ST. THOMAS COLLEGE (AUTONOMOUS)
THRISSUR

Affiliated to
UNIVERSITY OF CALICUT

SYLLABUS FOR DEGREE OF

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

SYLLABUS & MODEL QUESTION PAPERS
w.e.f. 2024 admission onwards

St. Thomas College Four Year Under Graduate Programme
[STCFYUGP]

RESEARCH & POSTGRADUATE DEPARTMENT OF ZOOLOGY

ST.THOMAS COLLEGE (AUTONOMOUS) THRISSUR

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Board of Studies of Zoology

St. Thomas College (Autonomous), Thrissur

1. **Prof. (Dr.) C F Binoy (Chairman, BoS)**

Dean of Science, Professor & Head

Research & PG Department of Zoology

St. Thomas College (Autonomous), Thrissur

2. **Prof. (Dr.) Sabu K. Thomas,**

Professor, Department of Zoology, University of Calicut

3. **Prof. (Dr.) Mani Chellappan**

Professor, College of Agriculture, Kerala Agricultural University, Thrissur

4. **Dr. Achuthan C Raghavamenon**

Associate Professor, Department of Biochemistry

Amala Cancer Research Centre, Thrissur

5. **Dr. Janeesh PA**

Assistant Professor, Department of Biochemistry

University of Kerala

6. **Dr. K. S. Rishad**

Research Coordinator, Unibiosys Biotech Research Labs, Cochin

7. **Dr. Vimala K John**

Assistant Professor, Research & PG Department of Zoology

St. Thomas College (Autonomous), Thrissur

8. **Dr. Joyce Jose**

Assistant Professor, Research & PG Department of Zoology

St. Thomas College (Autonomous), Thrissur

9. **Mr. Shaun Paul Adambukulam**

Assistant Professor, Research & PG Department of Zoology,

St. Thomas College (Autonomous), Thrissur

10. **Mrs. Sheeba Raphel**

Assistant Professor, Research & PG Department of Zoology,

St. Thomas College (Autonomous), Thrissur

PROGRAMME OUTCOMES (PO):

At the end of the graduate programme at St.Thomas College (Autonomus) Thrissur, a student would:

PO1:	**Knowledge Acquisition:** Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2:	**Communication, Collaboration, Inclusiveness, and Leadership:** Exhibit effective communication skills, fostering teamwork to demonstrate transformative leadership, exercising inclusivity.
PO3	**Professional Skills**: Apply professional skills to navigate diverse career paths with confidence and adaptability
PO4	**Digital Intelligence:** Utilize varied digital and technological tools proficiently to understand and interact with the digital world, effectively processing complex information.
PO5	**Scientific Awareness and Critical Thinking:**Solve problems innovatively and mediate effectively by applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	**Human Values, Professional Ethics, and Societal and Environmental Responsibility** Lead responsibly with a steadfast commitment to human values, ethical conduct, and dedication to the well-being of society and the environment
PO7	**Research, Innovation, and Entrepreneurship** Conduct research and lead entrepreneurial initiatives, forging collaborative partnerships with industry, academia, and communities to develop enduring solutions for local, regional, and global development

PROGRAMME SPECIFIC OUTCOMES (PSO):

At the end of the B.Sc. Zoology Honours programme at St.Thomas College, 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 STCFYUGP

<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">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="2">Intern-ship</th><th rowspan="2">Total Credits</th><th rowspan="2">Example</th></tr>
<tr><td colspan="2">Each course has 4 credits</td></tr>
<tr><td></td><td></td><td colspan="2"></td><td>Each course has 3 credits</td><td></td><td></td><td></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="8">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	**ZOO1CJ101/ ZOO1MN100**	Core Course 1 in Major – AN OVERVIEW OF HUMAN PHYSIOLOGY: LIFE SUSTAININGSYSTEMS	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 – Otherthan Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
2	**ZOO2CJ102 / ZOO2MN100**	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 – Otherthan Major	45	3	3	25	50	75
		Total		**23/ 25**	**21**			**525**
3	**ZOO3CJ201**	Core Course 3 in Major – SYSTEMATICS, EVOLUTION &ZOOGEOGRAPHY	60	4	4	30	70	100
	ZOO3CJ202/ ZOO3CJ200	Core Course 4 in Major – PRACTISESIN 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 – KeralaKnowledge 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	**ZOO4CJ203**	Core Course 5 in Major – ANIMAL DIVERSITY - I – NON CHORDATA	75	5	4	30	70	100
	ZOO4CJ204	Core Course 6 in Major – CELL BIOLOGY & GENETICS	75	5	4	30	70	100
	ZOO4CJ205	Core Course 7 in Major – BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTISES	75	5	4	30	70	100
	ENG4FV109(2)	Value-Added Course 2 – English	45	3	3	25	50	75
		Value-Added Course 3 – Additional Language	45	3	3	25	50	75
	ENG4FS111(2)	Skill Enhancement Course 1 – English	60	4	3	25	50	75
		Total		**25**	**21**			**525**
5	**ZOO5CJ301**	Core Course 8 in Major – ANIMAL DIVERSITY - II - CHORDATA	75	5	4	30	70	100
	ZOO5CJ302	Core Course 9 in Major – BIOSTATISTICS & BIO-TECHNIQUES	75	5	4	30	70	100
	ZOO5CJ303	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	**ZOO6CJ304/ ZOO8MN304**	Core Course 11 in Major – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	75	5	4	30	70	100
	ZOO6CJ305/ ZOO8MN305	Core Course 12 in Major– BASICS OF BIOTECHNOLOGY, & IMMUNOLOGY	75	5	4	30	70	100
	ZOO 6CJ306/ 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
	ZOO6FS113	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	**ZOO8CJ406/ ZOO8MN406**	Core Course 19 in Major – COMPUTATIONAL BIOLOGY & STATISTICAL APPLICATIONS	75	5	4	30	70	100
	ZOO8CJ 407/ ZOO8MN 407	Core Course 20 in Major – ADVANCES AND APPLICATIONS OF IMMUNOLOGY	60	4	4	30	70	100
	ZOO8CJ 408/ ZOO8MN 408	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 13 hrs/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	**ZOO2CJ102/ 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/ ZOOMN200	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
	ZOO4CJ 205	Core Course 7 in Major – BASICS IN AQUACULTURE AND FISHERY SCIENCE PRACTICES	5	4
5	**ZOO5CJ 301**	Core Course 8 in Major – ANIMAL DIVERSITY - II - CHORDATA	5	4
	ZOO5CJ 302	Core Course 9 in Major – BIOSTATISTICS & BIO-TECHNIQUES	5	4
	ZOO5CJ 303	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	**ZOO6CJ 304/ ZOO8MN304**	Core Course 11 in Major – FUNDAMENTALS OF BIOCHEMISTRY & MICROBIOLOGY	5	4
	ZOO6CJ 305/ ZOO8MN305	Core Course 12 in Major– BASICS OF BIOTECHNOLOGY, & IMMUNOLOGY	5	4

	ZOO6CJ 306/ ZOO8MN306	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/ ZOO8MN406**	Core Course 19 in Major – COMPUTATIONAL BIOLOGY & STATISTICAL APPLICATIONS	5	4
	ZOO8CJ 407/ ZOO8MN407	Core Course 20 in Major – ADVANCES AND APPLICATIONS OF IMMUNOLOGY	4	4
	ZOO8CJ 408/ ZOO8MN408	Core Course 21 in Major – ADVANCES IN BIOTECHNOLOGY & MICROBIAL PROCESSING	4	4
	OR (instead of Core Courses 19 – 21 in Major)			
	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

Sl. No.	Course Code	Title	Semester	Total Hrs	Hrs/ Week	Credits	Marks		
							Internal	External	Total
	ENTOMOLOGY								
1	**ZOO5EJ 301(1)**	ENTOMOLOGY - I- STRUCTURE, ADAPTATIONS AND CLASSIFICATION OF INSECTS	5	60	4	4	30	70	100
2	**ZOO5EJ 302(1)**	ENTOMOLOGY - II- AGRICULTURAL ENTOMOLOGY	5	60	4	4	30	70	100
3	**ZOO6EJ 303(1)**	ENTOMOLOGY - III- INSECT ECOLOGY	6	60	4	4	30	70	100
4	**ZOO6EJ 304(1)**	ENTOMOLOGY - IV- INSECT PEST MANAGEMENT	6	60	4	4	30	70	100

ELECTIVE COURSES IN ZOOLOGY WITH NO SPECIALISATION

1.	**ZOO8EJ 407**	FORENSIC BIOLOGY - I - BIOLOGICAL EVIDENCES & FORENSIC SEROLOGY	8	60	4	4	30	70	100
2.	**ZOO8EJ 408**	FORENSIC BIOLOGY -II - WILDLIFE FORENSICS AND FORENSIC MEDICINE	8	60	4	4	30	70	100
3.	**ZOO8EJ 409**	FORENSIC BIOLOGY -III - FORENSIC ENTOMOLOGY	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	**ZOO1MN 101**	FUNDAMENTALS OF ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR	1	75	5	4	30	70	100
	2	**ZOO2MN 101**	INTRODUCTORY HUMAN PHYSIOLOGY	2	75	5	4	30	70	100
	3	**ZOO3MN 201**	ANIMAL DIVERSITY, REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY	3	75	5	4	30	70	100
2		**HUMAN PHYSIOLOGY**								
	1	**ZOO1MN 102**	FUNDAMENTALS OF CELLULAR PHYSIOLOGY	1	75	5	4	30	70	100
	2	**ZOO2MN 102**	NEUROPHYSIOLOGY	2	75	5	4	30	70	100
	3	**ZOO3MN 202**	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
1		**APPLIED ZOOLOGY**								
	1	**ZOO1VN101**	BASICS IN ENTOMOLOGICAL, POULTRY SCIENCE AND DAIRY SCIENCE APPLICATIONS	1	75	5	4	30	70	100
	2	**ZOO2VN101**	AQUACULTURE AND FISHERY SCIENCE PRACTISES	2	75	5	4	30	70	100

	3	**ZOO3VN201**	FOUNDATIONS OF BIOSTATISTICS AND BIOTECHNIQUES	3	75	5	4	30	70	100
	4	**ZOO8VN301**	COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATIONS	8	75	5	4	30	70	100
2		**SKILL ZOOLOGY**								
	1	**ZOO1VN102**	ECOLOGICAL TOOLS AND TECHNIQUES	1	75	5	4	30	70	100
	2	**ZOO2VN102**	FOOD PROCESSING & QUALITY CONTROL	2	75	5	4	30	70	100
	3	**ZOO3VN202**	LIFE SKILL TECHNIQUES	3	75	5	4	30	70	100
	4	**ZOO8VN302**	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
2.	**ZOO2FM106(3)**	Multi-Disciplinary Course 2 –BIOLOGY FOR COMPETITIVE EXAMS	45	3	3	25	50	75
3.	**ZOO3FV108**	Value-Added Course 1 – HEALTH - A HOLISTICAPPROACH	45	3	3	25	50	75

4.	**ZOO4FV110**	Value-Added Course 2 – ECOLOGICAL ECONOMICS& SUSTAINABLE LIFE	45	3	3	25	50	75
5.	**ZOO5FS112**	Skill Enhancement Course 2 – LABORATORY EQUIPMENT MAINTENANCE & MUSEUMCURATION	45	3	3	25	50	75
6.	**ZOO6FS113**	Skill Enhancement Course 3 – ITSKILS 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*/ ZOO2MN 100	Core Course 2 in Major Zoology – ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR (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)	Multi-Disciplinary Course 1 in Zoology – NUTRITION, HEALTH & HYGIENE	45	3	3	25	50	75
		Total		**24/ 25**	**21**			**525**
2	**ZOO2CJ 101/ZOO4CJ 203***	Core Course 3 in Major Zoology – ANIMAL DIVERSITY - I – NON CHORDATA	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(3)	Multi-Disciplinary Course 2 in 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 – PRACTISES 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/ ZOO4CJ 204***	Core Course 6 in Major Zoology – CELL BIOLOGY & GENETICS	75	5	4	30	70	100
		Core Course 6 in Major B	60/ 75	4/ 5	4	30	70	100
	ZOO4CJ 204/ ZOO4CJ 205*	Core Course 7 in Major Zoology – BASICS IN AQUACULTURE & FISHERY SCIENCE PRACTISES (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 302/ 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 303/ 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)

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 102 / 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
	ZOO2CJ103/ ZOO4CJ 204*	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	45	3	3	25	50	75

		BIOLOGY FOR COMPETITIVE EXAMS						
		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 – PRACTISES 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 / ZOO6FS 113	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	**ZOO6CJ302/ 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 303/ ZOO6CJ 306*/ ZOO8MN 306	Core Course 9 in Major Zoology – 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
		ElectiveCourse 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	-
		20	10	10	20*
	Total	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 scheme of continuous evaluation and the end-semester examination and viva-voce of practical component shall be as given below:

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 College 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.

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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 andViva-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 College or any other College/ HEI can offer the Honours with Research programme.
- A faculty member of the 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 College/Department.

The scheme of continuous evaluation and the end-semester viva-voce of the Project shall be as given below: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 College	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	100

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
		20	5
	Total	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 College 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.

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

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 STCFYUGP shall be calculated by the followingformula

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

  CGPA for the four-year programme in STCFYUGP shall be calculated by the followingformula.

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

- 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 College shall issue the transcript for each semester and a consolidated transcript indicating the performance in all semesters.

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				
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

Course outcomes (CO)CourseCO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Examine the structural and functional organization of human body[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Analyse the mechanism of transport and exchange of respiratory gases and itscontrol[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Analyse different components of blood and various blood groups; cardio-vascular problems[PSO1]	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Identify the different types of neurons; Analyse the 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[PSO3]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Impliment the skills in estimating and enumerating blood parameters; calculating BMI, measuring the respiratory volumes, etc. [PSO4]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Identify the mechanism of excretion and its hormonal control; enumerate common renal disorders in man.[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 1 x 3 = 3marks, paragraph 1 x 6 = 6 marks; Module 2 : short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; Module 3 : short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks ; Module 4 : short answer 3 x 3= 9 marks, paragraph 3 x 6 = 18 marks.

Module 1: Unit 1: Introduction to human physiology :(3 hrs)

Branches of human physiology, (self study) Components of body system, Human body systems and functions, vital and non vital organs, Levels of physiological regulation: Intracelluar, local andextrinsic regulation. Homeostasis,

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

Unit 1: Respiration (8 hrs): Basic structure of respiratory and circulatory system (self study/assignments) 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;; Nervous and chemical control of respiration, Clincal significance:Carbon monoxide poisoning 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,

Clincial significance: 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)

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):

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): Structure of Excretory system (Self study/assigniments) 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 clinical 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)
5. Calculation of BMI
6. Recording of Blood pressure using a sphygmomanometer
7. Anthropometry other than BMI

Of the remaining experiments any 4 can be selected by the Supervising teacher from the followinglist.

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

Field study: A) Visit to Anatomy Museum B) Visit to Diagonostic 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

SUGGESTED READINGS

- 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

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 :

	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				4					3				
CO6		3					3						

ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOR

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	Analyse 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 [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
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.. [PSO1]	R	F	Assignments,Seminars, Class test & Semester Exams
CO3	Explain the 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. [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Examine the sociobiology of different animals, the concept of social organisation in animals, and the concept of proximate factors[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams

CO5	Develop skill in estimating ecological parameters like dissolved Oxygen, Carbondioxide, pH etc. . [PSO4]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Examine the characteristics of different types of ecosystems, pattern of flow of materials and energy in ecosystem, etc.	U	F&C	Assignments,Seminars, Class test & Semester Exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Question paper pattern for external examination: Module 1 : short answer 3 x 3 = 9 marks, paragraph 1x 6 = 6 marks, Essay 1 x10 = 10 marks ; Module 2 : short answer 2 x 3= 6 marks, paragraph 2x 6 =12marks,; Module 3 : short answer 2 x 3= 6 marks, paragraph 3x 6 = 18 marks; Module 4 : short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks

Module 1. Ecosystem (12hrs)

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- Autoecology, 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)

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 &loitic habitats- its characteristics. Faunal characteristics & adaptations.

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

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

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, 2002; 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)

Unit 1: Foundations of Ethology(02hrs*)*-Introduction and historical development of ethology, Contributions of Konard Lorenz,Von Frish &Niko Tinbergen, 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, Sign stimuli,.Fixed action patterns (FAPs) and releaser stimuli. Examples of instinctive behavioursin different species.

Unit 3: Acquired behaviour/Learned behaviour & Memory (02hrs): Habituation, Conditioned reflex, latent learning, Imprinting, Habituation and Trial and error and learning with suitable example.Memory & types of memory

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 and Ultimate factors

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS (ANY 3)

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 Supervising Teacher from the followinglist.

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/ Cole624pp

- 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. - College of Chicago Press 576pp
- Manning, O.2016 Introduction to Animal behaviour South Asia Ed, 6th Ed. Cambridge College Press, India 456pp
- Mathur, R. 2022 Animal Behaviour -Visionias 676pp
- Alcock, J. 2005 Animal Behavior - SP Oxford College Press 556pp

Capping 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						

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			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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO3	Analyse the various theories on evolution, the concept of species and speciation; and the factors leading to speciation	U	F&C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO5	Develop general awareness on Evolutionary principles by presenting seminars and debates,	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Examine the difference between the evolutionary principles and the mythological features and stories, identify the pseudoscience elements ingeneral beilief.	Ap	C&M	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 2x 3 = 6marks, paragraph 1x 6 = 6marks, Essay1 x10 = 10 marks; Module 2 : short answer 2x 3= 6marks, paragraph 2 x 6 = 12marks, Essay x10 = marks; Module 3 : short answer 2x 3=6marks, paragraph 3x 6 = 18marks ; Module 4 : short answer 4 x 3= 12marks, paragraph2 x 6 = 12marks.

Module 1: Systematics (10hrs)

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)

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 (7hrs)- 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, Geological Timescale-evolution of horse, Archaeopteryx.

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

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

Module IV Zoogeography (10hrs)

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: Experiential learning in Systematics, Evolution & Zoogeography (12hrs)

1. Observe any two common animals in your locality and classify it upto the species level
2. Study of geological time scale and evaluate the evolution of any 4 major animal groups (invertebrates, fishes, amphibians, reptiles, mammals and man)
3. Study of homologous organs and its evolutionary significance
4. Study of divergent evolution and adaptive radiation and its evolutionary significance
5. Study of analogous organs and its evolutionary significance
6. Study of convergent evolution and parallel evolution and its evolutionary significance
7. Study of vestigial organs and its evolutionary significance
8. Study of connecting links and its evolutionary significance
9. Study of different zoogeographical realms and plot them in a world map
10. Study of different biogeographic zones of India and plot them in a geographic map of India
11. Mark Wallace line, Webers line &Wallacea in a world map
12. Mark the distribution of Peripatus, lungfishes and Sphenodon in a world map

The teacher can design student activities like assignments, seminars, debates collection of notes/reference materials related to the topics of module 2&3,, 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

- The Zoogeography: The geographical distribution of animals. Darlington, P.J.
- 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				4	3			3					
CO6					3						3		

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-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 statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyse 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	Assignments,Seminars, Class test & Semester Exams
CO2	Identify 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	Assignments,Seminars, Class test & Semester Exams
CO3	Demonstarte various traps and other physical meansto control insect pests	U	F&C	Assignments,Seminars, Class test & Semester Exams

CO4	identify different breeds of cattle and fowls for various purposes, different appliances and parts of cattle and poultry rearing houses	R	F	Assignments,Seminars, Class test & Semester Exams
CO5	Develop the skills to maintain Bee hives, Silkworm rearing houses and insect traps in a scientific way.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Examine different species of honey bees and silkworms for their rearing characteristics	U	F&C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: Module 1 : short answer 3x 3 = 9marks, paragraph 1x 6 = 6marks, Essay1 x10 = 10 marks; Module 2 : short answer 2x 3= 6marks, paragraph 2 x 6 = 12marks, Essay x10 = marks; Module 3 : short answer 2 x 3=6 marks,aragraph 2x 6 = 12marks ; Module 4 : short answer 3 x 3= 9 marks, paragraph3 x 6 =18marks.

Module 1: Apiculture (12Hrs)

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 Beekeeping; 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)

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 (7hrs)- 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)

Unit 1 : Insect traps (5hrs) – Passive traps: Window flight trap, barrier trap, Malaise trap, cone trap, pan trap, bucket trap, Aquqtic 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)

Unit 1: Dairy cattle breeding (3hrs)- Diffeent breeds fof 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 Major diseases of cattle and its prevention ,control (2hrs)**Introduction Disease,

1 Pathogens, Disease Transfer 2 Bacterial Diseases 3Viral Diseases 5 Fungal Diseases 6 Parasites 7 Parasites 8 Parasites 9 Noninfectious Disease 10 Noninfectious Disease 11 Zoonosis 12 Biosecurity 13 Epidemiology, Vaccination

Unit 4: Current status of Indian poultry industry (3hrs)- avian biology and welfare; breeds and varieties of poultry, poultry breeding and genetics.

Unit 5: Physical requirements of incubation and hatchery management(2hrs)- 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 Supervising Teacher from the followinglist..

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)

FieldStudy: 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(Meliponidae).
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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- B. V. David and V.V. Ramamurthy. 2016. Elements of Economic Entomology. 8thEdition. ISBN: 9780994869104, 099486910X, Brillion Publishing. 400 pages.
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- 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
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Online Sources

1. https://www.vedantu.com/biology/apiculture-and-sericulture

2. https://elearning.icar.gov.in/eLearning_ContentDisplayUG.aspx?CourseCode=7UV3MOEAK1USxrGrYOy7VQ==&CourseName=AabP6XqFFfb5/FvzYT1aGGZAlW05pNbzZ1x4ZpuEo2OXSkGj/DaCsEk/HLGqrq6CbisPvpLgM4vZ7EWBwZLlPjc1awujk2II9I0w21IPwEM=
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 :	PSO 1	PSO 2	PSO 3	PSO4	PSO5	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				
CO6		3					3						

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	Assignments,Seminars, Class test & Semester Exams
CO2	Analyse the evolutionary history and relationships of different non-chordates	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Outline the classification and compare the specified protists, acoelomates, pseudocoelomates and coelomates non-chordate phyla.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Analyze the organization, complexity and characteristic features of non- chordates of various animal phyla.	An	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Explain the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO6	Develop skills in 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	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: Module 1*: short answer 3 x 3 = 9marks, paragraph 2 x 6 = 12 marks;* ***Module 2:*** *short answer 1 x 3= 3 marks, paragraph 2 x 6 = 12marks, Essay 1 x10 = 10 marks****; Module 3:*** *short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks;* ***Module 4:*** *short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks,*

Module 1: Protists to Animals (10 hrs)

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)

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 AnthozoaClass 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)

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*,*Troidesminos*(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 ClassEchinoidea(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).

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- Any two
P*erna,/inctada, Sepia/ Loligo*
Harmful forms – *Teredo*, Any one Insect pest *Spodoptera mauritia / Oryctes rhinoceros*

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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand 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 :

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

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 the following online courses				
Course objectives	n understanding in the cellular organization, geneconcept and c.				

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyse the life cycle of cells, aging of cells, apoptosis and its deregulation in diseases such as cancer.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the ultrastructure and important functions of plasma membrane as well as membraned and non-membraned cell organelles	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain chromosomal inheritance, Mendel's contributions, allelic and non-allelic interactions, structure & classification of human chromosomes	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Distinguish genes; gene types, gene bank, gene cloning, gene mapping, genome sequencing and different modes of inheritance	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Develop skill to perform experiments like, staining of epithelial cells, blood cells, chromosomes of onion and drosophila.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Conduct surveying to find out the intensity of occurrence of various genetic traits in local population.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1****: short answer 3 x 3 =9marks, paragraph 2 x 6=12 marks;* ***Module 2:*** *short answer3 x 3= 9marks, paragraph 2x 6 = 12marks, Essay 1 x10 = 10 marks;* ***Module 3****: short answer2 x3= 6marks, paragraph1 x 6=6marks, Essay1 x10 = 10marks;* ***Module 4:*** *short answer 2x 3= 6marks, paragraph3x 6 = 18marks,*

Module 1: Cell - life cycle (12 Hrs)

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)

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 (2 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: Ribosomes (1 Hrs) - Ultra structure and functioning

Unit 5: Centrosome and (2 Hrs) - Location, ultrastructure and functions.Centrosome cycle.

Unit 6: Cytoskeleton. (**1 Hrs)** Microtubules, Microfilaments and Intermediate filaments Ultrastructure, and functions

Module . 3 Factors of Inheritance (12 Hrs)

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)

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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Lodish, H. Berk A, Zipursky SL, et al., 2000: Molecular Cell Biology, 4th edition., W.H. Freeman, New York.

Susan Mahler Zneimer (2016) Cytogenetic Laboratory Management: Chromosomal, FISH andMicroarray-Based Best Practices and Procedures;1st Edition, ISBN-10: 9781119069744, Wiley- Blackwell.

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	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				3				
CO6				3	3	3		2	3				3

BASICS IN AQUACULTURE AND FISHERIES 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				

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

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. [PSO1, PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the concepts of pond culture, pen culture, cage culture and other advanced culture systems [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain different types of tools used in fishing and resource utilization[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Explain induced breeding of fish and hatcherytechnology; fish disease diagnosis	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO5	Develop expertise in setting up and maintenance of different types of aquaculture systems in commercial level. [PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Prepare field reports on visiting aquaculture systems, fish processing centers and fish landing centers [PSO6]	C	M&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1: short answer 3 x 3 marks = 9marks; Module 2: short answer4 x 3 marks= 12marks, paragraph 3 x 6 marks= 18marks; Module 3: short answer1 x3 marks= 3marks, paragraph3 x 6marks =18marks,Essay1 x10 marks = 10marks; Module 4: short answer 4x 3 marks= 12marks, paragraph2x 6 marks = 12marks, Essay 2 x10marks = 20 marks

Module 1: Unit 1: Introduction to Aquaculture (6hrs)

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)

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)

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)

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 one from each). 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.

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. Making of culture devices: rafts for mussel culture, happa for fish culture etc.
7. Water quality analysis of aquaculture systems
8. Culturing of any commonly available culture fishes in synthetic tanks, ponds e

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 :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	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

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:				
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: Upon completion of this course, students will be able to:

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Analyse the salient features and examplesof 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	Creates a conservation programme for endangered/endemic species incorporating sustainable practices	C	F C P &M	Project 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)				

Question paper pattern for external examination: Module 1: short answer 3 x 3 = 9marks, paragraph 2 x 6 = 12 marks; Module 2: short answer 1 x 3= 3 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; Module 3: short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks; Module 4: short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks

MODULE I. Protochordates to Tetrapods (11 hours)

Unit 1. Introduction to Chordates(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 DivisionII – 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*

Sub-terranean fishes from Kerala: Aenigmachanna gollum (Gollum Snakehead), Kryptoglanis shajii, Horaglanis krishnai (Blind Catfish) & Monopterus digressus (Blind cave eel). Mention recent addition to ornamental fish trade - Sahyadria denisonii (Miss Kerala).

Self study topics：

1. Migration of fishes 2. Parental care in fishes 3Accessory respiratory organs in fishes

4 Economic importance of fishes. ,5 Adaptations of hill stream fishes, and deepsea fishes

6 Luminous organs in fishes, 7 Air Bladder Accessory Respiratory organs in fishes,

8 swim bladder and its modifications, electric organs in fishes 9, Poisonous and venomous fishes,

10 Larvicidal fishes,

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

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,

Characteristicfeatures 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., *Chamaeleo zeylanicus*

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)

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., *Eudynamys scolopaceus*

Order Psittaciformes e.g., *Psittacula krameri*

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 withspecified 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., *Paraechinus nudiventris*

Order Chiroptera e.g. *Pteropus giganteus, Latidens salimalii*

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)

Unit 1. Ecologically important chordates from Kerala

Sub-terranean fishes from Kerala:

Mention *Pangiopathala, Kryptoglanisshajii, Horaglanis populi, Monopterus, Rakthamichthys indicus, Aenigmachanna gollum*

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 –*Tylototriton verrucosus (*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]*Ptyasmucosus*c] *Gongylophis*(= *Eryx*) *conicus*d] *Indotyphlops braminus*e] *Bungarus caeruleus* f] *Naja naja*g] *Daboia russelli*ih] *Ophiophagus hannah*

Identification key for venomous and non-venomous snakes

Endemic birds of the Western Ghats

Myophonus horsfieldii (Malabar Whistlingthrush), *Leptocoma minima* (Crimson-backed Sunbird), *Anthus nilghiriensis* (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

Nasikabatrachus sahyadrensis

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

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

Recent Extinctions: Passenger Pigeon [*Ectopistes migratorius*), Dodo [*Raphus cucullatus*],

Pink-headed Duck [*Rhodonessa caryophyllacea*], 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 and assignthem to the 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 Supervising Teacher from the followinglist..

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.Locatethedistributionoffollowinganimalsintheworldmap:Lungfishes,*Sphenodon,* monotremes, marsupials

11. Study on different types of Feather, Structure and Adaptations

12. Morphometric measurements of fishes

13. **Local Biodiversity Record:** Observe Fishes/Amphibians/Birds/Mammals of the locality in their natural habitat andprepare a field note (Minimum 15 specimens should be recorded with geo tagged photographs.).

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 :

	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						2

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 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	Describe various data collection and presentation methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Perform various data analysis procedure using the given data	Ap	C&P	Assignments,Seminars, Class test & Semester Exams

CO3	Describe the procedures for centrifugation, electrophoresis, chromatography etc.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Explain DNA extraction and purification and histochemical tissue preparation methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Develop skills to Perform experiments related to biostatistics and tissue processing techniques	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Compare the merits and demerits of different techniques for molecular, cutological and histological studies	U	F&C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: ***Module 1*** *: short answer 2 x 3 = 6marks, paragraph 2 x 6 = 12 marks;* ***Module 2*** *: short answer 2 x 3= 6 marks, paragraph 2x 6 = 12 marks, Essay 1 x10 = 10 marks;* ***Module 3*** *: short answer 2 x 3= 6marks, paragraph 2x 6 = 12marks , Essay 1 x10 = 10 marks ;* ***Module 4*** *: short answer 4 x 3= 9 marks, paragraph 2x 6 = 12marks.*

Module 1 Data – Collection and Presentation (7Hrs)

Unit 1: Introduction (2hrs) - Definition; Applications; Terminology, variables. Limitations of statistical methods.Why statistics in Biology?

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 (1Hr)

Unit 3: Presentation of data (3hrs) - 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). (SELF STUDY)

All this using MS EXCEL WILL BE DISCUSSED IN THE CLASS

MODULE 2 Data Analysis **(15 Hrs)**

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. (7Hrs) 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(7hrs)- Introduction to the concept of Hypothesis testing Parametric and Non parametric tests Examples of Statistical hypothesis testing i)'t' test, ii) chi square test iii) F-test (One Way ANOVA) Problems to be discussed .Concept of Ecological statistics

MODULE 3 (12 Hrs)

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) (6Hrs)

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)

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

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Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

01. Calculate the mean, median and mode (raw data, discrete series & continuous series) for the given data manually and using MS EXCEL
02. Calculate the standard deviation of the given set of data (raw data, discrete series & continuous series). manually and using MS EXCEL
03. Demonstration of Paper Chromtography/Centrifugation- Pipetting and dilution technique
04. Staining any tissue sample (serial sectioning) and whole mount preparation
05. Draw a pie diagram using suitable data
06. Measure the size of two set of samples and present the data in a suitable graphical form. Compare using t-test.
07. Measure the size of given shells / any sample of data and represent it in a graphicalform and interpret it.
08. Construct a frequency curve and frequency polygon with mean ± SD using suitable data.

Of the remaining experiments any 4 can be selected by the Supervising Teacher from the followinglist.

09. Draw a bar diagram with mean ± SD employing suitable data. Construct a histogram with mean ± SD utilizing suitable data.
10. Demonstration of PCR set up and optimization
11. Demonstration of any one type of Electrophoresis
12. Karyotyping of the given sample.
13. Demonstration of PCR set up and optimization
14. Demonstration of any one type of Electrophoresis
15. 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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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						

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	48	12	60
Pre-requisites	+2 /VHSC Biology or the following online courses 1. https://onlinecourses.swayam2.ac.in/nou24_bt05 2. https://onlinecourses.nptel.ac.in/noc24_bt03 3. https://onlinecourses.nptel.ac.in/noc24_bt07				
Course objectives	The course aims to develop an outlook on basic cocnepts in Molecular biology and Bioinformatics				

Course outcomes

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	Assignments,Seminars, Class test & Semester Exams
CO2	Describe transcription, translation and protein targeting mechanisms in prokaryotes and eukaryotes.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe gene regulation and diverse regulatory mechanisms in prokaryotes and eukaryotes.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Analyze major biological databases, demonstrate proficiency in sequence analysis, and utilize search engines for effective data retrieval and submission.	An	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Apply genomics and proteomics tools for comprehensive molecular analysis and drug discovery in bioinformatics and Comprehend molecular phylogenetics.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Identify appropriate model organisms, genetic engineering technique and bioinformatic tools for advanced research and biotechnological applications.	An	C&M	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination**: **Module 1** : short answer 2 x 3 = 6marks, paragraph 2 x 6 = 12 marks; **Module 2 :** short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; **Module 3** : short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks ; **Module 4** : short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks,*

Module 1: GENOME ORGANIZATION (10 Hrs)

Unit 1: Basic Concepts of genome (2 hrs): Importance of Molecular Biology, Central Dogma of Molecular Biology, Nucleic acid as the genetic material (Griffith'sexperiment and Hershey-Chase experiment),

Unit 2:Structure of Nucleic acids(5hrs) : Nucleosides and nucleotides, purines and pyrimidines, biologically important nucleotides. Nucleic acids, Watson and Crick model of DNA structure, A, B &Z forms of DNA, RNA structure and types of RNA (mRNA, tRNA, r RNA) Supercoiled and relaxed DNA, denaturation and renaturation of DNA, melting temperature (Tm), hyperchromic effect, Cot Curve

Unit 3: Genome and its organization (3Hrs) 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)

self study Genetic Code, its characteristics and exceptions, Genetic Code Dictionationary, Wobble hypothesis

Module 2: DNA REPLICATION AND GENE EXPRESSION(14Hrs)

Unit 1: Replication of DNA (3Hrs): DNA replication in prokaryotes and eukaryotes, semiconservative nature of DNA replication, Uni-directional and bidirectional DNA replication. DNA Repair mechanisms (brief account only)

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; Components of Protein synthetic machinery: Messenger RNA, tRNA function, Charging of tRNA, aminoacyl tRNA synthetases, ribosome structure and assembly, Mechanism of protein synthesis in prokaryotesand 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: lac operon & trp operon concept; RNA mediated gene silencing(si RNA, mi RNA and RNAi) *

Module 3:INTRODUCTION TO BIOINFORMATICS (14hrs)

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 (, Genbank); Protein databases (Primary-Swiss Prot, PIR, and Secondary-PROSITE, PRINTS); Metabolite databases (KEGG, EcoCyc) SpecializedGenome databases: (VirGen, GOLD, TIGR). Structure databases (PDB, NDB) Special databases – CATH, OWL, PubMed.

Unit 2 :Database Search Engines (2Hrs): Entrez at NCBI of USA, Data retrieval with Entrez.Sequence submissionto 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 Omega and COBALT

Module 4: -OMICS in Bioinformatics and its application (10hrs):

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 Chemoinformatics

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.

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)

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

1. downloading sequences from DNA
2. comparing using BLAST
3. building phylogentic trees

4. molecule modelling

(Example Molecular docking/Protein-Protein docking). Introduce widely used software such as Pymol and VMD. Machine learning in bioinformatics,Mention Modern AI techniques in biology (Example Support vector machines/Neural networks/deep learning).

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- 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 (8^{th} 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

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

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			60
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives	The student gains knowledge of Structure and adapataions of insects.Also get knowledge of different orders of insects				

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	Assignments,Seminars, Class test & Semester Exams
CO2	Analyse the morphological adaptations of insects and assess the role of these adaptations.	R, U & An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the insect classification, taxonomic tools and curation techniques for insects.	R, U	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Critically assess the morphology and biology of five hyper-diverse orders namely Coleoptera, Hemiptera, Hymenoptera, Lepidoptera and Diptera.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Develop skill to collect, preserve and curate different insect groups	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Analyse the life stages of holometabolus and hemimetabolous insects.	U	C &F	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination: Module 1** : short answer x 3 = marks, paragraph x 6 = marks, Essay x 10marks = marks; Module 2 : short answer x 3 = marks,*

paragraph x 6 = marks, Essay x 10 = marks; Module 3 : short answer x 3 = marks, paragraph x 6 = marks; Module 4 : short answer x 3 = marks, paragraph x 6 = marks.

Module 1. Introduction to Insect Morphology (10hrs)

Insect Diversity and Abundance - Specialties of insects and the causes of the success of insects over other creatures

Overview of insect body plan and morphology Insect body regions-head, thorax, and abdomen, Insect cuticle, sclerites, and external processes

Module 2: **Insect Adaptations(11hrs)** Head: Segmentation, structure, modifications, Insect mouth parts and their modifications, Insect antennae and their modifications, photoreceptors (compound and simple eyes), Thorax: Segmentation, structure, legs, and their modifications, wingsand their modifications; wing venation, Abdomen: Segmentation, structure and their modifications.

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

Module 4: Hyper-diverse Orders of Insectsn(15hrs)

Bugs: Hemiptera - Classification and characteristics of economically important families (Belostomatidae, Pentatomidae, Cicadidae,Coccidae,Aphididae)

Beetles: Coleoptera - Classification and characteristics of economically important families (Carabidae, Chrysomelidae, Curculionidae, Scarabaeidae, Cerambycidae)

Moths and Butterflies: Lepidoptera - Classification and characteristics of economically important families (Papilionidae, Nymphalidae, Noctuidae, Saturniidae, Pyralidae)

Flies: Diptera - Classification and characteristics of economically important families (Tachinidae, Asilidae, Oestridae, Culicidae, Chironomidae).

Module 5: Experiential learning in Entomology

1.Collection, processing and curation of common insects of Orders Coleoptera, Lepidoptera, Hemiptera, Orthoptera,Odonata, Hymenoptera and Diptera and submit any 10 common insects.

2.Observe and study the different life stages of hemimetabolous and holometabolous insects

3.Observe and study the different types of antennae in insects

4.Observe and study the different types of legs in insects

5.Observe and study the different types of mouthparts in insects

6.Observe and study the different types of insect larvae and pupae

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 College 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 College Press. ISBN:9780521821490. 755 pages.
- Dunston P. Ambrose. 2015. Insects: Structure, Function and Biodiversity. Kalyani Publishers. ISBN:9789327251746. 626 pages.

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

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	4	1	60
Pre-requisites	+2 /VHSC Biology or the following online courses				
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.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Analyze and describe the various insect habitats in agricultural landscapes.	R, U & An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Analyze factors influencing insect population dynamics, including abiotic and biotic factors.	R, U	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Recognize and assess the symptoms of pest damage on crops.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO6	Develop skill to collect, preserve and curate insects of different orders, and	U & Ap	C &F	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: Module 1*: short answer x 3 = marks, paragraph x 6 = marks, Essay x10marks = 10 marks; Module 2: short answer x 3= marks, paragraph x 6 = marks, Essay x10 = marks; Module 3: short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks; Module 4: short answer x 3= marks, paragraph x 6 = marks, Essay x10marks = marks*

Module 1:Unit 1: Introduction to Agriculture Entomology:(12 hours)

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

Pests in agroecosystem - definition – classification into insects and non-insects with examples, categories of pests – based on occurrence - based on level of infestation - basedon percentage of crop loss they cause with examples, pest outbreak-definition-reasons, Impactof global warming on pest status. Pest surveillance and pest forecasting.

.

Module 2: Unit 1:Insect pests affecting crops of Kerala - I (16 hours)

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. *Exelastis atomosa*

Pests of Coconut 1. *Oryctes rhinoceros* 2. *Opisina arenosella* 3. *Rhynchophorus ferrugineus.* Mention damage caused by *Aceria guerrironis*

Pests of Gingelly 1. *Antigastra catalaunali* 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:Unit 1:Insect Pests Affecting Crops of Kerala – II (10 hours)

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

Pests of Spices and Condiments

Pest of Ginger & Turmeric 1. *Formosina flavipes* 2. *Chalcidomyia atricornis*

Pest of Cardamom 1. *Sciothrips cardamomi* 2. *Eupterote canarica*

Pest of Pepper 1. *Lanka ramakrishnai 2*. *Laspeyresia hemidoxa*

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*

Pests of vegetables:

Pest of Lady's finger 1. *Sylepta derogata* 2. *Earias vitella*

Pest of Brinjal 1. *Leucinodes orbonalis* 2. *Henosepilachna vigintioctopunctata*

Pest of Cucurbits 1. *Bactrocera cucurbitae* 2. *Raphidopalpa foveicollis*

Module:4 Unit 1:Insect Pests Affecting Crops of Kerala – III (10 Hours)

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

Pest of stored products

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

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*

Polyphagous Pests- Locust, Termites

Module 5: Experiencial Learning (12hrs):

Collection, observation, processing and cod of common insect pests of Orders Coleoptera, Lepidoptera, Orthoiptera,Odonata, Hymenoptera and Hemiptera and submit any10 specimens which includes common pests,predators,scavnegers, beneficial insects

Observe and study the different life stages of common insect pests

Observe and study any 10 common crop pests and the nature of damage caused and control measures

Observe and study the different species of natural insect predators of pests in your locality

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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Mani, M. S. 1968. General Entomology. Oxford and IBH Publishing Company, New Delhi. 912 p.
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Pedigo, L. P. 1999. Entomology and Pest Management. Third Edition. Prentice Hall, New Jersey, USA, 691p.
Richards, O.W. and Davies, R. G. 1977. Imm's General Text Book of Entomology, Vol.1&2, Chapman and Hall Publication, London, 1345p.
Srivastava, P. D. and Singh, R. P. 1997. An Introduction to Entomology, Concept Publishing Company, New Delhi, 269p.
Dhaliwal, G. S. and Singh, B. 1998. Pesticides – The Ecological Impact in Developing Countries. Commonwealth Publishers, New Delhi. 256p.
Metcalf, C. K. and Flint, W. P. 1970. Destructive and Useful Insects: Their Habits and Control. Tata McGraw Hill Publishing Company. New Delhi. 1074p.
Odum, E.P. 1996. Fundamentals of Ecology. Nataraj Publishers. Dehra-Dun. 574 p.
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Nair, M. R. G. K. 1999. Monograph on Crop Pests of Kerala and Their Management. Kerala Agricultural College. Thrissur. 227p.
Pradhan, S. 1983. Agricultural Entomology and Pest Control. Indian Council of Agricultural Research, New Delhi. 267p.
Rao, P. A., Mathur, K. C and Pasalu. L. C. 1987. Rice Storage and Insect Pest Management. B.R publishers. New Delhi. 187p.
Gopal Swarup and Dasgupta D. R. 1986. Plant Parasitic Nematodes of India Problems and Progress. Indian Agricultural Research Institute, New Delhi
Haq, M. A. and Ramani, N. 1992. Mites and Environment. Anjengo Publications, Kerala. 171p. Jeppson, L. R., Keifer, H. H. and Baker, E.W. 1975. Mite Injurious to Economic Plants. College of California Press. California. 614p.
Prakash, I and Mathur, R. P. 1987. Management of Rodent Pests. Indian Council of Agricultural Research, New Delhi 133 p.

Practicals: Reference

Atwal, A. S. 1991. Agricultural Pests of India and South–East Asia. Kalyani Publishers, New Delhi. 529p. David, B. V. 2001. Elements of Economic Entomology. Popular Book Depot, Madras, 536p.
Ghosh, S. K. Durbey, S. L. 2003. Integrated Management of Stored Grain Pests. International

Book Distributing Company. 263p. Nair, M. R. G. K. 1986. Insects and Mites of Crops in India. Indian Council of Agricultural Research, New Delhi. 267p. Nair, M. R. G. K. 1999. Monograph on Crop Pests of Kerala and Their Management. Kerala Agricultural College. Thrissur. 227p. Pradhan, S. 1983. Agricultural Entomology and Pest Control. Indian Council of Agricultural Research, New Delhi. 267p. Rao, P. A., Mathur, K. C and Pasalu. L. C. 1987. RiceStorage and Insect Pest Management. B.R publishers. New Delhi. 187p.

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Odum, E.P. 1996. Fundamentals of Ecology. Nataraj Publishers. Dehra-Dun. 574 p. Pedigo, L. P. 2002. Entomology and Pest Management. Fourth Edition. Prentice Hall.New Delhi. India . 742p.

Srivastava, K. P. 2003. A Text Book of Applied Entomology. Vol. II. Kalyani Publishers, Ludhiana. 497p.

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 :

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

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	4		0	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	Gain knowledge and skill in the fundamentals of biochemical sciences, interactions and interdependence of physiological and biochemical processes	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Demonstrate foundation knowledge in biochemistry; synthesis of proteins, lipids, nucleic acids, and carbohydrates; and their role in metabolic pathways along with their regulation.	R, & U	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Get exposed to various biochemical processes used in industries and gain skills in techniques of chromatography and spectroscopy.	R, U	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Know about enzyme classification, properties, enzyme action- activation &inhibition,regulation	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand the microbial diversity in environment and the various techniques for handling microbes in the laboratory and Comprehend molecular phylogenetics.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Understand the common useful and harmful microbes existing and their impacts.	U & Ap	C &F	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination*: **Module 1** : short answer 3x 3 = 9marks, paragraph 3 x 6 = 18marks; **Module 2 :** short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; **Module 3** : short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks; **Module 4** : short answer 2 x 3= 6 marks, paragraph 1 x 6 = 6 marks, Essay 1 x10 = 10 marks*

MODULE 1 Biomolecules in relation to animals(13hrs)

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

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

1.3 Lipids- Structure, Classification and biological functions of lipids - simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithins, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins) (3hrs)

1.4 Proteins - Amino acids: Basic structure, Classification and General properties of aminoacids ; physiological importance of essential and non-essential - amino acids, classification of proteins, Structure of proteins - Primary, Secondary, tertiary and quaternary structures, Denaturation (4 hrs)

1.5 Structure of purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids, Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA, Complementarity of DNA(2hrs)

Module 2 Metabolism of Biomolecules (7hrs)

2.1 Carbohydrate metabolism - Glycolysis, Kreb`scycle (BriefAccount), ETS, oxidative phosphorylation, Glycogenesis. Glycogenolysis, Gluconeogenesis,HMP Shunt Pathway, Lipid metabolism (Fatty Acid Synthesis, Fatty Acid Oxidation),Protein metabolism (Deamination, Transamination, Transdeamination, Decarboxylation) (5hrs)

2.2 Biosynthesis and degradation of Purines and Pyrimidines: Nucleotide biosynthesis- de novo and salvage pathways for biosynthesis of purine and pyrimidine. Mechanism of Purine and Pyrimidine catabolism. (2 hrs)

Module 3 Introduction & Methods in Microbiology (5hrs)

Brief note on Microbial Diversity: Archaebacteria, Eubacteria, Prochlorophyta, Viruses, Viroids, Prions, Mycoplasma and Rickettsias; 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; Bacteria: Structure of a typical Bacterium, Bacterial growth: Growth phases.

Module 4 Medical Microbiology (4hrs)

Normal microflora of the human body: skin, throat, gastrointestinal tract and urinogenital tract. Diseases caused by: (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. Primary & Secondary metabolites from Microbes – Enzymes, Antibiotics, Acids

General topic

Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.

Microbial Taxonomy and Phylogeny 1Major characteristics (classic and molecular), Numerical taxonomy, Taxonomic ranks, Phylogenetic studies, Phenetic classification Bergey's Manuel (mention major groups)

Microbial fermentation Lactic acid fermentation - Homolactic and heterolactic fermenters, Mention dairy products -cheese and yogurt Alcoholic fermentation.. Microbial Bioremediation. Microbiological analysis of drinking water. Biogas plant.

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

SectionA:Biochemistry

1.Detection of organic constituents, proteins and lipids only) from sample solutions

Carbohydrates

Detectionofcarbohydrate: Molisch`s Test

Detection of reducingsugar:Glucose/Fructose[Fehling'stest,Benedict's test].

Detectionofnon-reducingsugars:Sucrose[Hydrolysistest].

Detectionof polysaccharides: Starch [Lugol'siodinetest, confirmatoryheating&coolingtest]

Proteins

Detectionofproteins:[Biuret test,Nitricacidtest,Xanthoproteictest].

Lipids

Detectionoflipids:[SudanIIIorIVtest,Spottest].

2.Separation of aminoacids(oranyothercompounds)fromamixtureby usingpaperchromatography

3. Determination of concentration of unknown solutions using Photoelectriccolorimeter (Demonstration).

SectionB: Microbiology

1. **Gramstaining** for the identification of Gram positive and Gram negative bacteria (*Lactobacilius* and *Rhizobium)*(Major).
2. **Mannitol Motility Test**-for microbial motility (Demonstration).
3. **Preparation of culturemedia** for bacteria (Synthetic Media, Natural Media, Simple Media, Differential Media and Selective Media).
4. **Methyle blue reduction test for assessing the quality of raw milk**
5. **Preparation of a fungal smear–Lactophenol cottonblue staining & mounting**

REFERENCES

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2 David L. Nelson and Michael Cox (2017): Lehninger Principles of Biochemistry 7th Edition,ISBN-10: 1-4641-2611-9, W.H. Freeman, 1172 pages

3 David P. Plummer (2017)- Introduction to Practical Biochemistry, 3rd Edition,ISBN-10: 9780070994874, McGraw Hill Education, 498 pages

4 Donald Voet, Charlotte W. Pratt and Judith G. Voet (2001): Principles of Biochemistry 4th Edition,ISBN-10: 9780471417590, Wiley

5 Geoffrey L Zubay (1999): Biochemistry 4th Edition, ISBN-10: 0697219003,Wm.C. Brown Publishers, 1104 pages

6 Gerald Michal and Dietmar Schomburg (2012): Biochemical Pathways: An Atlas of Biochemistry and Molecular Biology 2nd Revised Edition, ISBN-10: 9780470146842, Wiley Blackwell, 416 pages

7 Jeremy M Berg, LubertStryer, John L. Tymoczko, Gregory J Gatto (2015): Biochemistry 8th Edition, ISBN-10: 1464126100, W.H. Freeman, 1120 pages

8 D M Vasudevan, Sreekumari S, Kannan Vaidyanathan(2013)Textbook of Biochemistry for Medical Students JP Medical Ltd, - Medical - 791 pages

9 U Satyanarayana (2013) :Biochemistry Elsevier Health Sciences, 15 Jun 2013 - Medical - 812 pages

10 Keith Wilson and John Walker(2010) Principles and Techniques of Biochemistry and Molecular Biology, 6th edition,ISBN-10: 9780521731676, Cambridge Low Price edition, 759 pages

11 Victor W., Ph.D. Rodwell, David A. Bender, Kathleen M., Botham, Peter J. Kennelly, P. Anthony and Weil(2018): Harpers Illustrated Biochemistry, 31st Edition, ISBN-10: 1259837939, McGraw-Hill, 800 pages

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1. Claus, W.G. (1989). Understanding microbes: A laboratory text book for Microbiology. W.H. Freeman & Company, New York.
2. Harma, R. and Kanika, J. (2009). Manual of Microbiology Tools and Techniques. Ane Books Pvt. Ltd. New Delhi
3. Pelczar, M. J. (Jr.), Chan, E. C. S. and Kreig, N. R. (1998). Microbiology, Tata McGraw Hill Inc. New York.
4. Chakraborty.P.A.(2009) Text Book of Microbiology, ISBN-10: 8173810818 New Central Book Agency, 1026 pages
5. Rao, A.S. (1997) Introduction to microbiology, ISBN-10: 8120312171, Prentice Hall, 216 pages
6. Joanne Willey, Kathleen Sandman, Dorothy Wood Presccott`s Microbiology 11th Edition 2019McGraw Hill Publishers

7. Michael T Madigan, John N Martinko, Kelly S Bender, DA Buckley, DA Stahl Brock Biology of Microorganisms 14thedn Pearson Publishers

8. Ananthanarayanan&Panicker`s Text book of Microbiology Reba Kanungo (Eds.) 12thEdnSonal Saxena Publishers

ONLINE SOURCES

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

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	4		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	Basic understanding of genetic engineering and Appreciation in various biotechnological methods and its applications	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Explain the methods of transfection, transgenic animals and applied aspects of molecular techniques in unique gene pattern identification	R, & U	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Deep understanding ofhuman Immune system and functioning.	R, U	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	A knowledge in Immunity and diseases - Autoimmune diseases primary and secondary immunodeficiency diseases,immunology of tumor and organ transplantation	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand 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	Assignments,Seminars, Class test & Semester Exams
CO6	Detection of human blood groups and histology and functioning of organs of immune system	U & Ap	C &F	Assignments,Seminars, Class test & Semester Exams

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

***Question paper pattern for external examination**: **Module 1** : short answer 2 x 3 = 6marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks; **Module 2 :** short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks,; **Module 3** : short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks ; **Module 4** : short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks,*

Section A: BIOTECHNOLOGY (23 hours)

MODULE 1 (14 hrs) INTRODUCTION, GENETIC ENGINEERING AND ITS APPLICATIONS

Introduction(1 hr)

Concept and scope of biotechnology – Mention various branches of biotechnology

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).

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)

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.

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: (8 hrs) APPLICATIONS OF BIOTECHNOLOGY AND HUMAN WELFARE

Environmental Biotechnology: Enzymes in detergents and leather industries, Heterologous protein production, Biofiltration, Bioremediation, Bioleaching, and Bioreactors.

Molecular markers: (brief account) RFLP, RAPD, VNTR, SNPs and their uses/applications agriculture, personalized medicines and in DNA Fingerprinting.

Biotechnology for human healthcare :Disease diagnosis- (Cystic Fibrosis, Huntington's Disease and Sickle CellAnemia). Recombinant DNA in Medicines and Molecular

pharming (Recombinant Insulin and Human Growth Hormone).

Vaccines and Therapeutic agents, Antenataldiagnosis, Reproductive cloning, Gene/stem celltherapyand therapeutic cloning (SCID), artificialskinand 3D organ printing, GM food, Organ banking, PND act, andEthics and National Biotechnology policy of India (Protecting Human Subjects in Clinical Trials, Animal ethics, Privacy,Stem Cell Research (short notes)

Section B: IMMUNOLOGY (22 hours)

MODULE 3: (14 hrs) CELLS AND ORGANS OF IMMUNE SYSTEM, ANTIGENS, IMMUNOGLOBULINS, IMMUNITY AND MHC

Introduction (1 hr)

Immunity: Natural and acquired, active and passive immunization, vaccines (Brief), mechanisms of innate immunity - barriers, inflammation, phagocytosis.

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).

Antigens andImmunoglobulins (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.

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 organismvaccines. Recombinant vectorvaccines, DNAvaccines, Synthetic peptidevaccines, Multivalentvaccines).

Major Histocompatability Complex (2 hrs)

MHC, HLA, Class I MHC, Class II MHC molecules and structure. Mention Class III MHC.

Techniques in Immunology (2 Hrs)

Principles and applications of Various Immuno assays, ELISA, RIA, and Flow cytometry (Brief Account)

MODULE 4: (8 hrs) AUTOIMMUNE AND IMMUNODEFICIENCY DISEASES, TUMOR AND TRANSPLANTATION IMMUNOLOGY

Autoimmune diseases (2 hrs)

Auto immune diseases: Systemic (SLE, multiple sclerosis and rheumatoid arthritis). Organ specific-(Hashimoto’s thyroiditis, Grave’s disease, Myasthenia gravis)

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.

Tumor immunology (2 hrs)

Malignant transformation of cells, tumor antigens, immune response to tumor antigens.

Transplantation Immunology (1 hr)

Transplantation Antigens, Various organ transplantation and immunology of rejection (liver ,

Bone marrow and kidney transplantations -Brief account).

MODULE5: PRACTICALS [30 Hrs]

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 adiagnostic Lab)

III.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 (Ex. 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(Ex. Phagocytosis on cavity slides, ELISA, Immuno electrophoresis etc).

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- Abul K. Abbas, Andrew H. Lichtman & Shiv Pillai (2017) *Cellular & Molecular Immunology* 8th Edtion, Paperback ISBN: 9780323479783, Elsevier, 608 pages
- Andrew E Williams (2011) *Immunology Mucosal and Body Surface Defenses*, Ist Edition, ISBN: 0470090049, Wiley and Blackwell, 398 pages

- David Male, Jonathan Brostoff, David Roth and Ivan Roitt (2013) *Immunology*, 8th Edition, ISBN: 9780323080583, Elsevier, 482 pages
- Helen Chapel, ManselHaeney, Siraj Misbah & Neil Snowden (2014) *Essentials of ClinicalImmunology* 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

- Lauren Sompayrac (2015) *How the Immune System Works,* 5th Edition, ISBN: 978-1-118-99781-9, Wiley Blackwell, 160 pages
- Owen, Punt and Stanford (2013) *Kuby's Immunology,* 7th Edition, ISBN-10: 1464119910, W.H. Freeman, 692 pages
- Peter J. Delves, Seamus J., Martin Dennis, Burton J. Ivan &M. Roitt (2012) *Roitt's EssentialImmunology* 12th Edition, ISBN: 978-1-444-39482-5, Wiley & Blackwell, 288 pages
- Peter Parham (2014) *The Immune System*, 4th Edition, ISBN-10: 0815345267, W.W.Norton& Co., 532 pages
- Warren Levinson (2016) *Review of Medical Microbiology & Immunology* 14th Edition, ISBN- 10: 0071845747, Mc Graw Hill Education, 832 pages
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Lippincot Williams & Wilkins, 1312 pages

- Molecular Biotechnology: Principles and Applications of Recombinant DNA" by Bernard R. Glick and Jack J. Pasternak
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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					3		
CO 2	3		3	3		3		3			3		3
CO 3	3					3					3		
CO 4				3		3							
CO 5				3				3					
CO6				3		2				3			

FOUNDATIONS OF ENDOCRINOLOGY, DEVELOPMENTAL BIOLOGY AND REPRODUCTIVE BIOLOGY

Programme	BSc 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			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 statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand basic concepts like classification of hormones, major endocrine glands in human body and their secretions; Understand neuro-endocrinology and mechanism of hormonal action at cellular and molecular level.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO4	Introduce reproductive biology, discuss the events in human reproduction from structure of organs to parturition & lactation, summarize technologies for infertility management and prenatal diagnosis	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
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	R, U, Ap, An & E	F, C & M	Assignments,Seminars, Class test & Semester Exams
CO6	Develop skills to identify different stages of embryonic developments of amphibinas,fish & mammals	R & U	F & C	Practical

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

Question paper pattern for external examination: Module 1 : short answer 1 x 3 = 3 marks, paragraph 2 x 6 = 12 marks, Essay 1 x 10marks = 10 marks; Module 2 : short answer 3 x 3 = 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x 10 = 10 marks; Module 3 : short answer 2 x 3 = 6 marks, paragraph 2 x 6 = 12 marks; Module 4 : short answer 4 x 3 = 12 marks, paragraph 2 x 6 = 12 marks.

SECTION-A: ENDOCRINOLOGY (12 hours)

Module 1. Introduction, Neuro-endocrinology and Hormonal action (12 hours)

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 nonchordates 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)

Unit 1- Introductio(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)

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(7hours)
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(12Hours)
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.Practical (12hrs)

1. Demonstration of chick blastoderm.

2. Induced ovulation in fish.

3.Study of life cycle in *Drosophila.*

4. Spotters: Types of eggs (Insect, Amphioxus, frog, chick, and human).
5. Cleavage in frog (use slides / diagrams/models).
6. Shark: Yolk sac placenta.

7. Development of Frog: Blastula, gastrula, neurula.
8. Development of Chick: 18, 24, 32, 48 hours of incubation.
9. Mammal: Any two mammalian embryos.
10. Larval forms of invertebrates (any five) and vertebrates (any two).

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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:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	**PO7**
CO1	3					3					3		
CO2	3		3	3		3		3			3		3
CO3	3					3					3		
CO4				3		3							
CO5				3				3					
CO 6				3		2				3			

DISCIPLINE SPECIFIC ELECTIVECOURSES

ENTOMOLOGYIII: 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			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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO3	Evaluate the factors affecting insect population dynamics and describe the mechanisms that regulate insect populations.	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe the role of insects in different ecological processes, such as pollination, nutrient cycling, and decomposition.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Critically assess the principles and strategies employed in managing insect pests, including both ecological and traditional methods.	An	F & C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1: short answer 1 x 3 = 3 marks, paragraph 1 x 6 = 6 marks; Module 2: short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; Module 3: short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks ; Module 4: short answer 3 x 3= 9 marks, paragraph 3 x 6 = 18 marks,

Module 1: Introduction to Insect Ecology

- Unit 1.1: Introduction and History of Insect Ecology
  - Definition and scope of insect ecology
  - Historical development of insect ecology and entomology
- Unit 1.2: Diversity and Importance of Insects
  - Insect diversity and its ecological significance
  - The insect adaptations for different environments

Module 2: Insect-Environment Interactions

- Unit 2.1: Abiotic Factors and Insects
  - Temperature, light, moisture, and wind as ecological factors
- Unit 2.2: Biotic Interactions and Insects
  - Interspecific interactions: competition, predation, parasitism, and mutualism
  - Intraspecific interactions: cooperation and competition

Module 3: Population and Community Ecology of Insects

- Unit 3.1: Population Dynamics and Regulation
  - Factors affecting insect population growth and decline
  - Population regulation mechanisms: density dependent and independent
- Unit 3.2: Insect Communities and Ecosystem Services
  - Assembly and structure of insect communities
  - Species Interactions, The role of insects in pollination, nutrient cycling, and decomposition

Module 4: Applied Insect Ecology

- Unit 4.1: Insect Pests and Management
  - Principles of insect pest management
  - Ecological, biological, and chemical control methods
- Unit 4.2: Insects and Human Health
  - Insect-borne diseases and their transmission
  - Strategies for vector control and disease prevention

Module 5: Open end

Field study**: A) Visit to Entomology Museum Experiential learning in insect ecology**

Field study: A) Visit to Entomology Museums at KAU/ KFRI / ZSI Calicut / Calicut College / other entomological centres
B) Field visit of 4 – 5 days to observe interactions of insects in different ecosystems, and preparation of detailed field study report at the time of semester end practical examination.
C) Observing the population of a commonly available insect species in your locality
D) Observing the pollinators / insect visitors of common flowering plants

E) Observing and reporting the different pest control strategies adopted in an agricultural field / vegetable garden
F) Observe and report the various insect vectors in your locality and the strategies adopted for vector control
G) Evaluaute atleast one video content based on module 3 or 4 and present a report / PPT

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ONLINE SOURCES

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

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			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 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	Understand historical and current pest control strategies.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Identify and apply various Biological Pest control methods.	An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Identify and apply various Chemical Pest control methods.	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Evaluate the effectiveness of different pest control techniques.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand different types of advanced insect control methods	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO6	Devlop skill to identify pests in the field,setting of different types of insect traps and preparation of botanical insecticides.	R & U	F & C	Field Visit & Report

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

Question paper pattern for external examination: Module 1 : short answer x 3 = marks, paragraph x 6 = marks, Essay x10marks = 10 mzarks; Module 2 : short answer x 3= marks, paragraph x 6 = marks, Essay x10 = marks; Module 3 : short answer x 3= marks, paragraph x 6 = marksEssay x10 = marks; Module 4 : short answer x 3= marks, paragraph x 6 = marks, Essay x10marks = 10 marks

MODULE 1: Control of Insect Pests (10 Hours)
Historical aspects of pest control, Natural vs. Applied (Artificial) ControlProphylactic and Curative Methods: Cultural, Mechanical, Legal methods.

MODULE 2: Biological Control(12 Hours)
History of Biological control, Ecological, Biological, and Economic Dimensions of Biological control, Steps in biological control, Case Studies: Three Major Biological Control Projects in India, Merits and Demerits of Biological Control.

MODULE 3: Chemical Control(13 Hours)
Classification of Insecticides: Mode of Entry and Mode of Action (Brief note only), Classificationbased on Chemical Nature: Organochlorines, Organophosphates, Carbamates. Botanical Insecticides: Pyrethrum, Neem, Rotenone, and Nicotine. Insecticide Residue, Resistance, and Resurgence (brief notes only) Pesticide Appliances. Environmental Degradation of Pesticides

MODULE 4: Advanced Pest Control Methods(10 Hours)
Autocidal Control: Process in autocidal control, Advantages and disadvantages, Pheromonal Control. Microbial Control.
Insect Traps: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).

Integrated Pest Management (IPM): Features and advantages.

MODULE5:
EXPERIENTIAL LEARNING IN INSECT PEST MANAGEMENT

1) Visits to local farms or agricultural research centres to observe pest control methods in practice**.**

2) Preparation of insect traps using locally available materials: Sweep Net, Light Trap, Sticky Traps, Pitfall Trap, Food Attractant Trap

3) Observing soil insects collected using different collection methods

4) Visit to a Biocontrol lab to observe and study the biological control process

5) Preparation of botanical / plant based insecticides and their usage in home gardens

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

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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
CO 1	3					3					3		
CO 2	3		3	3		3		3			3		3
CO 3	3					3					3		
CO 4				3		3							
CO 5				3				3					
CO6				3		2				3			

DISCIPLINE SPECIFIC CORE COURSES

PHYSIOLOGY

Programme	B.Sc. Zoology				
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	4		0	75
Pre-requisites	+2 /VHSC Biology or equivalent online courses				
Course objectives					

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	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	To describe different functional areas of brain.	An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Discuss the physiology of various organ systems in the body.	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Contrast the structural and functional differentiation of sense organs, and dfffferentiate the structure and functions of various organs in the human body.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	. Explain the role memory in human behavioural control	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO6	Acquire knowledge indifferent disorders and diseases affected in human sense organs	R & U	F & C	Assignments,Seminars, Class test & Semester Exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks, paragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

MODULE 1: LYMPHATIC SYSTEM&ENVIRONMENTAL PHYSIOLOGY AND STRESS PHYSIOLOGY:(9hrs)

A) 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

B) Environmental Physiology and Stress Physiology: (5hrs)

Environmental influence on growth and metabolism, Acclimatization, Concept of stress, stressors, integrated stress response, eustress, 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 Nrf2transcription factor in stress regulation.Stress and Heat Shock Proteins.Stress-induced diseases.

MODULE II: MEMORY (3hrs)

Memory- 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 ,braintumor, Encephalitis. Bipolar disorders, PTSD

MODULE III: PHYSIOLOGY OF CONTROL AND CO-ORDINATION:

Nervous system: Structure and function. (15hrs)

A) Structural Organization of human brain.

Cerebrum: 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.

B) Cerebellum and Medulla oblongata: structure and function. Diencephalon organisation and function.

C) Functional brain systems: Limbic system and reticular formation. Protection of brain Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function.

D) Spinal cord: 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.

E) Disorders: Guillain-Barré syndrome, ALS (Lou Gehrig's Diseases),Brain

aneurysm,Numbness and tingling

MODULE IV: SENSORY PHYSIOLOGY (18hrs)

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

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: Oralthrush, Glossitis,Macroglossia, Burningtongue, ,Leukoplakia, Kawasakisyndrome, Fissured tongue.

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

Touch: (brief note**) (3hrs)**

Mechanoreceptors and their stimulation, Pain receptors and their stimulation Thermal receptors and their stimulation.Skin diseases: Acne, Alopeciaareata,Atopic dermatitis,Psoriasis,Raynaud's phenomenon, Rosacea,Skin cancer,Vitiligo

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: Pendredsyndrome,Ushersyndrome,VestibularSchwannoma, Otosclerosis,Tinnitus, Ear infection.

Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS
1. Identification of parts of Brain usingVirtual 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'stuning 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 Supervising Teacher 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 ofthermoreceptors of the skin. (Thermoreceptor adaptation test)
13. Practise of stress releasing excercises.

Supervising Teacheral visit to Hospitals or other Medical centers to study the procedures to detectvisual or auditory defects in children (not more than one day)
References

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

ENZYMOLOGY AND CLINICAL BIOCHEMISTRY

Programme	B.Sc. Zoology				
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	4		0	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	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	explain how enzymes are able to increase speed of an biochemical reaction in sense of thermodynamics, kinetics and molecular interactions;	An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	use 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	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	apply appropriate methods for determination of catalytic parameters and activity of enzymes and resolve problems considering kinetics and thermodynamics of enzymatic reactions.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	analyze options for applying enzymes and their inhibitors in medicine and various industries	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO6	apply theoretical, practical, IT and statistical knowledge during processing experimental results and their correct interpretation	R & U	F & C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination*: **Module 1** : short answer 3x 3 = 9marks, paragraph 2 x 6 = 12marks; **Module 2 :** short answer2 x 3=6 marks, paragraph2 x 6 = 12marks, Essay x10 = 10 marks; **Module 3** : short answer3 x 3=9 marks, paragraph 3 x 6 = 18marks; Essay x10 = 10 marks, **Module 4** : short answer 2 x 3= 6marks, paragraph1 x 6 = 6 marks.*

Module 1 Introduction to Enzymes (10 hrs)

Nomenclature and classification; 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; (2hrs)

Interaction between enzyme and substrate- lock and key model, induced fit model., Features of active site, activation energy, Rate enhancement through transition state stabilization, (3hrs)

Chemical mechanism for transition state stabilization. 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 characterisation of enzymes and criteria of purity.(5hrs)

Module 2 Enzyme kinetics, Inhibition & Regulation (15 hrs)

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, LineweaverBurk 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.(6hrs)

Enzyme inhibition: 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.(3hrs)

Regulation of Enzyme activity: 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 transcarbamoylase. Isoenzymes- Lactate dehydrogenase and creatine phosphokinase (6 hrs)

Module 3 DisordersofCarbohydrate, amino acid , lipids, purine pyrimidine and porphyrin metabolism (10 hrs)

Disorders of Carbohydrate metabolism.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 (4hrs)

Disorders of aminoacids metabolism -Etiology and clinical manifestation of phenylketonuria, cystinuria, alkaptonuria, albinism and tyrosinemia, organic acid disorders, urea cycle disorders (2 hrs)
Disorders in lipid metabolism: Plasma lipoproteins - lipoproteinemias, lipid metabolism in liver and adipose tissue.Cholelithiasis, Obesity, Fattyliver-.Hypo and hypercholesterolemia. Atherosclerosis–aetiology,clinical features and complications (2 hrs)
Disorders of purine, pyrimidine and porphyrin metabolism- Hyper uricemia and gout.Lesch-Nyhansyndrome, SCID.Oroticaciduria – Primary & Secondary (Reye`s Syndrome), Porphyrias.(2 hrs)

Module 4 Urineandbloodanalysis:Liver Function tests, Renal function tests and Thyroid function test GastricfunctiontestsandClinicalenzymology(10 hrs)

Urine: Normal composition of urine– Volume, pH, colour, specific gravity.
Constituents- urea, uricacid, creatinine, pigment .Abnormal
Constituents - glucose, albumin, ketonebodies, variations in urea, creatinine, pigments and their clinical significance in brief.(3hrs)
Blood: Normal constituents of blood and their variation in pathological conditions - 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 andf eaces), anti-coagulant and preservatives for blood and urine.Transport of biological samples. (3hrs)

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 (2hrs)
Renal function tests- Clearance tests-urea, creatinine, PAH test, concentration and dilution tests. (2hrs)
Thyroid function test-Significane of T3, T4 and TSH-values, hypo-and hyper thyroidism.(2hrs)
Gastric function tests- Collection of gastric contents, examination of gastric residium, stimulation tests, tubeless gastric analysis (1hr)
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

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4. *WilliamJMarshal*,(2008)**ClinicalBiochemistry**,Metabolicandclinical

Mapping of CO, PSO & PO

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

ADVANCES IN ECOLOGICAL & AND EVOLUTIONARY STUDIES.

Programme	B.Sc. Zoology				
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	STCFYUGP - Three year B. Sc. Zoology or basic level course of II semester –Environmental Biology and Animal Behaviour				
Course objectives	Students understands 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.				

CO	CO statement	CognitiveLevel*	Knowledge Category#	Evaluation Tools used
CO1	Understanding of the fundamental concepts of ecology,including evolutionary, population, community, and ecosystemsscales.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Identify and understand	An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Explain how different types of mutation occur & affect genetic variation in apopulation	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Understand the concept of population.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams

CO5	To impart descriptive knowledge regarding Origin and Evolution of Man.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO6	Apply the understanding of the topic to a research theme related to the students own specialization area	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination*. Module 1: Short answer 3x 3 = 9 marks, paragraph 2 x 6 = 6 marks, = 10 marks; Module 2: Short answer 1 x 3 = 3 marks, paragraph 1x 6 = 12 marks, Essay 1 x 10 marks = 10 marks; Module 3: Short answer 3 x 3 = marks, paragraph 2 x 6 = 12 marks, Essay 1 x 10 marks = 10 marks; Module 4: Short answer 3 x 3 = 9 marks, paragraph 3x 6 = 18marks.*

Module 1: Unit 1: Frontiers in Population and Community Ecology (15hrs)

Unit 1: Ecological interactions

Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation, competition–intraspecific and interspecific, Ecological and environmental significance of interactions.

Unit 2: Population dynamics

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. Metapopulation dynamics: 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)

Unit 1: Global carbon, nitrogen, and phosphorus cycles: anthropogenic perturbations, feedbacks, and tipping points. Ecosystem services and valuation: ecological functions, economic approaches, policy implications.

Unit 2: Multifunctionality and resilience: 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 hours)

Unit 1: Niche construction: 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: 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 hours)

Unit 1: Human Evolution: 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: Addressing climate change and other global challenges. Ethical considerations in ecological and evolutionary research, such as gene editing and species reintroduction.

Module 5: Practicals(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 freeCO^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 Supervising Teacher 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.
11. Transect sampling of insects/ birds and calculation of different diversity indices

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- Gary G. Mittelbach (2012) Community Ecology. Sinauer Associates, Inc.; 1 edition. ISBN: 978-0878935093.
- Peter Stiling, 2015. Ecology: Global Insights and Investigations 2nd Edition. McGraw-Hill international edition.
- Krishnamurthy K. V. (2003). An Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
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Evolutionary Biology

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- 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
- Freeman S, Herron JC. 2016. Evolutionary Analysis. Pearson Education Limited, Noida, India.
- Futuyma DJ. 1997. Evolutionary Biology. SinauerAssociates.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 :

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

MOLECULAR BIOLOGY AND CYTOGENETICS

Programme	B.Sc. Zoology				
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 4. **https://www.udemy.com/course/molecular-biology-biotechnology-principles/** 5. **https://onlinecourses.nptel.ac.in/noc24_bt07/preview** 6. **https://onlinecourses.swayam2.ac.in/cec20_ma13/preview**				
Course objectives					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the structural and functional aspects of eukaryotic genomes, including the organization of genetic elements, multigene families, transposable elements, and pseudogenes.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO2	Analyze the molecular mechanisms underlying gene expression and its regulation as well as protein processing	An	F, C & P	Assignments,Seminars, Class test & Semester Exams
CO3	Understand DNA damage and repair mechanisms, and regulation of gene expression in bacteriophages.	E	F, C	Assignments,Seminars, Class test & Semester Exams
CO4	Analyze the Molecular Mechanisms of Cell Division and DNA recombination, ultrastructure and organization of Key Cellular components involved in cell division and dys-regulation of cell division in cancer development.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand and analyze the mechanisms of sex determination, chromosomal anomalies and disorders and genetic counseling practices.	R & U	F & C	Assignments,Seminars, Class test & Semester Exams

CO6	Demonstration of isolation of genetic materials, separation techniques of protein and DNA, stages of meiosis, and analysis of normal and abnormal human karyotypes	R & U	F & C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination: Module 1** : short answer 3 x 3 = 9marks, paragraph 2 x 6 = 12 marks; **Module 2 :** short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks; Essay 1 x10 = 10 marks; **Module 3** : short answer 2 x 3= 6marks, paragraph 2 x 6 = 12 marks; **Module 4** : short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks*

MODULE 1 INSIGHTS INTO EUKARYOTIC GENOME ORGANIZATION (11Hrs)

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: hemoglobins, 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/Jumping genes (3 Hrs): Definition, features and types, Brief history of discovery by Barbara McClintock in maize and the significance of her work. Transposition mechanism, Transposons in bacteria, IS elements, Tn family, Mu phage as a transposable element, Transposons in eukaryotes, SINE, Alufamily; LINE, L1, P elements in Drosophila, Retroviruses and transposition

Unit 4: Pseudogenes(1Hrs): 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)

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 cross linking agents, intercalating agents. DNA Repair: Direct reversal, Base excision repair, Nucleotide excision repair, mismatch repair, SOS repair.

Genetic Disorders: Examples of diseases caused by defects in transcriptional machinery or DNA repair mechanisms (e.g., Xeroderma Pigmentosum

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 targetting, brief account on vescicular transport Gene expression and regulation in bacteriophages and viruses (brief account only)

MODULE 3: CELLULAR REPRODUCTION AND GENETIC DIVERSITY(11 hrs)

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 Holliday intermediate, heteroduplex DNA, gene conversion, Role of Rec A protein in genetic recombination

MODULE 4 SEX DETERMINATION AND CYTOGENETIC DISORDERS (11 hrs)

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, Classsification 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 Supervising

Teacher from thefollowing 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 (priciple,procedure and application)
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.
9. PCR principle,procedure and application

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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of the Gene, Pearson Education.

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Waverly Pvt. Ltd, New Delhi.

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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 :

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

Programme	B.Sc. Zoology				
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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO3	Explores and establishes the correspondences between body parts of organisms from different species.	An	F C & P	Assignments,Seminars, Class test & Semester Exams
CO4	Understand basic concepts of developmental biology, Embryogenesis & organogenesis	U	F,C &P	Assignments,Seminars, Class test & Semester Exams
CO5	Understand the cellular,molecular & genetic basis of development	U	F,C &P	Assignments,Seminars, Class test & Semester Exams
CO6	Develop skill to identify different types of brains, feathers, developmental stages of chick, pelvic and pectoral girdles of different animals.	U	F,C &P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 3 x 3 = 9 marks, paragraph 2 x 6 = 12 marks; Module 2 : short answer 3 x 3= 9 marks, paragraph 2x 6 = 12 marks,, Essay 1 x10 = 10 marks; Module 3 : short answer 2 x 3= 6 marks, paragraph 1 x 6 = 6 marks Essay 1 x10 = 10 marks ; Module 4 : short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks.

COMPARATIVE ANATOMY (20 hrs)

Module 1. Comparative Anatomy – Part I (12hrs)

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)

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)

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;

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)

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 & 72 hours 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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand 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 theirstained temporary/permanent mounts
12. Study of fate map

REFERENCES:

COMPARATIVE ANATOMY

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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:

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3					3					3	
CO2	3		3	3		3		3			3	
CO3	3					3					3	
CO4				3		3						
CO5				3				3				

COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATONS

Programme	B.Sc. Zoology				
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					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will develop a thorough knowledge of computational biology, including its historical context and importance in contemporary biological research, enable them to recognize diverse biological databases and acquire skills in retrieving and analyzing data from these databases through online tools and resources	R	F	Assignments,Seminars, Class test & Semester Exams
CO2	Understand the importance of algorithms in computational biology, their role in solving complex biological problems, develop competency in various algorithmic techniques like recursion, linear searches, and divide and conquer algorithms.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Understand 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.	An	F C & P	Assignments,Seminars, Class test & Semester Exams

CO4	Understand 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	U	F,C &P	Assignments,Seminars, Class test & Semester Exams
CO5	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	U	F,C &P	Assignments,Seminars, Class test & Semester Exams
CO6	: Utilize 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 &P	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks, paragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

Module 1: Fundamentals of Computational Biology (12hrs)

Unit 1 Introduction to Computational Biology: Overview of computational biology, significance in modern biological research; Historical background and milestones, Scope and applications of Unit 2 Biological Databases and Data Retrieval:Overview of biological databases: 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: 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 : 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)

Unit 1: Genomics and proteomics: 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: 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.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 : 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: 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)

Unit 1: Basics of Biostatistics and Data Management: 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: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: 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: 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)

Unit 1: Bayesian Methods and Markov Chain Monte Carlo (MCMC): 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: 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: 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 datausing 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: 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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1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
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3. Xiong, J. (2006). Essential bioinformatics. Cambridge College Press.
4. Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. Garland Science.
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8. Bergeron, B. P. (2003). Bioinformatics computing. Prentice Hall Professional.
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ONLINE SOURCE

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

ADVANCES AND APPLICATIONS OF IMMUNOLOGY

Programme	B.Sc. Zoology				
Type of Course	Core-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 [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Explain the mechanisms of humoral and cellular immunity, immune cell receptor, and intracellular signal cascades related to immune system activation and response [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Comprehend key principles behind host microbiome interactions, complement responses, and the importance of gut microbiota in developing immunity [PSO2].	R	F	Assignments,Seminars, Class test & Semester Exams

CO4	Evaluate the various causes and immune mechanisms behind hypersensitivity, allergic responses, transplant rejection, and immune deficiency diseases [PSO5].	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Discriminate ,distinguish and apply the basic scientific principles, procedures, and applications of advanced immunotechniques used in the biomedical field and to develop new methods and techniques on the basis of the earned knowledge [PSO5].	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Describe Hematopoiesis, maturation, and antigen-antibody interactions and appreciation of the mechanism of generation of antibody diversity [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks, paragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

Module I:Introduction to Hematopoiesis and Antigen-Antibody Interactions (8 hours)

Unit 1 :Hematopoiesis: (2 Hrs)

Process of hematopoiesis and Immune cell lineages, Regulation and hematopoietic growth factors. Genes responsible for haematopoesis(brief account)

Unit 2 :Immunoglobulins- Diversity and properties (6 Hrs)

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 (8 hours)

Unit 1 :Humoral and Cellular immunity(5 hours).

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. Mention Memory B-cells and long term immunity

Unit 2: Cytokines(3 hours)

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)

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)

Unit 1 Hypersensitivity Reactions (3Hrs)
Allergens, Types I-IV Hypersensitivity reactions; Immune mechanisms and examples, Cytokine shock or Cytokinerelease syndrome (CRS), Cytokine related diseases (Bacterial septic shock, Chaga's disease, lymphoid and myeloid cancers). Cross talk between hyper sensitivity reactions- short account.

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, anddendritic 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.Types of antigen presenting cells 213

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 - Advanced Immunological Applications (3 hours)

Suggestions
Immunotechniques
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

SUGGESTED READINGS

- Abdul K Abbas and Andrew H. Lichtman (2004). Basic Immunology – Functions andDisorders of the Immune System (second edition, Elsevier Science, USA).
- Abdul K Abbas and Andrew H. Lichtman (2003). Cellular and Molecular Immunity(fifth edition, Elsevier Science, USA).
- Godkar P.B (1998). A Text Book of Medical Laboratory Technology (Bhalani Publishing House, Mumbai).
- Janis Kuby (2000). Immunology (7th ed. W.H. Freeman & Co., New York).
- Joshi K. R and Osamo N. O (1994). Immunology (Agro Bios Publishers, Jodhpur).
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- Peter Parham (2004). The Immune System (Second edition, Garlands, New York).
- Ivan M. Roit (2002). Essentials of Immunology (ELBS, New Delhi).
- Shetty N (1993). Immunology (Wiley Eastern Ltd, New Delhi).
- Richard Coico and Geoffrey Sunshine (2009). Immunology - A Short Course (WileyBlackwell, CA, USA).

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

ADVANCES IN BIOTECHNOLOGY AND MICROBIAL PROCESSiNG

Programme	B.Sc. Zoology				
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					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The student learn the features of various types of cloning vectors and exploredifferent steps involved in molecular cloning	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	The student will describe the techniques involved in the production of molecular probes,Genomic and cDNA library,analyse techniques involved in isolation, sequencing and synthesis of genes, andget familial with the biotechnological techniques like antisense RNA and their applications	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	The student will understand various aspects of IPR, the ethical issues in cloning, GM food crops and social implications of biotechnology in the body.	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Describe role of microbes in Industry	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Expain the functioning of Bioreactors	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Explain the down stream processing	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks, paragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

PART A BIOTECHNOLOGY

MODULE I Introduction to cloning vectors and methods (10hrs)

Cloning vectors–

Plasmids: pBR322 andpUC

Phages: λgt10 and M13vector

Cosmids: generalfeatures

Phagemids: generalfeatures

Viruses: SV40 andCaMV

Transposones; Ac transposon and Ds transposon of Maize, P-elementof *Drosophila*

Artificial chromosomes: BAC, YAC andMAC.

Shuttle vectors: applications andexample

Expression vectors: mention commonly used promoters in expressionvectors(Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter ofCaMV, Polyhedrin promoter fromBaculovirus

Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use oflinkers)

Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization

Amplification – Multiplication, Expression, and integration of the DNA insert in host genome

2.MODULE II Advanced techniques in Biotechnology(15hr)

Molecular probes and Applications

FISH, McFISH andGISH

Construction of Genomic library.

Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity

Chromosomewalking

PCR methods, Inverse PCR, Anchored PCR, Asymmetric PCR,

PCR for mutagenesis and Real Time PCR

Applications of PCR in Biotechnology and geneticengineering

DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide syntheticmethod,NGS.

Gene synthesismachines

AntisenceTechnology : Antisense RNA and its applications in biomedical and agriculture fields, RNAinterference, Gene knockouts and Knock outmouse

Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning)– Advantages and disadvantages ofcloning

Intellectual property rights and ethical and social implications of Biotechnology

Intellectual propertyprotection, Patents, copy right, trade secrets,trademarks, GATT and TRIPS, patenting of biologicalmaterials,, International co-operation, obligation with patent applications, implications of patenting- current issues, Social acceptance of medical biotechnology- Various cloning procedures,

Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants-Animals andethics- 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 Industrialbiotechnology

MODULE III: Module 4: Introduction to Bioprocess & Microbes in Industry (10hrs)

Introduction to bioprocess engineering: 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.

Upstream processing: Microbial Nutrition, Media formulation for industrial fermentation. Development of inocula for the industrial fermentations. Scale up.

MODULE IV: Bioprocess Technology (15hrs)

Bioreactors: batch, fed –batch and continuous bioreactors, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.

Industrial production of chemicals, alcohol(ethanol),acids (citric, acetic and gluconic),solvents (glycerol,acetone,butanol,antibiotics(pencilliin,streptomycin,tetracycline),aminoacids (lysine, glutamic acid),single cell protein. Enzyme and whole cell immobilization and their industrial applications.

Downstream processing: 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 V: Open ended
The teacher can design activites related to Module 2 and 3

1. Estimation of DNA by Diphenylamine method
2. Methylene Blue DNA Staining
3. Estimation of RNA by Orcinol Reaction
4. Buccal epithelial smear and barr bodies
5. Karyotype Analysis in Man: Down’s Syndrome and Turner Syndrome
6. Preparation of Wine
7. Estimation of alcohol content in wine.
8. Production of Citric acid microorganism
9. Quantitative estimation of citric acid
10. Study of immobilization technique.
11. Water test by MPN technique
12. Biodegradation of pesticides.
13. Southern Blotting (First Method) Southern Blotting (Second Method) (Demonstration only)

14 . Western Blotting Western Blot Analysis of Epitoped-tagged Proteins using the Chemifluorescent Detection Method for Alkaline Phosphatase-conjugated Antibodies(Demonstration only)

15 Visit to industry (Not less than 3 days).

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 CollegePress.
4. Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall ofIndia
5. Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge Collegepress.
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
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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.
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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.
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23. 6. Bioprocess engineering: Basic Concepts, Shuler,M.L., and Kargi,F., Prentice Hall, Engelwood Cliffs.
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26. 9. Chemical Engineering Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE. 30
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ONLINE SOURCE

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

DISCIPLINE SPECIFIC ELECTIVE COURSES

FORENSICBIOLOGY I: BIOLOGICAL EVIDENCES & FORENSIC SEROLOGY

Programme	B. Sc Zoology				
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	Understand theimportanceofbiologicalfluid (semen, synovial fluid, gastrointestina secretions,tear, milk, faeces, saliva, aqueou humour, Vaginal fluid, epithelial cells) incrime investigations and gain knowledge o composition, formation and functior collection and preservation o biologicalfluids.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Understand the morphological and biochemical organization & to know the forensicimportanceofhairevidence & fibres, and identification of various botanical evidences in forensics	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the basis of blood typing and understand how characterisation of blood stains is done, Understand the collection, evaluations and tests for identification of blood,urine,semen,saliva,sweat and milk–in crime investigations	R	F	Assignments,Seminars, Class test & Semester Exams

CO4	Understand the usefulness of genetic markers in forensic investigations, The forensic importance of blood stain patterns and their documentation	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Critically assess the principles and strategies employed in managing insect pests, including both ecological and traditional methods.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO6	Understand thebasicprincipleofDNAanalysis, To know theforensic significance of DNA typing, Understand the importance of short tandem repeats and restriction fragmentl ength polymorphismin DNA technique	R	F	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: Module 1: short answer 3x 3 = 9marks, paragraph 2x 6 = 12marks; Module 2: short answer 1 x 3= 3 marks, paragraph 1 x 6 = 6marks,; Module 3: short answer 3 x 3= 9marks, paragraph 3x 6 = 18 marks Essay 1 x10 = 10 marks ; Module 4: short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12marks, Essay 1 x10 = 10 marks

Module I: Biological evidences

- 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. (5 hrs)
- Types of fibre ,Forensic aspect of fibre examination- fluorescent, optical properties, refractive index, birefringence, dye analysis etc. Collection and preservation of fiberevidenc, Forensic Examination of Fiber. (3 hrs)
- Diatoms: Isolationofdiatomsfromvariousbodyorgansandtheirforensicsignificanceindrowning cases.(2hrs)
- Types of woods, timbers, seeds and leaves and their forensic importance. Identification and matching of various types of wood, timber varieties, seeds and leaves. (3hrs)

Identification of pollen grains, Identification of starch grains, powder and stains of spices etc. (2 hrs)

Module II: Blood (10hrs)

- Composition, formation and function of body fluids. Collection and preservation of biologicalfluids. Types and distribution of body fluids (semen, synovial fluid, gastrointestinal secretions,tear, milk, faeces, saliva, aqueous humour, Vaginal fluid, epithelial cells, etc.). Blood and itsvariants: Blood composition, Blood

group antigens the classification of blood cell antigens,Forensic significance of ABO blood group. (10hrs)

Module III: Immunology, Serology& DNA Profiling (15hrs)

- 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.

- Bloodgroups that make racial distinctions. Lewis antigen, Bombay Blood groups. HLA antigens andHLA typing. Role of sero-genetic markers in individualization and paternity disputes. Pitfalls inred cell typing.(7hrs)
- Possible sources for DNA, collection, transportation and preservation of various forensic samplesfor DNA profiling. DNA extraction techniques for different forensic samples (early techniques,solidphaseextraction,differentialextraction,chelexextraction,automatedtechniques,commercial extraction kits), RNA extraction from different forensic samples. Determining qualityand Quantity of DNA and RNA, Gel elution technique. DNA Amplification: Types of PCR(6hrs)

Profiling Applications: Case studies in disputed paternity cases, child swapping, missing person's identity,civil immigration, veterinary, wild life and agriculture cases.(2hrs)

Module IV: Determination of human and animal origin (12hrs)

- Determination of human and animal origin from bones, hair, flesh, nails, skin, teeth body tissue,fluids/ stains viz. blood, menstrual blood, semen, saliva, sweat, tear, pus, vomit, etc., throughimmunodiffusion and immuno - electrophoresis, cross reactivity among closely related species.Individualization of blood stains: Determination of blood groups, sex age and racial origin fromdried bloodstains. (8 hrs)
- Red cell enzymes: Genetics, polymorphism and typing of PGM, GLO-I, ESD,EAP, AK, ADA etc. and their forensic significance. (2hrs)

Serum proteins: Genetics, polymorphism andtyping of- Hb, HP, Tf, Bf, C3 etc. and their forensic significance. (4 hrs

Module : Open end(10hrs)

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 assigments& 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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- Pollen morphology & Plant taxonomy: angiosperms (an introduction to palynology),Erdtman, G Hafner Publishing Co.,
- Forensic botany, Coyle, Heather Miller CRC Press,College botany, Gangulee, Hirendra Chandra New Central Book Agency,
- Plant anatomy, Esau, Katherine Wiley Eastern Ltd,Plant anatomy, Chandurkar, P J Oxford & IBH Publishing Co,
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ONLINE SOURCES

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

FORENSIC BIOLOGY II: WILDLIFE FORENSICS AND FORENSIC MEDICINE

Programme	B. Sc Zoology				
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	Understand the nature of wild life crimes an methods of identification, the legal aspects o wild life crimes	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Understand potential microbes in warfare an Microbes of Forensic Importance & hav knowledge of the analytical techniques i toxin analysis	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Analyse the steps involved in processing the death scene and the importance of ascertaining whether the crime was staged to appear as suicide or accident	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Understand the importance of bloodstain patterns inreconstructing the crime scene.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand the importance of autopsy.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Understand the recovery and identification of human skeletal remains for analysis	U	F&C	Assignments,Seminars, Class test & Semester

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

Question paper pattern for external examination: Module 1: short answer 2x 3 = 6marks, paragraph 1x 6 = 6marks; Module 2: short answer 3x 3= 9 marks, paragraph 2 x 6= 12 marks, Essay 1 x10 = 10 marks; Module 3: short answer 3 x 3= 9marks, , paragraph 3x 6 = 18 marks Essay 1 x10 = 10 marks; Module 4: short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12marks

Module I: Wild Life Forensics (10hrs)

- Protectedandendangeredspeciesofanimalsandplants;Sanctuariesandtheirimportance;Types of wildlife crimes, different methodsof killing and poaching of wildlife animals; Enforcement of wildlife protection policy, Wildanimals 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 onthe surface international trade in reptile skins.(6 hrs)

- Challenges to species identification of reptile skinproducts,species and products represented in the reptile skin trade,reptilescale mo rphology basics and current limitations, Identifying features of major reptilegroups. Identification of pug marks of animals, Wildlife (Protection)Act-1972.(4hrs)

Module II: Microbial Forensics (18hrs)

- Defining the microbial forensics programme, epidemiology, Microbial forensic tools.Dynamics of disease transmission, Outbreak Investigation.Deliberate introductionofabiologic alagent.
  Microbes of Forensic Importance: *Bacillus anthracis, Yersinia pestis,Francisellatularensis, Brucella spp., BurkholderiaPseudomallei, Clostridium botulinum, Listeriamonocytogenes* and their morphological & biochemical studies.DNA of microbes in soil for crime detection.
  Fungi of forensic importance: Opportunistic mycoses, *Chytridiomycota zygomycota,Aspergillusfumigates,Microsporidum,Pneumocytosisjiroveci,Asp.flavus*&*Candida*sp,epidemiology, Antifungal agents. Food borne – shigella, salmonella. etc**.** (10 hrs)
- Forensic Aspects Of Biological Toxins:Microbial Forensic Analysis ofTraceandUnculturableSpecimens.Etc.Biological agents in warfare: Collection, transportation and preservation of microbial forensicsamples,
  Categories of biological weapons, study of potential bacteria, fungi, viruses, and theirtoxins, mode of action, identification, preventive measures during handling, laboratory
  setup,epidemiologicinvestigationforpublichealth,investigationofsuspiciousdiseaseoutbreak,Biosafety and biosecurity, Bio surveillance, documentation, and case studies, Toxin analysis using mass spectrometry, Non-DNA methods for Biological Signatures, Electron beam based methodsfor bio-forensic investigations, proteomics development and application for bio-forensics, design

ofgenomics, design of nucleic acid signature for pathogen identification and characterization.(8 hrs)

Module III: Forensic Medicine (9hrs)

- Death: 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 ofbodyandtissues bymaggots and other insects, rodents, fish and crabs, moulds. Medico legal aspects of death- Asphyxia, syncope, coma, death by starvation,Asphyxial death- hanging, strangulationand drowning and Causes and mechanism of traumatic death. (6 hrs)
- Mechanical Injuries: 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. (3 hrs)

Module IV: Forensic Odontology (10hrs)

- Definition and Scope of Forensic Odontology, 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 inPersonalIdentification.(5 hrs)
- Bitemarks:Types&forensicimportance. Collection and preservation of samples,analysis of Bite marks, presentation of bitemarkevidencesincourtoflaw.RoleofForensicOdontologyinmassdisastervictim identification. Dental Charting. Comparison of Ante-mortem and post-mortem dental records. (5 hrs)

Module 5 : Experiential learning (10hrs)

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..) & giveassigments& seminars from Module III.

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28. Dental Autopsy, William E Silver, Richard R Souviron, 1st Ed, CRP Press, 2009
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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					3		
CO 2	3		3	3		3		3			3		3
CO 3	3					3					3		
CO 4				3		3							
CO 5				3				3					
CO6				3		2				3			

FORENSIC BIOLOGY III: FORENSIC ENTOMOLOGY

Programme	B. Sc Zoology				
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	Identify the forensically important insect groups and their relationship at different the stages of death.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Distinguish among major insect types associated with carrion.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Undertand method of evidence collection the	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Types and identification of microbes of forensic significance.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Understand different stages of decomposition	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Demonstrate skills to identify different insects of forensic importance	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1: short answer 3x 3 = 9marks, paragraph 3x 6 = 18marks Essay 1 x10 = 10 marks ; Module 2: short answer 2x 3= 6 marks, paragraph 2 x 6= 12 marks,; Module 3: short answer 2 x 3= 6marks, , paragraph 2x 6 = 12 marks; Module 4: short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12marks, Essay 1 x10 = 10 marks

Module I: Taxonomy and Biology of forensically important insects (8hrs)

- Insectsofforensicimportance
- Coleoptera–Generalcharacters,taxonomy and biology of Silphidae (carrion beetles), Staphylinidae (rove beetles), Histeridae(clownbeetles),Dermestidae(hide&skinbeetles),Cleridae(checkeredbeetles),Carabidae(Groundbeetles).(6 hrs)
- Diptera-Generalcharacters,taxonomyandbiologyofCalliphoridae,Sarcophagidae,Phoridae,Muscidae,Fannidae.(2 hrs)

Module II: Evidence during death investigations (10hrs)

Collectionofentomological evidence during legal investigations; collection of meteorological data, specimensbefore body removal, ground-crawling arthropods on and around the body, entomological samples from the body, entomological samples during autopsy, specimens from buried remains, fromenclosed structures & aquatic habitats. (10 hrs)

Module III: Entomological evidences during death investigations (12hrs)

- Laboratory rearing of insects of forensic significance:Larvalrearing,rearingcontainers,monitoringgrowth,larvaldispersalin laboratory,adultemergence, rearing aquatic insects, unique host preference, rearing beetles in the laboratory.(9 hrs)

Factors influencing insect succession on carrion, its application to forensic entomology. (3 hrs)

Module IV: Insect succession on carrion (13hrs)

- Stages of decompositionof deadbody in terrestial and aquatic region, Insect succession on carrion and its relationship to determine time since death,geographicaldifferences in succession, effects of season, humidity, effects of sunlight exposure, urban versusruralscenarios,bodiesfoundinsidebuildings,effectsofburial,bodiesinwater,bodiesinvehicles,bodiesinenclosedspaces,hangedbodies,burntremains,wrappedremains,estimatingthepostmorteminterval.(7 hrs)

Soilenvironment and forensic entomology, entomo-toxicology : Current concepts, trends, challenges and techniques. Implication of morphmetric and growth rate, chemo-ecology, molecular methods for forensicentomology.(6 hrs)

Module V: Experiential learning (10hrs)

The teacher can design student activities related to Practicals of Module II & IIIas Identification of insects of forensic importance, rear some of the insects of forensic significance

, give assigments& seminars from Module IV

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Suggested Online Courses:

S.No.	Course offered	College	Link of the course
1	Introduct on to Forensic Sciences	Nanyang Technological College, Singapore	(https://www.coursera.org/learn/forensic-science)
2	Veterinary Forensics	WUF Health College 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 College	(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 :

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

RESEARCH METHODOLOGY IN ZOOLOGY

Programme	B. Sc Zoology				
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					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain the different data colletion and analysis methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe procedure of reaearch paper writing	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the importance of developing areserch plan	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Attain skill in using statistical applications	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Describe the intellectual property right and the laws related to it	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Prepare a research article	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

***Question paper pattern for external examination: Module 1** : short answer x 3 = marks, paragraph x 6 = marks, Essay x 10marks = marks; Module 2 : short answer x 3 = marks,*

paragraph x 6 = marks, Essay x 10 = marks; Module 3 : short answer x 3 = marks, paragraph x 6 = marks; Module 4 : short answer x 3 = marks, paragraph x 6 = marks.

Module 1 Introduction and Research design (18hrs)

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;

Module 2 Data collection and analysis (12hrs)

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)

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

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 – softwares for checking plagiarism

Unit 4: Ethical issues – ethical committee in animal experiment and clinical trials

Module 4 (12hrs)

Biodiversity valuation, Conservation status, Endangered marine organisms, CITES, Red data list and its categories. Regulations concerned with the conservation of marine fauna and flora. Marine sanctuaries, Marine Protected Areas (MPAs), 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 Experintial learning12hrs)

Teacher can design student activities like, preparation of review paper, organzing 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 2004 Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications. Universal Law Publishing Co Ltd

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

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 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 [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
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.. [PSO1]	R	F	Assignments,Seminars, Class test & Semester Exams
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. [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe sociobiology of different animals, the concept of social organisation in animals, and the concept of proximate factors[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams

CO5	Acquire skill in estimating ecological parameters like dissolved Oxygen, Carbondioxide, pH etc. . [PSO4]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Compare the characteristics of different types of ecosystems, pattern of flow of materials and energy in ecosystem, etc.	U	F&C	Assignments,Seminars, Class test & Semester Exams

* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C)

- Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)

Question paper pattern for external examination: Module 1 : short answer 3 x 3 = 9 marks, paragraph 1x 6 = 6 marks, Essay 1 x10 = 10 marks ; Module 2 : short answer 2 x 3= 6 marks, paragraph 2x 6 =12marks,; Module 3 : short answer 2 x 3= 6 marks, paragraph 3x 6 = 18 marks; Module 4 : short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks

Module 1. Ecosystem (12hrs)

Unit 1: Introduction, Ecosystem & Energetics.(02 hrs)

Fundamentals of EnvironmentalSciences. Scope of Environmental Science. Ecology as an inter-disciplinary science, Sub division of Ecology- Autoecology, 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)

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 &loitic habitats- its characteristics. Faunal characteristics & adaptations.

Marine ecology- Biotic divisions and its characteristics. Pelagic realm-Plantonic& nektonic

adaptations. Benthic realm-littoral & Abyssal adaptations. Adaptations of animals on sandy, muddy & rocky seashore.

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

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, 2002; 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)

Unit 1: Foundations of Ethology(02hrs*)*-

Introduction and historical development of ethology, Contributions of Lorenz,Von Frish & Niko Tinbergen 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

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.
Identify soil micro-organisms in soil samples collected from different localities-by floatation process & Berlese funnel method. Discuss the ecological significance of soil characteristics.
Demonstration of Phototaxis by earthworm
Demonstration of alarm pheromones in ants

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

Estimation of dissolved CO2 in water sample (Pond water, well-water, Tap water).

Discuss the ecological significance of dissolved CO2 in water.

22. Estimation of PH of water (Pond water, well-water, Tap water) Discuss the ecological significance of PH characteristics.
23. Locomotory behavior of dipteran larvae on different types of substrata
24. Determination of salinity of water
25. Determination of moisture content in different types of soil (sand, clay, laterite, etc.)
26. 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. - College of Chicago Press 576pp
- Manning, O.2016 Introduction to Animal behaviour South Asia Ed, 6th Ed. Cambridge College Press, India 456pp
- Mathur, R. 2022 Animal Behaviour -Visionias 676pp
- Alcock, J. 2005 Animal Behavior - SP Oxford College 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						

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 Biology or the following online courses				
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[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Explain the mechanism of transport and exchange of respiratory gases and its control[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Identify different components of blood and various blood groups; cardio-vascular problems[PSO1]	R	F	Assignments,Seminars, Class test & Semester Exams
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[PSO3]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Acquire skill in estimating and enumerating blood parameters; calculating BMI, measuring the respiratory volumes, etc. [PSO4]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Explain the mechanism of excretion and its hormonal control; enumerate common renal disorders in man.[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 1 x 3 = 3marks, paragraph 1 x 6 = 6 marks; Module 2 : short answer 3 x 3= 9 marks, paragraph 2 x 6 = 12 marks, Essay 1 x10 = 10 marks; Module 3 : short answer 3 x 3= 9marks, paragraph 2 x 6 = 12 marks Essay 1 x10 = 10 marks ; Module 4 : short answer 3 x 3= 9 marks, paragraph 3 x 6 = 18 marks.

Module 1: Unit 1: Introduction to human physiology :(3 hrs)
Branches of human physiology, Components of body system, Human body systems and functions, vital and non vital organs, Levels of physiological regulation: Intracelluar, local and extrinsic regulation. Homeostasis, Anthropometry, BMI and its significance.
Module 2: Physiology of Respiration & Circulation (18 hrs)
Unit 1: Respiration (8 hrs) : General structure of Respiratory **system (Self study)** Measures of lung volume : Vital capacity, tidal volume, residualvolume 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)
Structure & working of heart (Self study)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)
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):
C) 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
D) Excretion (6 hrs): General structures of Excreatory system (Self study) 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 significane: 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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand 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 Diagonostic centres, and submission of detailed field study report at the time of semester end practical examination.

SUGGESTED READINGS

- 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/

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				4					3				
CO6		3					3						

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 Biology 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	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the characteristic features and classification of phylum Chordata with examples and, the structural organization of *Oryctolagus cuniculus*	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain the structuraland 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	Assignments,Seminars, Class test & Semester Exams

CO4	Enumerate the types of eggs and cleavage, the different types of blastula, morphogenetic movements during gastrulationand germ layers and their derivatives	U	F&C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO6	Prepare field study report on observing local biodiversity	C	C&P	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: ***Module 1*** *: short answer 2 x 3 = 6marks, paragraph 2 x 6 = 12 marks;* ***Module 2*** *: short answer 2 x 3= 6 marks, paragraph 3x 6 = 18 marks, Essay 1 x10 = 10 marks;* ***Module 3*** *: short answer 2 x 3= 6marks, paragraph 1 x 6 = 6 marks , Essay 1 x10 = 10 marks ;* ***Module 4*** *: short answer 4 x 3= 9 marks, paragraph 2x 6 = 12marks.*

Module 1 Protists and Non-chordates (12hrs)

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(10hrs)

Salient features of phyla, classification down to classes (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*

Type: *Penaeus* sp. Morphology, digestive system, excretory system, sense organs (statocyst and compound eye), reproductive system (Exclude details of larval stages) (3 hrs)

Phylum Onychophora: e.g.: *Peripatus*

Phylum Mollusca: e.g. *Perna, Teredo, Pinctada*

Phylum Echinodermata: e.g. *Asterias, Holothuria*

MODULE 2. Kingdom Animalia Part II : Chordata (12hrs)

Unit 1:Chordata Classification (8hrs)

Salient features, Mention classes)

Subphylum Urochordata e.g. *Ascidia*

Subphylum Cephalochordata e.g. *Branchiostoma*

Subphylum Vertebrata:

Division I:Agnathae.g. *Petromyzon*

Division II: Gnathostomata

Super class: Pisces

Class: Chondrichthyes: e.g. *Narcine*

Class: Osteichthyes: e.g. *Echeneis, Hippocampus, Scomberomorus, Brama, Sahyadriadenisonii*(Miss Kerala)

Super class: Tetrapoda

ClassAmphibia:e.g.*Ichthyophis,Salamandra,Rhacophorus,Duttaphrynus,*Mention*Nasikabatrachussahyadrensis*

Class Reptilia: e.g. *Chamaeleo, Chelone, Naja, Bungarus, Daboia*

Class Avese.g.*Columba*

Class Mammalia eg.*Pteropus*

Unit 2: Chordata Type: *Oryctolagus cuniculus*(4 hrs)

External features, skeletal system, digestive system, sense organs and nervous system. [Exclude skin, skull bones, 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(7hrs)

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 (2 hrs) - Spermatogenesis and oogenesis.

Unit 1: Fertilization (2hrs) -Fertilizin and anti-fertilizin, capacitation, agglutination, spermpenetration, activation of egg and amphimixis. Physiological and biochemical changes during and after fertilization. Pregnancy, Gestation, Placentation, parturition and lactation.

Unit 2: 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 3- 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)

Unit 1: Introduction to Embryology (1 hr) -Embryology v/s Developmental biology. Mention phases in development. Cell differentiation, totipotency, pluripotency, de-differentiaton 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 orabsence 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 : Dentition, Pectoral and Pelvic girdle

2. **Mounting:**
   Penaeus: Appendages (minor).
   Honeybee: Mouth parts (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)
Amritha lab
V lab

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- Dhami, P. S. &Dhami, J. K.: Invertebrate Zoology. R. Chand & Co, New Delhi.
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- Jordan E.L.&Verma, P.S.(2009)InvertebrateZoology,15thEdition,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
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- Scott F. Gilbert (2016) *Developmental Biology* 11th Edition, Sinauer Associates is an imprint of Oxford College 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 ClinicalImmunology* 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'sImmunobiology,* 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.

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				
CO6						3		2					3

MINOR 2 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 Biology or the following online courses				
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

Course outcome	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	Assignments,Seminars, Class test & Semester Exams
CO2	Illustrate the structure of DNA, DNA replication, Mitosis, Meiosis, Chromosomes, Gene and genetic code, types of chromosomes,	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Predict possible inheritance patterns, in the real life or imaginary situations	AP	C& M	Assignments,Seminars, Class test & Semester Exams
CO4	Describe the characteristics of various types of chromosomal anomalies	U	**C**	Assignments,Seminars, Class test & Semester Exams

CO5	Aquire skill to handle microscopes and to do biological experiments	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Compare the characteristics of mendelian and Non mendeian inheritance patterns	U	C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: Module 1 : short answer 3 x 3 = 9marks, paragraph 2 x 6 =12 marks, Essay1 x10 = 10 marks; Module 2 : short answer3 x 3=9 marks, paragraph 2 x 6 = marks; Module 3 : short answer 2 x 3= 6marks, paragraph2 x 6 = 12marks,; Module 4 : short answer 2 x 3= 6 marks, paragraph2 x 6 = 12marks, Essay 1x10 =10 marks

Module 1: CYTOLOGY (15hrs)

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)

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)

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.

ho

Module :4 Mutations and Genetic disorders (6hrs)

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.

Unt 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. 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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand introduced to the students.

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)

References

1. Vijayakumaran Nair &Jayaprakash, Cell Biology, Genetics, Molecular Biology, Academia,
Thiruvananthapuram.
2. Guptha, P.K., Cell and Molecular Biology, Rastogi Publications, Meerat.
3. Dewitt-Saunders, Biology of the cell. B.Sc. Human Physiology syllabus (CCSS) Complementary
course 5
4. Strickberger W.M-Mac Millon, Genetics.
5. Gerald Karp, Cell and Molecular Biology: Concept and Experiments.
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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Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	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					

NEUROPHYSIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
Semester	II				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total hours
	4	3		2	5
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives					

COURSE OUTCOME

Course outcome	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify the different types of nerve cells, glial cells and nerve fibres.	R	F	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the structure and functions of CNS and reflex actions, types of reflex actions	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the structure and functions of the Cerebellum and Basal Ganglia	U	F&C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO5	Attain skill in doing experiments related to neurophysiology	Ap	P	Assignments,Seminars, Class test & Semester Exams
CO6	Identify various functional deformities of brain from the symptoms shown by individuals in real life or imaginary situations	Ap	M	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 3 =9 marks, paragraph 1 x 6 = 6 marks;* ***Module 2*** *: short answer 3x 3= 9marks, paragraph 2x 6 = 12 marks, Essay1 x10 =10 marks,;* ***Module 3*** *: short answer2 x 3=6 marks, paragraph 1 x 6 =6 marks Essay 1x10 = 10 marks; Module 4 : short answer 2 x 3= 3marks, paragraph 4 x 6 =*

24 marks,

Module 1: The Nervous System (11Hrs)

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)

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)

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)

Unit 1: Functions of the specific cortical areas(4hrs) –association areas (parietooccipito 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

1apping 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		

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					

Course outcome	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	Assignments,Seminars, Class test & Semester Exams
CO2	Explain importance of sex hormones, causes of stress, and the list of hormones influencing sexual behaviour	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Predict the nature of defects caused by the damage or deformity of different parts of eye and ear	Ap	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe the sensory pathways for the guatatory, olfactory, thermosensory, pain sensations	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Attain skill in doing experiments related to sensory functioning	Ap	P	Assignments,Seminars, Class test & Semester Exams
CO6	Prepare report on visiting institutions like, hospitals to study the sensory perception analysis procedures	Ap	P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 2x 3 =6 marks, paragraph 1 x 6 = 6marks;* ***Module 2*** *: short answer 3x 3= 9marks, paragraph 2 x 6 = 12marks,; Essay1 x10 =10 marks* ***Module 3*** *: short answer2 x 3=6 marks, paragraph 2 x 6 =12 marks Essay 1x10 = 10 marks; Module 4 : short answer 2 x 3= 6 marks, paragraph 3 x 6 = 18 marks,*

Module 1: Module 1: Physiological basis of hunger and thirst (10Hrs)

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)

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)

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)

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 colourblindness 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 PremaSembulingam, 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. SaradaSubrhmanian and K. MadhavanKutty, 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.

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					

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 Biology or the following online courses 3. https://onlinecourses.swayam2.ac.in/cec20_ge23/preview 4. 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 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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO3	Enlist various traps and other physical means to control insect pests	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	identify different breeds of cattle and fowls for various purposes, different appliances and parts of cattle and poultry rearing houses	R	F	Assignments,Seminars, Class test & Semester Exams
CO5	Acquire the skills to maintain Bee hives, Silk worm rearing houses and insect traps in a scientific way.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Compare different species of honey bees and silkworms for their rearing characteristics	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3x 3 = 9marks, paragraph 1x 6 = 6marks, Essay1 x10 = 10 marks;* ***Module 2*** *: short answer 2x 3= 6marks, paragraph 2 x 6 = 12marks, Essay x10 = marks;* ***Module 3*** *: short answer 2 x 3=6 marks, paragraph 2x 6 = 12marks ;* ***Module 4*** *: short answer 3 x 3= 9 marks, paragraph3 x 6 = 18marks.*

Module 1: Apiculture (12Hrs)

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 Beekeeping; 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)

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 (7hrs)- 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)

Unit 1 : Insect traps (5hrs) – Passive traps: Window flight trap, barrier trap, Malaise trap, cone trap, pan trap, bucket trap, Aquqtic 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)

Unit 1: Dairy cattle breeding (3hrs)- Diffeent 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

5. To study the different species and castes of Honey Bees.
6. Familiarise Bee keeping instruments and Bee hives.
7. Familiarise Silkworm rearing appliances.
8. Construction of any tw types of insect traps: light trap/ sticky trap/ pan trap/ malaise trap

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

5. Identification of different species of Silkworms and their life cycles.
6. To test the quality ofmilk
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)

FieldStudy: 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)

9. 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.
10. https://agritech.tnau.ac.in/farm_enterprises/fe_api_beekeepingaccessories.html
11. https://agritech.tnau.ac.in/sericulture/seri_silkworm%20types.html
12. https://agritech.tnau.ac.in/sericulture/seri_silkworm1_rearing%20house.html
13. https://www.beemaniacs.com/2015/04/18/cells-cells-and-cells/
14. https://ir.library.oregonstate.edu/downloads/m613n331f
15. https://agritech.tnau.ac.in/farm_enterprises/fe_api_typesofhoneybee.html#:~:text=The%2

0Indian%20hive%20bee%2C%20Apis,%2C%20Melipona%20irridipennis%20(Melipori

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- B. V. David and V.V. Ramamurthy. 2016. Elements of Economic Entomology. 8thEdition. 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

7. https://www.vedantu.com/biology/apiculture-and-sericulture

8. https://elearning.icar.gov.in/eLearning_ContentDisplayUG.aspx?CourseCode=7UV3MOEAK1USxrGrYOy7VQ==&CourseName=AabP6XqFFfb5/FvzYT1aGGZAlW05pNbzZ1x4ZpuEo2OXSkGj/DaCsEk/HLGqrq6CbisPvpLgM4vZ7EWBwZLlPjc1awujk2II9I0w21IPwEM=
9. https://agritech.tnau.ac.in/animal_husbandry/animhus_index.html
10. https://vetstudy.journeywithasr.com/p/bvsc-and-ah-1st-year-notes_2.html
11. https://www.vedantu.com/biology/poultry-farming
12. https://www.drprofessionals.in/2021/05/livestock-production-management.html#google_vignette

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				
CO6		3					3						

AQUACULTURE AND FISHERY SCIENCE PRACTISES

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 Biology 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. [PSO1, PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the concepts of pond culture, pen culture, cage culture and other advanced culture systems [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain different types of tools used in fishing and resource utilization[PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Develop expertise in setting up and maintenance of different types of aquaculture systems in commercial level. [PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO5	Prepare field reports on visiting aquaculture systems, fish processing centers and fish landing centers [PSO6]	C	M&P	Assignments,Seminars, Class test & Semester Exams
CO6	Recognize different disease or malnourishment conditions of culture fishes in real life and imaginary situations	Ap	M	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1****: short answer 3 x 3 marks = 9marks;* ***Module 2****: short answer4 x 3 marks= 12marks, paragraph 2 x 6 marks= 12marks;* ***Module 3****: short answer1 x3 marks= 3marks, paragraph3 x 6marks =18marks,Essay1 x10 arks = 10 marks;* ***Module 4****: short answer 4x 3 marks= 12marks, paragraph2x 6 marks = 12marks, Essay1 x10marks = 10 marks*

Module 1: Unit 1: Introduction to Aquaculture (6hrs)

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)

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)

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)

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

11. Identification of culturable species.
12. Feed formulation and preparation for cyprinids, catfishes, prawns, etc.
13. 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)
14. 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.

15. Identification of aquatic weeds, pests and predators.

16. Water quality analysis of aquaculture systems
17. Culturing of any commonly available culture fishes in synthetic tanks, ponds etc.
18. Making of culture devices: rafts for mussel culture, happa for fish culture etc.
19. Identification of culture fish diseases.
20. .Identification of preserved fish products

Virtual lab:

4. https://blue-cloud.d4science.org/web/aquacultureatlasgeneration
5. https://www.aquaexcel2020.eu/virtual-laboratory
6. https://www.aquafeed.com/regions/europe/new-virtual-fish-laboratory-open-for-use/

References

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- Jawid Ahsan and Subhas Prasad Sinha (2010): A hand Book on Economic Zoology; S. Chand, ISBN. 9788121908764, 314 pages
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- Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.
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- 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.

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

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 Biology 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	Describe various data collection and presentation methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Perform various data analysis procedure using the given data	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the procedures for centrifugation, electrophoresis, chromatography etc.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Explain DNA extraction and purification and histochemical tissue preparation methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Perform experiments related to biostatistics and tissue processing techniques	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Compare the merits and demerits of different techniques for molecular, cutological and histological studies	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 2 x 3 = 6marks, paragraph 2 x 6 = 12 marks;* ***Module 2*** *: short answer 2 x 3= 6 marks, paragraph 2x 6 = 12*

marks, Essay 1 x10 = 10 marks; ***Module 3*** *: short answer 2 x 3= 6marks, paragraph 2x 6 = 12marks , Essay 1 x10 = 10 marks ;* ***Module 4*** *: short answer 4 x 3= 9 marks, paragraph 2x 6 = 12marks.*

Module 1 Data – Collection and Presentation (9Hrs)

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 (1Hr)

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)**

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. (7Hrs) 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)

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) (6Hrs)

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)

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

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Module 5: PRACTICALS (1 CREDIT, 30 Hrs)

MANDATORY EXPERIMENTS

- Calculate the mean, median and mode (raw data, discrete series & continuous series) for the given data

- 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.
- Demonstration of Paper Chromatography/Centrifugation- Pipetting and dilution technique
- Staining any tissue sample (serial sectioning) and whole mount preparation

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

- Measure the size of given shells / any sample of data and represent it in a graphical form and interpret it.
- Census the avian fauna / any fauna of two different areas and present the data in a suitable graphical form. Compare by t-test.
- Construct a frequency curve and frequency polygon with mean ± SD using suitable data. Draw the same in Excel or using any free software and record it.
- Draw a bar diagram with mean ± SD employing suitable data. Construct a histogram with mean ± SD utilizing suitable data. Do the same with software
- Draw a pie diagram using suitable data. Draw the same in Excel or using any free software.
- Demonstration of PCR set up and optimization
- Demonstration of any one type of Electrophoresis
- 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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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				
CO 3		3					3						
CO 4		3					3						
CO 5				3					3				
CO6		3				3	2						

COMPUTATIONAL BIOLOGY AND STATISTICAL APPLICATONS

Programme	B.Sc. Zoology				
Type of Course	Minor				
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					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will develop a thorough knowledge of computational biology, including its historical context and importance in contemporary biological research, enable them to recognize diverse biological databases and acquire skills in retrieving and analyzing data from these databases through online tools and resources	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Understand the importance of algorithms in computational biology, their role in solving complex biological problems, develop competency in various algorithmic techniques like recursion, linear searches, and divide and conquer algorithms.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Understand 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.	R	F	Assignments,Seminars, Class test & Semester Exams

CO4	Understand 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	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	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	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	: Utilize 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	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks, paragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

Module 1: Fundamentals of Computational Biology (12hrs)

Unit 1 Introduction to Computational Biology: Overview of computational biology, significance in modern biological research; Historical background and milestones, Scope and applications of Unit 2 Biological Databases and Data Retrieval:Overview of biological databases: 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: 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 : 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)

Unit 1: Genomics and proteomics: 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: 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.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 : 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: 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)

Unit 1: Basics of Biostatistics and Data Management: 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: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: 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: 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)

Unit 1: Bayesian Methods and Markov Chain Monte Carlo (MCMC): 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: 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: 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: 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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1. Tom White " Hadoop: The Definitive Guide" Third Edit on, O'reily Media, 2012.
2. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2013). Bioinformatics: Methods And Applications: (Genomics, Proteomics and Drug Discovery). PHI Learning Pvt. Ltd.
3. Xiong, J. (2006). Essential bioinformatics. Cambridge College 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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12. Han, J., Kamber, M., & Pei, J. (2006). Data Mining: Concepts and Techniques, (The Morgan Kaufmann Series in Data Management Systems).

ONLINE SOURCE

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

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 Biology				
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 statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the characteristics of environment and its biotic andabiotic factors,	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Conduct direct surveys which gives first-hand observations of animals or other living organisms under laboratory or real-world conditions	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe process of data analysis and interpretation	R	F	Assignments,Seminars, Class test & Semester Exams
CO4	Explain various steps of scientific writing	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Identify various terms and population estimation methods	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Develop skills in applying statistical and ecological tools in practical life	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination. Module I: Short answer 2x 3 = 6 marks, paragraph 2 x 6 = 6 marks; Module II: Short answer 2 x 3 = 12 marks, paragraph 1 x 6 = 12 marks, Essay 1 x 10 = 10 marks; Module III: Short answer 3 x 3 = marks, paragraph 2 x 6 = 12 marks, Essay 1 x 10 = 10 marks; Module 4: Short answer 3 x 3 = 9 marks, paragraph 3x 6 = 18marks.

Module I: Introduction to Ecological Research (9 hours)

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, plagiarism prevention.

Module II: Field Sampling and CollectionTechniques (12 hours)

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)

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)

Unit 1: Scientific writing: Writing research reports, scientific papers, and abstracts, proper citation styles, effective communication of scientific findings**.**

Unit 2: Oral presentations: Preparing and delivering scientific presentations, using visual aids effectively, answering questions from the audience.

Unit 3: Data sharing and scientific collaboration: Importance of data sharing, online repositories for ecological data, collaboration with other researchers**.**

Unit 4: Scientific ethics and integrity: 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 Supervising Teacher 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:

- Bailey, N.T.J. Statistical method in Biology Low Priced Text Book English Language Society, London, 1959.
- Bencroft, H. Introduction to Biostatistics Harper and Row. New York, 1957.
- Biostatistics; Gupta, S.P. Sultan Chand andCo.
- 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

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1												
CO 2												
CO 3												
CO 4												
CO 5												
CO 6												

Correlation Levels:

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

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 Biology or equivalent online courses Online :- 1 Food Safety and Quality ControlCEC and English and Foreign Languages College 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 Processing www.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 statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Explain nutrient components of food and sensory evaluation methods of food.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Compare the efficiencies of various food preservation and infestation control methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe various food processing methods	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Explain various causes of food damage, Food hygiene and safety practises	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Peerform experiments to detect the quality of food materials, various processing and preservation tecchniques	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Identify the causes of food spoilage in real life or imaginary situations and suggest the remedies for it	Ap	M	Lab experiments and 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)				

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 3 =9 marks, paragraph 1 x 6 = 6marks;* ***Module 2*** *: short answer 3x 3= 9marks, paragraph 2 x 6 = 12marks, Essay1 x10 =10 marks;* ***Module 3*** *: short answer2 x 3=6 marks, paragraph 3 x 6 =18 marks;* ***Module 4*** *: short answer 2 x 3= 6 marks, paragraph 2 x 6 = 12 marks, Essay 1x10 = 10 marks*

Module 1: Food and its constituents (6hrs)

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)

UNIT I:-Preservation by using preservative (2 Hours) 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 II: Preservation by use of high temperature (4 Hours) 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 III : Preservation by use of low temperature (3 Hours) 1. Refrigeration - advantages and disadvantages, freezing: Types of freezing, common spoilages occurring during freezing, difference between refrigeration and freezing.

UNIT IV: Preservation by removal of moisture (2Hours) 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 V: Recent Methods in Food Preservation (1 Hours) 1. Pulsed electric field processing, High Pressure Processing, Processing using Ultra Sound, Dielectric, Ohmic and Infrared Heat.

UNIY VI :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)

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)

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 Hours). 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 (4Hours) 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 Hours) 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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand 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

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- Vijaya Kadar Food storage and preservation
- Central warehouse corporation, New Delhi Manual of storage practices
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- Satish Kumar Sharma Post harvest Management and processing of fruit and vegetables-Instant notes
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- 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

1 Professional Certificate in Essential Concepts in Food Safety and Hygiene
2 Professional Certificates in Introduction to Food Safety Standards
3 Food Safety and Nutrition A Global Approach to Public Health
4 Food 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
CO 1	2	3					3					
CO 2	2		3				3					
CO 3	2	3					3					
CO 4	2	3					3					
CO 5		2		3					3			
CO 6		2			3						3	

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 Biology 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 Aider, 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 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	Assignments,Seminars, Class test & Semester Exams
CO2	Explain different types of common injuries, the first aids provided for them,	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain the need of sex eduction and sex and reproductive health issues	U	F&C	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO5	Practice various first aid methods	Ap	P	Assignments,Seminars, Class test & Semester Exams
CO6	Provide first aid for the needy person in real life situations	Ap	P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 3 = 9marks, paragraph 2 x 6 = 12marks, Essay1 x10 = 10 marks;* ***Module 2*** *: short answer3 x 3=9 marks, paragraph 2x 6 =12 marks,;* ***Module 3*** *: short answer 2 x 3= 6marks, paragraph 1x 6 =6 marks Essay 1x10 =10 marks ;* ***Module 4*** *: short answer2 x 3= 6 marks, paragraph3 x 6 = 18marks,*

Module 1: Basics of First Aid (15 hrs)

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. 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)

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

Module 3: Sex education (12 hrs)

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 (4 hrs)

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; 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:4 Mental Health and Psychological First Aid (8hrs):
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 Supervising Teacher from the following list. Two experiments other than the listed should be selected by the Supervising teacherand 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.
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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

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1		3					3						
CO 2		3					3						
CO 3		3			3		3						
CO 4		3					3						
CO 5				3					3				
CO 6				3	2				3			2	

ADVANCES IN BIOTECHNOLOGY AND MICROBIOLOGY

Programme	B.Sc. Zoology				
Type of Course	Minor				
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					

Course outcomes (CO)

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	The studentlearn the features of various types of cloning vectors and exploredifferent steps involved in molecular cloning	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	The studentwill describe the techniques involved in the production of molecular probes,Genomic and CDNA library,analyse techniques involved in isolation, sequencing and synthesis of genes, andget familial with the biotechnological techniques like antisense RNA and their applications	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	The studentwill understand various aspects of IPR, the ethical issues in cloning, GM food crops and social implications of biotechnology in the body.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe role of microbes in Industry	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Expain the functioning of Bioreactors	Ap	P	Assignments,Seminars, Class test & Semester Exams
CO6	Explain the down stream processing	Ap	P	Assignments,Seminars, Class test & Semester Exams

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

***Question paper pattern for external examination**: **Module 1** : short answer x 3 = marks, paragraph x 6 = marks Essay x10 = marks; **Module 2 :** short answer x 3= marks,aragraph x 6 =marks,; **Module 3** : short answer x 3= marks, paragraph x 6 = marks Essay x10 = marks ; **Module 4** : short answer x 3= marks, paragraph x 6 = marks,*

PART A BIOTECHNOLOGY

MODULE I Introduction to cloning vectors and methods (10hrs)

Cloning vectors–

Plasmids: pBR322 andpUC

Phages: λgt10 and M13vector

Cosmids: generalfeatures

Phagemids: generalfeatures

Viruses: SV40 andCaMV

Transposones; Ac transposon and Ds transposon of Maize, P-elementof *Drosophila*

Artificial chromosomes: BAC, YAC andMAC.

Shuttle vectors: applications andexample

Expression vectors: mention commonly used promoters in expressionvectors(Nopaline synthase (*nos*) promoter from T-DNA, 35 S RNA promoter ofCaMV, Polyhedrin promoter fromBaculovirus

Construction of chimeric DNA (Blunt end ligation, cohesive end ligation, homopolymer tailing, use oflinkers)

Selection of transformed cells –blue white selection method, colony hybridization, Plaque hybridization

Amplification – Multiplication, Expression, and integration of the DNA insert in host genome

Module II Advanced techniques in Biotechnology(15hr)

Molecular probes and Applications

FISH, McFISH andGISH

Construction of Genomic library.

Screening –By DNA hybridization, Screening by immunological assay, and screening by protein activity

Chromosomewalking

PCR methods, Inverse PCR, Anchored PCR, Asymmetric PCR, PCR for mutagenesis and Real Time PCR

Applications of PCR in Biotechnology and geneticengineering

DNA sequencing – Maxam and Gilbert's chemical degradation method, Sanger's dideoxynucleotide syntheticmethod,NGS.

Gene synthesismachines

AntisenceTechnology : Antisense RNA and its applications in biomedical and agriculture fields, RNAinterference, Gene knockouts and Knock outmouse

Cloning procedures (adult DNA cloning, Therapeutic cloning, Embryo cloning)– Advantages and disadvantages ofcloning

Intellectual property rights and ethical and social implications of Biotechnology
Intellectual propertyprotection,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

Ethics of Genetic engineering - Social impacts - Human safety-Virus resistant plants- Animals andethics-

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 Industrialbiotechnology

MODULE III: Module 4: Introduction to Bioprocess & Microbes in Industry (10hrs)

Introduction to bioprocess engineering: 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.

Upstream processing: Microbial Nutrition, Media formulation for industrial fermentation. Development of inocula for the industrial fermentations. Scale up.

MODULE IV: Bioprocess Technology (15hrs)

Bioreactors: batch, fed –batch and continuous bioreactors, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.

Industrial production of chemicals, alcohol (ethanol), acids (citric, acetic and gluconic),solvents
Glycerol,acetone,butanol,antibiotics(pencilliin,streptomycin,tetracycline),aminoacids (lysine, glutamic acid),single cell protein. Enzyme and whole cell immobilization and their industrial applications.

Downstream processing: 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 V: Experiential learning

1. FISH &GISH
2. Different types of PCR and their application
3. Sangers method of DNA sequencing
4. RNA interference and its application
5. Gene knockout
6. Knock out mouse
7. GATT & TRIPS

References

Part- A- Biotechnology

Alphey - DNA sequencing-Bios Scientificpublishers-
Bernard R. Glick and Jack J. Pasternak-Molecular Biotechnology-Principles and applications of recombinant DNA- ASM press WashingtonD.C.
Charles Hardin (2008): Cloning, Gene expression, and Protein purification-Experimental procedures and process rationale - Oxford CollegePress.
Chatterji, A.K.(2007). Introduction to environmental biotechnology-Prentice Hall ofIndia
Colin Ratledge and Bjorn Kristiasen-Basic Biotechnology - Cambridge Collegepress.
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
Dubey, R.C. -A text book of biotechnology-S. Chand &Co.
Emmanuel. C., Rev. Fr. Ignacimuthu. S. and Vincent. S. Applied Genetics: Recent Trends and Techniques, MJP Publishers,Chennai
Gupta. P.K. -Elements of biotechnology-Rastogipublications.
Singh, B.D.(2002).Biotechnology-Kalyanipublishers.
Sobti, R.C. and Suparna, S. Pachauri-Essentials of Biotechnology-Ane Books Pvt.Ltd.
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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.
Alberts,B., Bray, D., Lewis, J., Raff., M, Roberts, K. And Watson, J.D. (2000). Molecular Biology of the cell. Garland Science, NewYork.
Brown .T.A. (2002).Genomes II ed. John Wiley and Sons, NewYork.
Freshney, Ian R.(2006). Culture of Animal Cell. 5thed. Wiley-LissPublications.
Glick,B.R.and Pasternak, J.J.(1998). Molecular Biotechnology-Principlesand Applications of Recombinant DNA.

BIOPROCESSING

Reference Books: 1. Biochemical Engineering, Aiba,S., Humprey,A.E., and Millis,N.F., Unty. of Tokyo Press, Tokyo.
Biochemical Reactors. Atkinson,B., Pion, Ltd., London.
Biochemical Engineering Fundamentals. Baily,J.E., and Ollis,D.F., McGraw – Hill Book Co. New York.
Bioprocess Technology: Fundamentals and applications, KTH, Stockholm. 5. Process Engineering in Biotechnology, Jackson,A.T., Prentice Hall, Engelwood Cliffs.
Bioprocess engineering: Basic Concepts, Shuler,M.L., and Kargi,F., Prentice Hall, Engelwood Cliffs.
Principles of Fermentation Technology. Stanbury,P.F., and Whitaker,A., Pergamann Press, Oxford.
Bioreaction Engineering Principles ,Neilson,J., and Villadsen,J. Plenum Press.
Chemical Engineering Problems in Biotechnology, Shuler, M.L.(Ed.), AICHE. 30
Biochemical Engineering, Lee,J.M., Prentice hall Inc.
. Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression, Vieth, W.F., John Wiley and Sons, Inc.

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

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 Biology 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				

CO	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts in nutrition [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Enlist the vitamins and minerals and their roles in human nutrition [PSO1]	R	F	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the importance of hygienic and body fitness paractises and ill effects of smoking and other abuses[PSO]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Illustrate diet therapy and dietary management of various conditions [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Perform first aid management in emergency situations [PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Describe the major communicable, non-communicable, congenital and sexually transmitted human diseases [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Q*uestion paper pattern for external examination:* ***Module 1*** *: short answer 2 x 2=4 marks, paragraph1 x 6 =6 marks,;* ***Module 2*** *: short answer3 x 2= 6marks, paragraph 2 x 6 = 12marks, Essay 1 x10 =10 marks;* ***Module 3*** *: short answer 2 x2= 4marks, paragraph 1 x 6 = marks;* ***Module 4*** *: short answer3 x 2=6 marks, paragraph1 x 6 = 6marks, Essay 1x10marks = 10 marks*

Module 1: Basics of Nutrition (6 hrs)

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)

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)

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: Smokig 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)

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 haemorrhage 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. Experiential learning (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.

The student should produce record of following works at the end of course /semester

1. Calculation of BMI
2. Calculation of BMR
3. Prepare 10 healthy eating tips for busy working man, woman and student
4. prepare a healthy nutrition for college students
5. Meal Planning: - Diet Planning for several lifestyle disorders --.
6. Diabetes ,
7. Renal and Liver Cardiac Disorder,
8. Gastrointestinal disorder
9. weight management

Laboratory demonstration, practicals and instrument handling

Protein , Fat and Energy Kcal Estimation

Food Labeling and Packet Analysis

References

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- ICMR (2010) Recommended Dietary Allowances for Indians .Published by National Institute of Nutrition, Hyderabad.
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- Seth V and Singh K (2006). Diet Planning through the Life Cycle: Part 1 Normal Nutrition. A Practical Manual. Elite Publishing House Pvt. Ltd. New Delhi.
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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				
CO 6		3					3						

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.			

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	Assignments,Seminars, Class test & Semester Exams
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	R	F	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
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	Assignments,Seminars, Class test & Semester Exams
CO5	Explain the importance of sex education, various fertility control methods and important sexually transmitted diseases	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Manage to conduct awareness programmes on the need of sex education	U	F&C	Assignments,Seminars, Class test & Semester Exams
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 2= 6marks, Paragragh 2 x 6 = 12marks ;* ***Module 2*** *: short answer 1 x 2= 2 marks, paragraph 2 x 6 = 12 marks, Essay1 x10 = 10 marks;* ***Module 3*** *: short answer 4 x 2= 8marks, paragraph 1 x 6 = 6marks;* ***Module 4*** *: short answer 2 x 2= 4 marks, Essay 1 x10 = 10 marks*

Module 1. Introduction, Ethical aspects, Sexual orientation, abuse & myths (9hours)

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)

Unit 1- Sex determination (3 hours)

Mechanism of sex determination- chromosomal, environmental and hormonal; Barr body; sex mosaicicm; 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)

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)

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

	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						

AQUACULTURE AND ORNAMENTAL FISH FARMING

rogramme	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 Biology 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 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. [PSO1, PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the different types of tools used in aquariums [PSO2]	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Identify the diversity of ornamental fishes and develop skills in aquarium fabrication and maintenance. [PSO4, PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO4	Develop skills in culture and breeding of freshwater and marine ornamental fish varieties.[PSO4, PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO5	Develop expertise in setting up and maintenance of freshwater and marine aquariums as hobby and also in commercial level. [PSO5]	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Employment and Entrepreneurship skill development in the field of ornamental fish industry. [PSO5]	Ap	M&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 3 x 2 marks = 6 marks, paragraph 2 x 6 marks = 12 marks; Module 2 : short answer 3 x 2 marks= 6 marks, paragraph 1 x 6 marks = 6 marks; Module 3 : short answer 2 x 2 marks= 4 marks, paragraph 2 x 6 marks = 12 marks,Essay1 x10 marks = 10 marks; Module 4 : short answer 2 x 3 marks= 6 marks, paragraph 3x 6 marks = 18 marks, Essay 1x10marks = 10 marks; Module 5: paragraph 2 x 6 marks = 12 marks

Module 1: Introduction to Aquaculture 9hrs)

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)

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)

Unit 1:Introduction (2hrs)- Farm design, quarantine facility, transportation of fishes, Government programs and institutions facilitating the ornamental fish production.

Unit 2: Aquarium cinstruction (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)

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: Ornamental fishes and skill development (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.

References

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- Jawid Ahsan and Subhas Prasad Sinha (2010): A hand Book on Economic Zoology; S. Chand, ISBN. 9788121908764, 314 pages
- V. B. Upadhyay and G. S. Shukla (2007): Applied and Economic Zoology; Rastogi Publications. 496 pages
- Ahilan. B, Felix. N. & Jameson, J.D., 2009. Goldfish. Daya Publishing House, New Delhi. 87 pp.
- Alappat, H.J. & A. Biju Kumar 1996. Aquarium Fishes (A Colourful Profile). B.R. Publ., Delhi, 106 pp. Alderton, D., 2019.
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- Bailey M., & Sanford, G., 2017. Aquarium fish- a definitive guide to identify and keeping freshwater and marine fishes. Smithmark Publishers, USA. 256 pp.
- Biju Kumar, A. & Alappat, H.J., 1996. A Complete Guide to Aquarium Keeping. Books for All, Delhi, 80 pp.
- Dholakia, A.D., 2009. Ornamental fish Culture & Aquarium Management. Daya Publishing House, Delhi, 313 pp.
- Kurup, M.B,. 2008. Ornamental Fish Farming, Breeding and Trade. Dept. Fish., Govt. Kerala, 280 pp.
- Meenakshi, J., N.K. Yadava & Gupta, R.K., 2010. Freshwater Ornamental Fishes. Mangalam Pubications, Delhi, 397 pp.
- Mills, D., 1984. A Fish Keepers Guide to the Tropical Aquarium. Salamander Books, Ltd., London, 115 pp.
- Rataj, K. &Zukal, R., 1971. Aquarium Fishes and Plants. The Hamlyn Publ. Group Ltd., London.
- Mills, D., 1987. The Practical Encyclopedia of the Marine Aquarium. Salamander Books Limited, London.

Online Sources

1. https://thefishsite.com/articles/an-introduction-to-ornamental-aquaculture
2. http://cifa.nic.in/sites/default/files/Ornamental_fish.pdf
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 :

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

CO 4				2	3				3				
CO 5					3				3				
CO 6					3				3				

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			45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives	The student get an acquaintance with the Apiculture a d Sericulture practises				

Course outcome	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe the basic concepts of Apiculture & Sericulture.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Explain different species and races of Honey Bees & Silk Insect.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Describe the importance of health and hygiene in Beekeeping & Sericulture.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Analyse the possibilities of entrepreneurship in apiculture and sericulture	An	C&P	Assignments,Seminars, Class test & Semester Exams
CO5	Describe the economic importance of Apiculture and Sericulture.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO6	Maintain Bee hives and Silk worm rearing houses in a scientific way	Ap	P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 2 =6marks, paragraph 1 x 6 = 6marks, Essay1 x10 =10 marks;* ***Module 2*** *: short answer 2x 2= 4marks, paragraph 1x 6 = 12marks,;* ***Module 3*** *: short answer3 x 2=4marks, paragraph 1x 6=18 marks Essay 1x10 = 10 marks;* ***Module 4*** *: short answer 2 x 2= 4 marks, paragraph 2 x 6 = 12 marks,*

Module 1: Apiculture (9hrs)

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)

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)

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)

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 to Traditional methods and Recent Developments in Apiculture and Sericulture; practice sessions to construct beehives; a field visit to an apiary or sericulture centers

References

- 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.

8thEdition. ISBN: 9780994869104, 099486910X, Brillion Publishing. 400 pages.
- . 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.
- Benjamin, G. 2022. Veetuvalappile theneecha valarthal (Malayalam) H &C publishers
- Mohanan, P. V. & Shaju Joseph 2016-Theneecha Valarthal (Malayalam Edition) DC Books

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	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			2		2
CO 5		3											
CO 6				3	2				3				

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			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 comeptitve exams,				

Course outcome	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Identify various names, functions and structural parts of the cell	R	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the various theories of evolution, the importance of Ecological study, components of ecosystem, different kinds of population interactions.	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Correlate the structure and functions of various organ system in human body	Ap	C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe the symptoms and causes of various human diseases	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Organize model competitive tests based on the course content	C	M	Assignments,Seminars, Class test & Semester Exams
CO6	Make comparison with the course content and questions in the recent competitive exams and suggest modifications for the course content	An	M	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 2 x 2 =4 marks, paragraph 2x 6 = 6marks;* ***Module 2*** *: short answer 3x 2= 6marks, paragraph 1x 6 = 6marks, Essay1 x10 =10 marks;* ***Module 3*** *: short answer3 x 2=6 marks, paragraph 1 x 6 =6*

marks; Essay 1x10 = 10 marks ***Module 4*** *: short answer 2 x 2= 4 marks, paragraph 1 x 6 = 6marks,*

Module 1: Introduction to the course and Cell organization (7hrs)

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 andecological principles-(11hrs)

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)

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)

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: (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

- Gupta, P. K. (2018): Cell and Molecular Biology, Revised 5th edition, ISBN, 978-93-5078-154-8, Rastogi Pubs., 1192 pages.
- Verma, P.S. & Agarwal, V.K. (1999): Cytology. S., Chand & Co., 504 pages.
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- Mange, E.J. & Mange, A.P. (1999) Basic Human Genetics, Rastogi Pubs
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- Odum, E.P. (1971). Fundamentals of Ecology. W.B. Saunders Co. USA, 574p ISBN 10: 0721669417.
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- Arthur C.Guyton & John E. Hall (2003): Textbook of Medical Physiology, Saunders.
- Jain A.K. (2009): Text Book of Physiology (Vol. I & II), Avichal Publishing Company, New Delhi.
- ChakrabortyP.A.(2009) Text Book of Microbiology, ISBN-10: 8173810818 New Central Book Agency, 1026 pages.
- Prakash Kothari (1995): Common sexual problems and solutions, 2nd Edition, ISBN10: 8185674086, UBS Publ. and Distributors Ltd., 173 pages.
- ttp://www.biologydiscussion.com/essay/reproductive-health-in-human-problemsand-strategies/5167

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								
CO 4		3					3						
CO 5						3		3					
CO 6					3						3	2	

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			45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives					

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	Assignments,Seminars, Class test & Semester Exams
CO2	Explain various ways for stress management	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Explain different kinds of mental health problems, and way to improve mental health	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe need of self empowerment, different empowerment exercises	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Practice various exercises for a holistic health	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Describe the importance of healthy diet for the development of holistic health	U	F&C	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 2 =6marks, paragraph 1 x 6 = 6marks, Essay1 x10 =10 marks;* ***Module 2*** *: short answer 2x 2= 4marks, paragraph 1x 6 = 12marks,;* ***Module 3*** *: short answer3 x 2=4marks, paragraph 1x 6=18*

marks Essay 1x10 = 10 marks; ***Module 4*** *: short answer 2 x 2= 4 marks, paragraph 2 x 6 = 12 marks,*

Module 1: 1 Holistic health –Basic Aspects(12hrs)

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 3: 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)

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)

Unit 1: 1Emotional wellness (4hrs)- Definition, concept goals, signs ,importance; Ways to improve emotional well being ; 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)

Unit 1: Ways to achieve self empowerment, Personal empowerment exercise; importance, dimensions, self analysis; Tracks to empower self

Module 5: (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

1 James Clear Atomic Habits: An Easy & Proven Way to Build Good Habits & Break Bad Ones (2018) The #1 New York Times bestseller.

2 Stephen R. Covey The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change Paperback – Special Edition, (2013)

3 Travis Bradberry Emotional Intelligence Habits Hardcover –2023

4 How Not to Die: Discover the Foods Scientifically Proven to Prevent and Reverse Disease(2015) Michael Greger, Gene Stone by Flatiron Books ISBN 9781250066114 (ISBN10: 1250066115)

5 You Can Heal Your Life(1984)
Louise L. Hay Format 253 pages, Unknown Binding
Published by Full Circle ISBN 9788176210775 (ISBN10: 8176210773

6 Mind over Medicine: Scientific Proof That You Can Heal Yourself
Lissa Rankin, Kris Carr (Forward by) (2013)
259 pages, Published , by Hay House Inc ISBN 9781401939984 (ISBN10: 1401939988)

7 Heal Your Wounds & Find Your True Self Lise Bourbeau (2002) 232 pages, Published by Lotus Press (WI) ISBN 9782920932210 (ISBN10: 2920932217)

8 When the Body Says No: The Cost of Hidden Stress Gabor Maté (2004) 320 pages, Published , by Vintage Canada ISBN 9780676973129 (ISBN10: 0676973124)

9 Heal Your Body: The Mental Causes for Physical Illness and the Metaphysical Way to Overcome Them Louise L. Hay (1984) 96 pages, published by Hay House ISBN 9780937611357 (ISBN10: 0937611352)

10 The Biology Of Belief: Unleashing The Power Of Consciousness, Matter And Miracles Bruce H. Lipton(2005) 205 pages, Published by by Authors Pub Corp ISBN 9780975991473 (ISBN10: 0975991477)

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						

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			45
Pre-requisites	+2 /VHSC or equivalent online courses				
Course objectives					

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	Assignments,Seminars, Class test & Semester Exams
CO2	Apply economic principles to analyze environmental issues.		F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Enumerate the costs and benefits of environmental policies.	An	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Analyze the role of markets and institutions in environmental decision-making.	An	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Analyse the arguments for and sustainable development	An	F&C	Assignments,Seminars, Class test & Semester Exams
CO6	Make reports after analysing the functioning of different sustainable development and ecotourism projects	Ap	M&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: ***Module 1*** *: short answer 3 x 2 =6marks, paragraph 1 x 6 = 6marks,;* ***Module 2*** *: short answer 2x 2= 4marks, paragraph 1x 6 = 6marks, Essay1 x10 =10 marks,;* ***Module 3*** *: short answer 2 x 2=4marks, paragraph 1x 6=6 marks Essay 1x10 = 10 marks;* ***Module 4*** *: short answer 4 x 2= 8 marks, paragraph 2 x 6 = 12 marks,*

Module 1: Introduction to Ecological Economics and Sustainable Development (7hrs)

Unit 1: Foundations of ecological economics: 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: Brundtland Commission report; Different approaches and perspectives; SDGs (Sustainable Development Goals) and their importance.
Unit 3: Challenges to sustainable development: Climate change; Biodiversity loss; Resource depletion; Pollution and environmental degradation.

Module :2 Resource Management and Environmental Degradation (7hrs)
Unit 1: Renewable Resources: 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: Fossil fuels and climate change. Peak oil and resource depletion. Resource curse and economic development..
Unit 3: Pollution and Waste Management: Air pollution and its control. Water pollution and treatment. Solid waste management and recycling.

Module 3: Sustainable Development in Practice (10hrs)
Unit 1: Green economy and circular economy: 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: 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, 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)
Unit 1: Emerging issues in ecological economics and sustainable development: Technological innovations for sustainability; Climate change adaptation and mitigation strategies; Building resilience to environmental shocks
Unit 2: Climate change mitigation and adaptation strategies, 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: 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: (9hrs)

Teacher can design student activities like Field trip or online tour of a local sustainable development project. OR Calculation of ecological footprints of your campus

College Footprint Calculator: https://www.eusteps.eu/resources/College-footprint-calculator/

Global Footprint Network: https://www.footprintnetwork.org/

Ecological Footprint Standard: https://www.footprintnetwork.org/resources/data/

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2. Pearce, D. W., Turner, R. K., & Bateman, I. (2003). Economics of natural resources and the environment. Johns Hopkins College Press.
3. Tietenberg, T. (2005). Environmental economics and policy. Pearson Education.
4. Oates, W. E. (2008). The economics of environment: Pollution, regulation, and development. Edward Elgar Publishing.
5. Brundtland Commission. (1987). Our common future: Report of the World Commission on Environment and Development. UN Documents.
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 College Press.
8. Dasgupta, P. (2021). The economics of biodiversity: The value of the natural world. Oxford College 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.

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				2		
CO 3					3		3						
CO 4					3		3				2		
CO 5					3								
CO 6				2	2	3	3				3		

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	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)

Course outcome	CO statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Describe various care and maintenance methods for laboratory equipments	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO2	Describe the methods for preparation of biological museum specimens	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Expain the process of taxidermy	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Describe preservation techniques for biological specimens	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Develop skill in performing taxidermy and other preservation techniques.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Maintain an own collection of Biological specimens.	Ap	C&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 2 x 3 = 6marks,

Paragragh 2x 6 = 12marks ; Module 2 : short answer 3 x 3= 9 marks, paragraph 1 x 6 = 6 marks, Essay1 x10 = 10 marks; Module 3 : short answer 2 x 3= 6marks, paragraph 1 x 6 = 6 marks; Module 4 : short answer 3 x 3= 9 marks, paragraph 1 x 6 = 6 marks, Essay 1 x10 = 10 marks

Module 1. Laboratory equipment maintenance (10hrs)

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)

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)

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)

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. (8 hours)

Visit to natural history museums (GASS, ZSI,TNU.KFRI & KAU) and submit report at the time of practical examination.

Submit a preserved collection of common insects (at least 20 specimens)

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 – College of North Texas , McGraw-Hill Learning Solutions

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

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 is designed to develop			

Course Outcomes (CO)

Course outcome	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	Assignments,Seminars, Class test & Semester Exams
CO2	Explain the methods of ANOVA, Correlation and regression	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO3	Application of biostatistical tools in different in different Research problems in Biology	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO4	Deep understanding and applications of Free software related to biostatistics	U	F&C	Assignments,Seminars, Class test & Semester Exams
CO5	Basic practical understanding of Various biological databases and data retrieval methods	Ap	C&P	Assignments,Seminars, Class test & Semester Exams
CO6	Practical experience in molecular docking, including ligand selection, homology modelling of protein, drug binding /docking stability analyses and visualizations	Ap	C&P	Assignments,Seminars, Class test & Semester Exams

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

Question paper pattern for external examination: Module 1 : short answer 2 x 2= 4marks, Paragragh 2x 6 = 12marks ; Module 2 : short answer 3 x 2= 6marks, paragraph 1 x 6 = 6 marks, Essay1 x10 = 10 marks; Module 3 : short answer 2 x 2= 4marks, paragraph 1 x 6 = 6 marks, Essay 1 x10 = 10 marks; Module 4 : short answer 3 x 2= 6 marks, paragraph 1 x 6 = 6 marks,

Biostatistics (18Hrs)

MODULE 1 Data presentation and visualization (10 Hrs)

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 3: 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)

Unit 1: Introduction to PAST/ R softwares; Installation and applications (1hr)

Unit 2: t-test(2hrs): Types,* (problems to be discussed)*

Paired t-test

Unpairedt-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)

1. Biological Databanks Sequence Databases, Structure Databases, Specialized Databases.
2. Make list of Biological databases for DNA and protein by browsing search engines.
3. Visit NCBI,CLUSTAL W &COBALT. Explore them, List out the salient features of thesedatabases.
4. Data Retrieval tools and file formats :Retrieve the gene sequences by exploring and querying the nucleic acid databases.
5. Data Retrieval tools and file formats :Retrieve the protein sequences by exploring and querying the protein databases.
6. Sequence Similarity searching (NCBI BLAST)
7. Multiple Sequence Alignment (CLUSTAL W)
8. Molecular Phylogeny (PHYLIP/MEGA/NCBI/MSA)- Construction of phylogenetictree

MODULE 4 (9 Hrs)

9. Familiarize Databases PDB, SCOP, CATH, Pfam etc.
10. Protein sequence analysis (expasy proteomics tools) and secondary structure prediction using various tools available such as SOPMA, GOR, NN predict,etc
11. Retrieval of protein sequences and homology modelling

12. Molecular visualization of the 3D structure of any desired protein using the Molecular modeling tool (PyMol)
13. Drawing Small Drug /ligand Molecules Using Chemsketch
14. Selection of ligands and structure verification for docking
15. Molecular Docking of Modeled Protein With Ligands using swissdock
16. Visualization of Docked Molecule Using Rasmol

Module 5. (9 hours)
Collect data and perform statistical analysis with appropriate grsphical representation.
Perform eithe rof the following and submit the report as assignmnet
1.phylogenetic tree
2.molecular analysis

Design student activities like assignments, seminars, collection of notes/reference materials related to the topics of module 1&3.

REFERENCES

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2. Bioiformatics: A Practical Approach- K.Mani& N. Vijayaraj-Aparna Publishers NewDelhi

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Applications", Marcel Dekker.

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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 :

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

MODEL QUESTION PAPERS

FIRST SEMESTER

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1CJ101/ZOO1MN100: 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 **(Ceiling: 24 Marks)**

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. Explain the Ultra structure of skeletal muscle
12. Write an 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

(Ceiling: 36 Marks)

Section C

[Answer anyone. Each question carries 10 marks] (1x10=10marks)

19. Describe various mode of carbon dioxide transport
20. With appropriate illustration describe the propagation of nerve impulse **(1x10=10marks)**

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024 ZOO1MN101: FOUNDATIONS ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR

(Credits: 4)

Maximum Time: 2 hours Maximum Mark: 70

Section A

[Answer All .Each question carries 3marks] (Ceiling: 24 Marks)

1. What is meant by standing crop?
2. Describe ecology as interdisciplinary science.
3. Explain first law of thermodynamics with respect to ecosystem concept
4. Describe the features of Savanna
5. What are the features found in animals in a sandy shore?
6. What is meant by keystone species?
7. What is allelopathy ?
8. Differentiate between taxes and kinesis
9. Briefly explain Konrad Lorenz's contributions to Ethology
10. What is meant by ethogram? **(Ceiling: 24 Marks)**

Section-B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

10. Explain bi-directional flow model of energy flow.
11. What are the characteristics of tropical dry deciduous forest?
12. What are the planktonic adaptations?
13. Describe "r" and "k" strategies of life cycle patterns
14. Describe population growth curves
15. What are the main postulates of the Plastic Waste Management Rules, 2016 ?
16, Describe the features of Instinctive behaviour

(Ceiling: 36 Marks)

Section C

[Answer anyone. Each question carries10 marks] (1x10=10 marks)

19. Describe the Nitrogen cycle
20. write an essay on various learned behaviour

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1MN102: BASICS IN CELLULAR PHYSIOLOGY

(Credits: 4)

Maximum Time: 2 hours Maximum Marks: 70

Section A

[Answer All .Each question carries 3 marks] (Ceiling: 24 Marks)

1. Briefly describe the functions of golgi apparatus.
2. What are tight junctions? What are their functions?
3. What is the significance of differentiation?
4. What is genetic code? List out the names of two scientists, who contributedin its deciphering
5. What is meant by Okazaki fragments?
6. What are the different types of DNA polymerases?
7. Explain the second law of Mendelian inheritance
8. What is test cross?
9. What is the cause for Cri du chat syndrome?
10. Differentiate between euploidy and aneuploidy **(Ceiling: 24 Marks)**

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe various types of epithelial thissue, and their functions
12. Describe the concept of unit membrane model
13. Describe the Watson-Crick model of DNA structure
14. What is meant by Crossing over? What is its significance?
15. Explain the inheritance pattern of incomplete dominance
16. Explain the features of blood group inheritance
17. Describe the biochemical pathways leading to Phenylketonuria
18. Explain the sex chromosomal anomalies.

(Ceiling: 36 Marks)

Section C

[Answer anyone. Each question carries10 marks] (1x10=10marks)

19. Describe the phases of cell cycle and its checkpoints
20. Describe mutation and its types

(1x10=10marks)

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1VN101: BASICS IN ENTOMOLOGICAL, POULTRY SCIENCE AND DAIRY SCIENCE APPLICATIONS

(Credits: 4)

Maximum Time: 2 hours Maximum Marks: 70

Section A

[Answer All .Each question carries 3 marks] (Ceiling: 24 Marks)

1. Describe the uses of honey
2. What are the structural adaptations of honey bee worker\/
3. What is the role of Central Honey Bee Research and Training Institute?
4. Describe the fungal diseases of silkworm
5. Describe the hos requirements of Lac insect
6. Explain the setting ofmalaisetrap.
7. What is beeting card?
8. Describe the grading up procedure for cattle breeding.
9. How is the homogenization of milk done?
10. List out the poultry breeds reared for egg production **(Ceiling: 24 Marks)**

Section B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

11. Desscribe the features of different castes of honeybees
12. Explain the process of mulberry cultivation
13. Describe the lifecycle of lac insect.
14. Describe different types of light traps
15. Explain different types of aquatic traps.
16. Describe any two diseases of poultry and their control measures.
17. Describe different breeds of cattle for different purposes
18. Describe the procedures for the detection of any two adulterants of milk

(Ceiling: 36 Marks)

Section C

[Answer anyone. Each question carries10 marks] (1x10=10marks)

19. Explain the procedure and tools for beekeeping.
20. Describe the arrangements for silkworm rearing house and the tools used for.

(1x10=10marks)

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1VN102: ECOLOGICAL TOOLS AND TECHNIQUES

(Credits: 4)

Maximum Time:2hours **Maximum Marks: 70**

Section A

Answer all. Each question carries 3 marks

1. Differentiate between census and sampling.
2. Define standard deviation.
3. Differentiate auxiliary and adhoc hypothesis.
4. Write notes on primary depository of scientific information.
5. Comment on Plagiarism.
6. Define Ecology
7. Explain the advantages and disadvantages of standard deviation.
8. e- DNA sampling
9. Clinometer
10. Define mode.

(Ceiling: 24 Marks)

Section B

Answer All. Each question carries 6 marks.

11. Explain various thought process in developing hypothesis

12. CalculateMeanandSEofthefollowingdata.

Fishesx	10-20	20-30	30-40	40-50	50-60	60-70	70-80
F	3	5	6	7	3	2	1

13. Write a note on steps involved in preparing and delivering scientific presentations

14. Write note on any three tools involved in inferential statistics

15. What is data visualization?

16. What are ecological models?

17. Briefly explain methods involved in vegetation sampling

18. Role of ethical considerations in ecological research.

(Ceiling: 36 Marks)

Section C

Answer any one. Each question carries 10 marks

19. Certain manure was used on four plots of land A, B, C and D. The output of the crop in the beds of plots A, B, C and D is given below. Check the difference in crop production by using ANOVA.

A	B	C	D
6	15	9	8
8	10	3	12
10	4	7	1
8	7	1	3

20. Comment on Equipment and instrumentation in field sampling.

(1x10=10marks)

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1FM105(1): NUTRITION, HEALTH & HYGIENE

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 50

SectionA

[Answer All .Each question carries 2 marks] (Ceiling:16 Marks)

1. Write notes on RDA
2. What is the dietary importance of vegetables?
3. Differentiate between essential and nonessential aminoacids
4. What is the significance of water balance?
5. Describe the importance of Zinc as a nutrient
6. What are the importance of yoga?
7. What are the ill effects of drug abuse?
8. What is the importance of mosquito control?
9. Describe the symptoms of Autism
10. What are the importance of diet therapy?

SectionB

[AnswerAll.Each question carries 6 marks] (Ceiling:24Marks)

11. Describe the factors affecting BMR
12. Differentiate between essential and nonessential aminoacids.
13. What is meant by phytochemicals? What aretheir dietary significance ?
14. Describe the importance of hygienic practices ?
15. Describe the importance of first aid. What is the first aid to be given to a snake bite victim?

SectionC

[Answer anyone. Each question carries10 marks] (1x10=10marks)

16. Write an essay on the dietary importance of carbohydrates?
17. Describe various lifestyle diseases.

I Semester B.Sc. (STCFYUGP) Degree Examinations October 2024

ZOO1FM105(2): REPRODUCTIVE HEALTH AND SEX EDUCATION

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 50

SectionA

[Answer All .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

[Answer All. 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. (STCFYUGP) Degree Examinations March 2025

ZOO2CJ102/ZOO2MN100: ENVIRONMENTAL BIOLOGY & ANIMAL BEHAVIOUR

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 70

SectionA

[Answer All .Each question carries 3marks] (Ceiling: 24 Marks)

1. What is meant by Autecology?
2. Describe ecology as interdisciplinary science.
3. Explain first law of thermodynamics with respect to ecosystem concept
4. Describe the features of Savanna
5. What are the features found in animals in a sandy shore?
6. What is meant by keystone species?
7. What is allelopathy ?
8. Differentiate between taxes and kinesis
9. Briefly explain Konrad Lorenz's contributions to Ethology
10. What is meant by ethogram?

Section-B

[Answer All. Each question carries 6 marks] (Ceiling: 36 Marks)

10. Explain the importance od decomposers.
11. What are the characteristics of tropical dry deciduous forest?
12. What are the planktonic adaptations?
13. Describe "r" and "k" strategies of life cycle patterns
14. Describe population growth curves
15. What are the main postulates of the Plastic Waste Management Rules, 2016 ?
16, Describe the features of Instinctive behaviour

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Section C

[Answer anyone. Each question carries10 marks] (1x10=10 marks)

19. Describe the concept of productivity and energy flow models
20. write an essay on various learned behaviour

II Semester B.Sc. (STCFYUGP) Degree Examinations March 2025

ZOO2MN101: INTRODUCTORY HUMAN PHYSIOLOGY

(Credits:4)

Maximum Time: 2 hours Maximum Mark:70

Section A

[Answer All .Each question carries3marks] (Ceiling:24 Marks)

1. What is Homeostasis? Give an example
2. Define vitalcapacity. Write the formula to measure vital capacity.
3. What is ECG? Write its significance.
4. Explain saltatory conduction with suitable diagram.
5. What is Physical ergonomics? Write any four benefits of physical exercise.
6. Distinguish between Myocardial infarction & Angina pectoris
7. How do you correctly complete the chart below before going to blood donation

Blood group	Antigen	Antibodies	Can donate to	Can receive blood from
O				
AB				
A				
B				

8. Write an account on neurohormones and its functions.
9. What are the different levels of physiological regulation?
10. Sliding filament theory is suitable to explain muscle contraction, are you agree? Why?

Section B

[Answer All. Each question carries 6 marks] (Ceiling:36Marks)

11. Write an account on different nutritional disorders found in man
12. Writethe site where urea formation occurs. Explain the steps involving urea formation in man
13. Briefly describe the way of transport of oxygen.
14. What is synapsis? Write an account on neurotransmitters.
15. Write an account on intrinsic pathway of blood coagulation
16. Explain the Ultra structure of skeletal muscle
17. Comment on the respiratory problems and adaptations at high altitude.
18. Write an account on RBC & WBC

SectionC

[Answer any one.Each question carries 10 marks](1x10=10marks)

19. Describe the various steps in urine formation and write an account on counter current mechanism.
20. With appropriate illustration describe the propagation of nerve impulse

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ZOO2MN102: NEUROPHYSIOLOGY

(Credits:4)

Maximum Time: 2 hours Maximum Mark:70

SectionA

[Answer All .Each question carries3marks] (Ceiling:24 Marks)

1. Describe the structure of a nerve fiber
2. What is meant by neurotransmitter? Give examples
3. What are the functions of neuroglial cells?
4. What are the divisions of brain?
5. What is grey matter?
6. What are the functions of spinal cord?
7. What is choroid plexus?
8 What are purkinje cells ?
9, What is EEG?
10. Write notes on dominanthemisphere.

SectionB

[Answer All .Each question carries 6 marks] (Ceiling: 36 Marks)

11. Describe the blood-brain barrier.
12. Describe reflex action
13.Explain the neuronal control on muscle tone.
14. What are the structural details of cerebellum ?
15. Describe the sensory aspects of communication
16. What are the functions of limbic systems
17. Describe the procedure of MRI scanning
18. Write notes on brain waves

SectionC

[Answer anyone. Each question carries10 marks] (1x10=10marks)

19. Describe the process of synaptic transmission
20. Describe the structure and functions of basal ganglia.

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ZOO2VN101: AQUA CULTURE AND FISHERY SCIENCE PRACTISES

(Credits:4)

Maximum Time: 2 hours Maximum Marks :70

SectionA

[Answer All .Each question carries 3marks] (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

SectionB

[AnswerAll.Eachquestioncarries6 marks] (Ceiling:36Marks)

11. Explain different culture techniques
12. Briefly explain mussel culture
13. Describe the technique of induced breeding
14. Explain the procedure of pearl culture
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

SectionC

[Answeranyone.Eachquestioncarries10 marks] (1x10=10 marks)

19. Write an essay on bacterial, fungal and viral diseases in fishes and prawns
20. Write an essay on developing an aquaculture pond system

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ZOO2VN102: FOOD PROCESSING AND QUALITY CONTROL

(Credits:4)

Maximum Time: 2 hours Maximum Marks :70

SectionA

[Answer All .Each question carries 3marks] (Ceiling:24 Marks)

1. Explain the nutritive value of fish.
2. What is meant by functional food?
3. What are the anti-nutritional factors in food?
4. What is fermentation preservation
5. Describe various classes of preservatives
6 Describe dry preservation techniques.
7. Writes notes on the use of insects as food
8.What are the merits of food processing
9. Describe the importance of sanitation.
10. What is meant by BIS ?

SectionB

[Answer All. Each question carries 6 marks] (Ceiling: 36Marks)

11. Describe the nutritional value of pulses and legumes.
12. Explain various methods of low temperature methods of food preservation.
13. What are the different types of concentrated food?
14. Describe various steps in food processing.
15.What are the performance parameters in food processing?
16. Write notes on food analogue.
17. Describe the causes of food spoilage
18. Write notes on food sanitation checklists

SectionC

[Answer anyone. Each question carries10 marks] (1x10=10marks)

19. Explain various methods of food sterilization
20. Describe various food quality analysis methods.

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ZOO2FM106(1): AQUA CULTURE AND ORNAMENTAL FISH FARMING

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 50

SectionA

[Answer All .Each question carries 2 marks] (Ceiling:16 Marks)

1. Classify aquaculture based on environment
2. Mention 4 commercially important aquaculture species in India
3. What do you mean by mono and poly culture?
4. Explain the role of public aquaria
5. Which are the different types of aquaria based on water
6. What are nano aquariums?
7. What is oceanarium?
8. Write a note on aquarium plants
9. Mention the commonly used anaesthetics
10. What are formulated feeds?

SectionB

[Answer All. Each question carries 6 marks] (Ceiling24 marks)

11. Write a note on different culture techniques
12. Write a note on different physico-chemical parameters and their maintenance in aquarium
13. Explain the process of constructing a freshwater aquarium
14. Describe the process of cleaning an aquarium
15. Explain the process of identification of any 3 each exotic and indigenous ornamental fishes

SectionC

[Answeranyone.Eachquestioncarries10 marks] (1x10=10marks)

16. Write an essay on different types of accessories used in aquarium tanks
17. Write an essay on common parasites and diseases of ornamental fishes

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ZOO2FM106(2): APICULTURE AND SERICULTURE

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 50

SectionA

[Answer All .Each question carries 2 marks] (Ceiling:16 Marks)

1. Which are the species of honey bees used in apiculture ?
2. Which are the different casts of honey bees ?
3. What are the different bee products?
4, write notes on foul brood disease.
5. How is honey extraction done ?
6. Describe various species of silkworms
7. Describe non-mulberry sericulture
8. What is meant by RKO ?
9 . What is Flacherie ?
10. What is ahimsa silk ?

SectionB

[Answer All. Each question carries 6 marks] (Ceiling:24Marks)

11. What are the pre-requisites for bee keeping?
12. Describe the structure of bee hive.
13. What are the different types of mountages
14. Write notes on the scope of sericulture in Kerala
15. Describe any two fungal diseases of silkworm.

SectionC

[Answer anyone. Each question carries10 marks] (1x10=10marks)

16. Describe the social organization of honey bees.
17. Describe the silkworm rearing process.

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ZOO2FM106(3): BIOLOGY FOR COMPETITIVE EXAMS

(Credits:4)

Maximum Time: 2 hours Maximum Marks: 50

SectionA

[Answer All .Each question carries 2 marks] (Ceiling:16 Marks)

1. What are the functions of golgi apparatus
2. What is Barr body? What is its significance?
3. What is meant by geological time scale?
4. Define carrying capacity
5. What is ammensalism?
6. What is the composition of blood?
7. Whatis the significance of intestinal villi?
8. What is sarcomers?
9. What is meant by inoculative mode of transmission?
10. What is the symptoms of mumps?

SectionB

[Answer All. Each question carries 6 marks] (Ceiling:24Marks)

11. Describe the cell cycle
12. Describe the structure of mitochnondria
13. What are the evolutionary principles of Darwin?
14. Describe the gaseous exchange in human body.
15. What are the characteristics of cance cells?

SectionC

[Answer anyone. Each question carries10 marks] (1x10=10marks)

16. What are the threatsto biodiversity?
17. Describe important human hormones and their functions