters?
3. Describe any one method used for collecting and preserving benthos.
4. What is the Census of Marine Life (CoML), and what was its significance in marine biodiversity research?
5. What is barcoding, and how is it used in marine organism identification?
6. How do artificial reef systems support marine biodiversity?
7. how do photobioreactors contribute to this field?
8. How do sea sponges filter water, and what are the potential applications of this technology in water purification systems?
9. How can bioluminescent-inspired lighting systems contribute to sustainable energy solutions?
10. What are the properties of shark skin that contribute to drag reduction in water?

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. How are acoustic instruments used in oceanographic research?
12. Describe the working of Spectrofluorometer.
13. How is niche breadth, niche overlap, and concordance calculated and interpreted?
14. Describe any three taxonomic databases used in marine research
15. What are the common methods used to control biofouling organisms, and what are their limitations?
16. How are invertebrates being studied for their problem-solving abilities, and what implications might this have for our understanding of cognition?
17. How can biomimicry-inspired designs improve the efficiency and speed of boats and other watercraft?
18. How can biomimicry-inspired biosonar technology be used in various applications,

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10Marks)

19. Elaborate applications of oceanographic research in fields such as environmental monitoring, climate change, and natural resource management
20. Discuss, how can biotechnological innovations be applied to mitigate the impacts of biofouling in marine environments.

EIGHTH SEMESTER BSc (CUFYUGP) DEGREE EXAMINATIONS
ZOO8CJ489: RESEARCH METHODOLOGY IN ZOOLOGY
(Credits: 4)

Maximum Time: 2 hours **Maximum Marks: 70**

Section A
[Answer All. Each question carries 3 marks] (Ceiling: 24 Marks)

1. Write short notes on selection of research problem
2. Briefly describe the ethical issues of using animals in research experiments
3. Briefly discuss the significance of literature review
4. Write short notes on R programme
5. Briefly discuss the significance of Excel programme in the analysis of research data
6. Provide a brief account on technical considerations in an oral presentation
7. Explain the importance of literature collection and documentation in research
8. Write short notes on copy right
9. Comment on impact factor
10. Write short notes on citation index

Section B
[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Discuss ethics in research
12. Describe the testing of research hypothesis
13. Briefly discuss different sources of data
14. Provide an account on reference management tools
15. Discuss the key points to make an effective poster presentation?
16. Explain different types of scientific reports
17. Discuss intellectual property right
18. Write notes on plagiarism

Section C
[Answer any one. Each question carries 10 marks] (1x10=10marks)

19. Describe different types of sampling methods in research
20. Discuss the layout of scientific documentation