Learning Outcomes based Curriculum Framework (LOCF)

For

M.Sc. (Zoology)
Postgraduate Programme

Department of Zoology
Chaudhary Devi Lal University
Sirsa-125055

2021

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1. About the Department

The department of Zoology was established in 2018 with a mission to produce excellent workforce suitable for core and interdisciplinary work. The modern era requires a classical Zoologist with a modern approach to master many subjects of Zoology. There is a need for the students to compete with the globe, therefore, the main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research. The students can choose to focus on a ―whole animal‖ or a ―bits of animals‖ approach. The ―whole animal‖ pathway makes the students proficient in the identification and study of animals while the latter approach provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc.

2. Learning Outcomes based Curriculum Framework

The Choice Based Credit Scheme evolved into learning outcome based curriculum framework and provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1 Objectives of the Programme

- To understand the value of fauna and its relevance to the society and our environment
- To endow the practical skills of immunology, physiology and genetics in diagnosis
- To understand the impact of Climate change on fauna diversity and their survival etc.
- To equip ourselves to fit for entrepreneur with special attention on Aquaculture, Apiculture, Sericulture, medical lab technology etc.
- To provide wide opportunity in research to address the societal needs.

2.2 Programme Outcomes (POs)

PO1	*Knowledge*: Knowledge in the basic and advanced fields of the core and applied disciplines, for the fulfilment of professional requirements
PO2	*Critical Thinking*: Capability of critical thinking based on the contextual knowledge of living beings/organisms, non-living components and environmental basis of life, enabling them to critically analyse the day-to-day problems faced by

	the society.
PO3	*Interdisciplinary approach* & *Adaptation*: Understanding of the vital connections, within and among-the flora, fauna and the physical environment, enabling them to integrate and synthesize the acquired knowledge within their fields and beyond
PO4	*Application Development*: Understanding for the development of the applications of biological materials in food, health, medicine and environment for sustainable development of the society
PO5	*Ethics and Leadership*: Awareness about sound professional and character ethics as well as the qualities of leadership and team building skills
PO6	*Problem Solving*: Capability for developing innovative and solution cantered approach for handling any kind of problem and the paradigm of scientific temperament
PO7	*Skills and Inferential knowledge*: knowledge about various core and advanced skills for theoretical and practical understanding of different descriptive and inferential statistical tools and techniques
PO8	*Specialization and Employability*: specialization in various skills based on practical training, fields visits and project based vocational training as well as specialization for an entrepreneurial thinking and career-oriented approach in research as well as in industries

2.3 Programme Specific Outcomes (PSOs)

After completing the programme, the student will

PSO1	gain expertise in the theoretical and practical knowledge in basic and applied areas of Zoology. Demonstration of broad aspects of animal diversity, including knowledge of the scientific classification and evolutionary relationships of major groups of animals.
PSO2	become trained for the academic and professional fields of Zoology. Understanding will be developed about the applied biological sciences or economic Zoology such as sericulture, Apiculture, aquaculture, Industrial microbiology, rDNA technology and medicine for their career opportunities.

PSO3	develop proficiency in research methodology and assessment techniques in animal science and Characterizing the biological, chemical, and physical features of environments (e.g., terrestrial, freshwater, marine, host) that animals inhabit.
PSO4	able to gain competencies and professional skills for working and conducting research in the field of Zoology and related areas of life science research and will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ-system. Drawing upon this knowledge, they are able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different forms of life.

3 Programme Structure

Two year M.Sc. programme is divided into four-semesters. The student is required to complete 108 credits (Core Courses, Discipline Specific Elective Courses, Skill Enhancement Courses and Open-Elective Courses) for the completion of this programme and award of degree.

Table 1: Courses and Credit Scheme

Semester	Core Courses (CC)		Discipline Specific Elective Courses (DSC)		Skill Enhancement Courses (SEC)		Open Elective Courses (OEC)		Grand Total Credits
	1	2	3	4	5	6	7		
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	A total of 12 credits are to be earned from other departments or from MOOCs *Students have to opt open elective course in consultation with chairperson and Director, University Centre for Outreach Programmes and Extension*		2+4+6+7
I	4	**16**	-	0	4	**8**			**108**
II	4	**16**	**0**	**0**	3	**9**			
III	**3**	**12**	**3**	**12**	**-**	**0**			
IV	4	**14**	**2**	**8**	1	**1**			
Total	**Core Credits**	**58**	**Discipline Specific Elective Credits**	**20**	**Skill Enhancement Credits**	**18**	**Open Elective Credits**	**12**	**108**
Per-cent	**Core Credits**	**53.70**	**Discipline Specific Elective Credits**	**18.52**	**Skill Enhancement Credits**	**16.67**	**Open Elective Credits**	**11.11**	**100**

Table 2: Detailed break-up of Credit Courses

	Core Courses	Discipline Specific Elective Courses	Skill Enhancement Courses	Open Elective Courses	Total Courses
	CC	**DSC**	**SEC**	**OEC**	**CC+DSC+SEC**
Semester I	CC1 CC2 CC3 CC4	-	SEC1 SEC2 SEC3 SEC4	OECs offered by other departments or MOOCs **(May be enrolled in any of the four semesters)** *Students have to opt open elective course in consultation with chairperson and Director, University Centre for Outreach Programmes and Extension*	8
Semester II	CC5 CC6 CC7 CC8	-	SEC5 SEC6 SEC7		7
Semester III	CC9 CC10 CC11	DSC1 DSC2 DSC3 DSC4	-		7
Semester IV	CC12 CC13 CC14 CC15	DSC5 DSC6	SEC8		7

Table 3: Course code and Title along with credits detail

Sr. No.	Course Code	Course Title	Credits		
		Semester I	**Theory**	**Practical**	**Total**
1.	MSc/ZOO/1/CC1	Biology of Invertebrates	4		4
2.	MSc/ZOO/1/CC2	Animal Cell Biology	4		4
3.	MSc/ZOO/1/CC3	Comparative Animal Physiology	4		4
4.	MSc/ZOO/1/ SEC1	Introduction of Biotechniques	2		2
5.	MSc/ZOO/1/ SEC2	Lab Biotechniques		2	2
6.	MSc/ZOO/1/ CC4	Lab Pertaining to Theory CC1,CC2,CC3		4	4
7.	MSc/ZOO/1/ SEC3	Fundamentals of Vermiculture	2		2
8.	MSc/ZOO/1/ SEC4	Lab Vermiculture		2	2
		Total	**16**	**8**	**24**
		Semester II			
1.	MSc/ZOO/2/CC5	Biology of Vertebrates	4		4
2.	MSc/ZOO/2/CC6	Molecular Biology	4		4
3.	MSc/ZOO/2/CC7	Fundamentals of Animal Genetics	4		4
4.	MSc/ZOO/2/ SEC5	Basics in Biostatistics, Computer and Bioinformatics	4		4
5.	MSc/ZOO/2/SEC6	Lab Biostatistics, Computer and Bioinformatics		4	4
6.	MSc/ZOO/2/CC8	Lab Pertaining to Theory CC5,CC6,CC7		4	4
7.	MSc/ZOO/2/SEC7	Summer Training* (In House Training/Industrial Training/Research Training/Field Visit/Survey) **(Duration- 3 to 4 weeks during Summer vacation after exams of 2nd semester)**		1	1
		Total	**16**	**9**	**25**
		Semester III			
1.	MSc/ZOO/3/CC9	Principles of Ecology and Evolution	4		4
2.	MSc/ZOO/3/CC10	Developmental Biology	4		4
3.	MSc/ZOO/3/DSC1	A. Aquaculture B. Entomology C. MOOC	4		4
4.	MSc/ZOO/3/CC11	Lab Pertaining to Theory CC9,CC10		4	4
5.	MSc/ZOO/3/DSC2	A. Wildlife and their Conservation B. Reproductive Health in Animals C. MOOC	4		4
6.	MSc/ZOO/3/DSC3	Lab Pertaining to Theory DSC1A Lab Pertaining to Theory DSC1B		2	2
7.	MSc/ZOO/3/DSC4	Lab pertaining to theory DSC2A Lab pertaining to theory DSC2B		2	2

		Total	**16**	**8**	**24**
Semester IV					
1.	MSc/ZOO/4/CC12	Immunology	4		4
2.	MSc/ZOO/4/CC13	Endocrinology and Animal Behaviour	4		4
3.	MSc/ZOO/4/CC14	Cardinal Principles of Academic Integrity and Research Ethics	2		2
4.	MSc/ZOO/4/CC15	Lab Pertaining to Theory CC12,CC13		4	4
5.	MSc/ZOO/4/DSC5	A. Parasitology	4		4
		B. Biochemistry			
		C. Microbiology			
		D. MOOC			
6.	MSc/ZOO/4/DSC6	Lab Pertaining to Theory DSC5A		4	4
		Lab Pertaining to Theory DSC5B			
		Lab Pertaining to Theory DSC5C			
7.	MSc/ZOO/4/SEC8	Credit Seminar		1	1
Total			**14**	**9**	**23**

Table 4: Core Courses Offered by the Department

Course Code	Course Title	Credits
Core Courses		
MSc/ZOO/1/CC1	Biology of Invertebrates	4
MSc/ZOO/1/CC2	Animal Cell Biology	4
MSc/ZOO/1/CC3	Comparative Animal Physiology	4
MSc/ZOO/1/ CC4	Lab Pertaining to Theory CC1,CC2,CC3	4
MSc/ZOO/2/CC5	Biology of Vertebrates	4
MSc/ZOO/2/CC6	Molecular Biology	4
MSc/ZOO/2/CC7	Fundamentals of Animal Genetics	4
MSc/ZOO/2/CC8	Lab Pertaining to Theory CC5,CC6,CC7	4
MSc/ZOO/3/CC9	Principles of Ecology and Evolution	4
MSc/ZOO/3/CC10	Developmental Biology	4
MSc/ZOO/3/CC11	Lab Pertaining to Theory CC9,CC10	4
MSc/ZOO/4/CC12	Immunology	4
MSc/ZOO/4/CC13	Endocrinology and Animal Behaviour	4
MSc/ZOO/4/CC14	Cardinal Principles of Academic Integrity and Research Ethics	2
MSc/ZOO/4/CC15	Lab Pertaining to Theory CC12,CC13	4
	Total	**58**

Table No. 5 Discipline Specific Courses offered by Department

MSc/ZOO/3/DSC1	A. Aquaculture	4
	B. Entomology	
	C. MOOC	
MSc/ZOO/3/DSC2	A. Wildlife and their Conservation	4
	B. Reproductive Health in Animals	
	C. MOOC	
MSc/ZOO/3/DSC3	A. Lab Pertaining to Theory DSC1A	4
	B. Lab Pertaining to Theory DSC1B	
MSc/ZOO/4/DSC4	A. Lab pertaining to theory DSC2A	4
	B. Lab pertaining to theory DSC2B	
MSc/ZOO/4/DSC5	A. Parasitology	2
	B. Biochemistry	
	C. Microbiology	
	D. MOOC	
MSc/ZOO/4/DSC6	A. Lab Pertaining to Theory DSC5A	2
	B. Lab Pertaining to Theory DSC5B	
	C. Lab Pertaining to Theory DSC5C	

Total	**20**

Table No. 6 Skill Enhancement Course offered by the Department

MSc/ZOO/1/ SEC1	Biotechniques	2
MSc/ZOO/1/ SEC2	Lab Biotechniques	2
MSc/ZOO/1/ SEC3	Fundamentals of Vermiculture	2
MSc/ZOO/1/ SEC4	Lab Vermiculture	2
MSc/ZOO/2/ SEC5	Basics in Biostatistics, Computer and Bioinformatics	4
MSc/ZOO/2/SEC6	Lab Biostatistics, Computer and Bioinformatics	4
MSc/ZOO/2/SEC7	Summer Training* (In House Training/Industrial Training/research Training/Field Visit/Survey) **(Duration 3 to 4 weeks during Summer vacation after exams of 2nd semester)**	1
MSc/ZOO/4/SEC8	Credit Seminar	1
	Total	**18**

Table No. 7 Open Elective Courses offered by the Department

MSc/ZOO/9/OEC1	Economic Zoology-I	4
MSc/ZOO/9/OEC2	Economic Zoology-II	4
	Total	**8**

4 Attainment level

Table 8: CO-PO-PSO mapping matrix for all the courses offered by Department of Zoology

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
Semester-I												
M.Sc/ZOO/1/CC1	1.75	2	2	1.25	1.5	1.25	1.5	1	3	1.75	1.5	1.75
MSc/Zoo/1/CC2	1.5	1.25	1.5	1.5	1.25	1	1.25	1.75	2.25	2.25	2.25	2.75
MSc/Zoo/1/CC3	2	1.5	1.25	1.5	1.25	1.5	2	1.75	2.25	2	2.5	2.5
M.Sc/Zoo/1/SEC1	2.5	2	2.5	2.5	2	2	3	1.5	2	2.5	2.5	2.5
M.Sc/Zoo/1/SEC2	2.5	2.5	2.5	2	2	2	3	2.5	2	2.5	2.5	2
M.Sc/Zoo/1/CC4	3	2	2	1.75	1.75	2	3	2	3	1.25	1.5	2.25
M.Sc/Zoo/1/SEC3	2.5	1.5	2.5	2.5	3	3	2	2.5	3	2.5	2.5	2.5
M.Sc/Zoo/1/SEC4	1.5	3	2.5	1.5	1.5	2.5	2	2.5	2.5	1.5	2	3
Semester-II												
M.Sc/Zoo/2/CC5	1.75	2	2.25	1.5	1.5	2	2.5	2	2.5	1.5	2	2.25
M.Sc/Zoo/2/CC6	1.75	1.75	1.75	1.25	2	2	1.75	2.25	2.5	2.5	2.5	2.5
MSc/ZOO/2/CC7	2.25	1.5	1.75	2.25	1.5	1.75	1.75	2.75	2.25	1.75	2.25	3
MSc/ZOO/2/ SEC5	2	1.75	2	1.5	2.25	2	3	2	2.5	2.25	2	2
MSc/ZOO/2/ SEC6	2	1.75	1.75	1.5	2.25	2.25	3	2	2.5	2.25	2.25	2.25
MSc/ZOO/2/ CC8	2	1.5	2	1.75	1.5	1.5	2	1.75	1.75	1.75	1.75	2
MSc/ZOO/2/ SEC7	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2	2	3
Semester-III												
MSc/ZOO/3/CC9	2	2.5	2.5	2	1.75	2	1.5	2	2.25	2	2.25	2.25
M.Sc/ ZOO /3/CC10	1.75	2.5	2.25	2	1.5	2	1.75	1.5	2.5	2	1.75	2
MSc/ZOO/3/DSC1, A	2	1.5	1.75	1.5	2	2	1.5	2	2	3	2.25	2
MSc/ZOO/3/DSC1,B	1.75	2	2	1.5	1.5	1.5	2.5	1.5	1.75	2.25	1.75	1.5
M.Sc/ ZOO /3/CC11	2	1.5	1.5	2	2	1.75	1.75	1.5	2	1.5	2	2
M.Sc/ ZOO /3/DSC2,A	1.5	2	2.5	1.5	1.5	1.5	1.5	1.5	1.75	1.25	1.25	1.5
M.Sc/ ZOO /3/DSC2,B	1.5	1.5	1.5	2	2	1.5	2	1.5	1.5	1.5	2	2.25
M.Sc/ ZOO /3/DSC3,A	2	2	2	1.5	2	1.5	2.5	2.5	2.5	3	3	2.5
MSc/ZOO/3/DSC3,B	1.5	2	1.5	2.5	1.5	1.5	2.5	2	2	2.5	2	2
MSc/ZOO/3/DSC4,A	2	2	2.5	1.5	1.5	1.5	1.5	2	3	2.5	2	2
MSc/ZOO/3/DSC4,B	2.5	2	2.5	2	1.5	1.5	3	2	3	2.5	2.5	3
Semester-IV												
M.Sc/ZOO /4/CC12	2	2	1.5	2	2	2	1.75	2	1.25	2.25	1.75	2
M.Sc/ZOO /4/CC13	1.5	2	2.25	1.75	2.25	2.5	2.5	1.25	2.5	2.5	2.25	2

MSc/ZOO /4/CC14	2.5	2	1.25	2	3	2.5	3	2	2	2.5	2	2
M.Sc./ZOO /4/CC15	2	2	2	1.75	1.75	2	2.5	2.25	2.5	2	2	1.75
M.Sc./ZOO /4/DSC5,A	1.5	1.75	1.75	2.25	1.5	1.5	1.5	1.5	2	2	2	1.5
M.Sc./ZOO /4/DSC5,B	1.75	2	1.5	1.5	1.5	1	1.5	1.5	2	1.5	2	2
M.Sc/ZOO /4/DSC5,C	2.25	2	1.75	2.25	2	1.5	1.75	2	2.75	2	1.75	2.5
M.Sc/ZOO /4/DSC6,A	2	2.5	2.5	2.5	2	2.5	1.5	2	2.5	2.5	2	2
M.Sc/ZOO /4/DSC6,B	2	3	2.5	2.5	3	2.5	2.5	3	2	2	3	3
M.Sc/ZOO /4/DSC6,C	2.5	2.5	2.5	2	2	2.5	2.5	2.5	3	2	2	2.5
M.Sc/ZOO /4/SEC8	2.5	2.5	2.5	2	3	3	2.5	2.5	3	2	2	2.5
Average of above values	2.03	2.02	2.05	1.87	1.91	1.92	2.16	1.98	2.33	2.09	2.09	2.24

4.1 Attainment of COs:

Table 9: CO Attainment Levels for a Semester Examination of a course

Attainment Level	
1 (Low level of attainment)	50% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
2 (Medium level of attainment)	60% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.
3 (High level of attainment)	70% of students obtained letter grade of A or above (for CBCS programs) or score more than 60% of marks (for non-CBCS programs) of a course.

The CO attainment level for all the courses of the program can be obtained in a similar manner.

4.2 Calculation of Attainment values of POs and PSOs:

PO attainment value (for example for PO1) for a course can be obtained as follows:

$$AV\ for\ PO1 = \frac{(MFCPO1)\text{X}\ CO\ attainment\ value\ for\ the\ course\ (as\ per\ table\ 2)}{3}$$

Where

AV = Attainment value

MFCPO1 = Mapping factor for a course with PO1 as obtained from table 1

Likewise, PSO attainment value (for example for PSO1) for a course can be obtained as follows:

$$AV\ for\ PSO1 = \frac{(MFCPSO1)\text{X}\ CO\ attainment\ value\ for\ the\ cours(as\ per\ table\ 2)}{3}$$

Where

AV = Attainment value

MFCPSO1 = Mapping factor for a course with PSO1 as obtained from table 1

After finding the attainment values of each PO and PSO for various courses, we may write them in table form as given below:

Table 10: The calculated PO and PSO Attainment Values for all the courses

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
Semester-I												
M.Sc/ZOO/1/CC1												
MSc/Zoo/1/CC2												
MSc/Zoo/1/CC3												
M.Sc/Zoo/1/SEC1												
M.Sc/Zoo/1/SEC2												
M.Sc/Zoo/1/CC4												
M.Sc/Zoo/1/SEC3												
M.Sc/Zoo/1/SEC4												
Semester-II												
M.Sc/Zoo/2/CC5												
M.Sc/Zoo/2/CC6												
MSc/ZOO/2/CC7												
MSc/ZOO/2/ SEC5												
MSc/ZOO/2/ SEC6												
MSc/ZOO/2/ CC8												
MSc/ZOO/2/ SEC7												
Semester-III												
MSc/ZOO/3/CC9												
M.Sc/ ZOO /3/CC10												
MSc/ZOO/3/DSC1, A												
MSc/ZOO/3/DSC1,B												
M.Sc/ ZOO /3/CC11												
M.Sc/ ZOO /3/DSC2,A												
M.Sc/ ZOO /3/DSC2,B												
M.Sc/ ZOO /3/DSC3,A												
MSc/ZOO/3/DSC3,B												
MSc/ZOO/3/DSC4,A												
MSc/ZOO/3/DSC4,B												
Semester-IV												
M.Sc/ZOO /4/CC12												
M.Sc/ZOO /4/CC13												
MSc/ZOO /4/CC14												
M.Sc./ZOO /4/CC15												

M.Sc./ZOO /4/DSC5,A												
M.Sc./ZOO /4/DSC5,B												
M.Sc/ZOO /4/DSC5,C												
M.Sc/ZOO /4/DSC6,A												
M.Sc/ZOO /4/DSC6,B												
M.Sc/ZOO /4/DSC6,C												
M.Sc/ZOO /4/SEC8												
Average of above values												

The attainment of POs and PSOs is the average of individual PO and PSO attainment values. The PO and PSO attainment values obtained above are compared with set target. The set target for each PO and PSO may be different and can be finalized by the staff councils of the departments/institutes as described in the following table:

Table 11: PO and PSO Attainment Values and Set Target values

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
PO and PSO Attainment Values	2.03	2.02	2.05	1.87	1.91	1.92	2.16	1.98	2.33	2.09	2.09	2.24
Target Values	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2

If PO and PSO attainment value is less than the set target value then an action plan may be prepared for improvement in the subsequent academic session.

5 Course Wise Content Details for M.Sc Zoology Programme is given in following pages

M. Sc. (Zoology) – 1st Semester

M.Sc/ZOO/1/CC1-Biology of Invertebrates (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To Make students to understand how life evolved from simple to complex organization by division of labour & enhancing efficiency in Invertebrates.

Course outcomes:	
CO1	Make students to understand how life evolved from simple to complex organization by division of labour & enhancing efficiency in Invertebrates.
CO2	The study of invertebrates reveals progressive evolutionary history of organisms
CO3	Students would be able to understand scientific classification of various phyla and related organisms and their relation with physical environment.
CO4	Students will capture facts and figures about unique biological phenomena in diverse life forms.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Protozoa: Salient features classification upto classes; feeding, locomotion, reproduction; parasitic protozoa; economic importance of protozoa.
Porifera: salient features and classification upto classes with reference to diversity in animal form skeletal system and auriferous system in porifera

Unit II

Salient Features and classification up to classes with reference to diversity in animal form and function of Coelenterate, Helminthes, Nematodes
General account: Polymorphism in cnidarians; parasitic adaptations in helminthes; Larval form and their significance, corals and coral reefs

Unit III

Salient Features and classification up to classes with reference to diversity in animal form and function of Annelid, Arthropoda
General account: metamerism in annelids, mouth parts of insects, larval form and their significance in Arthropoda

Unit IV

Salient Features and classification up to classes with reference to diversity in animal form and function of Mollusca, Echinodermata

General account: Larval form and their significance in Echinodermata; Coelom; Torsion and detorsion in Mollusca; Ambulacral system.

List of Recommended Sources:

1. Kettle, D.S: Medical Veterinary Entomology (CAB International).
2. Boolotian and Stiles: College Zoology (Macmillan)
3. Campbell: Biology (Benjamin)
4. Marshall and Williams: Text Book of Zoology
5. Wolfe: Biology the Foundations (Wadsworth)'
6. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
7. Prescott: Cell (Jones & Bartlett).
8. M.Kato. The Biology of Biodiversity, Springer.
9. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, NY
10. E.O. Wilson. Biodiversity, Academic Press, Washington.

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/CC1												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1	2	1.5	1	1	1.25	1.5	1	3	1.5	1	3
CO2	1.5	2	1.5	1	1	1.25	1.5	1	3	1.5	1	1
CO3	2	2	3	1	2	1.25	1.5	1	3	1.5	2	1.5
CO4	2.5	2	2	2	2	1.25	1.5	1	3	2.5	2	1.5
Avg	1.75	2	2	1.25	1.5	1.25	1.5	1	3	1.75	1.5	1.75

M. Sc. (Zoology) – 1st Semester

M.Sc/ZOO/1/CC2-Animal Cell Biology (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To enable the students to learn the practical and practical aspects of cell biology. It will give insight into the cell signalling mechanism, transport across cell membrane, cell cycle, cell death, cancer and Biology of aging.

Course outcomes:	
CO1	This core course will make students able to understand how the different cell physically and chemically works as a unit of life.
CO2	Through this course, students will be able to appreciate the importance of various cell function and structures in the evolution of multi-cellular organisms.
CO3	The study will help the students to understand the new discoveries about the structure and internal functioning of the cell due to technological improvements.
CO4	The students will know about the basic cellular and molecular approaches for cancer development and drug treatment.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Structure of pro-and eukaryotic cells; Structure and function of cells and intracellular organelles of both prokaryotes and eukaryotes); Significance of intracellular compartments.
Structure of nucleus; Genetic analysis in Cell Biology: Nucleus; Mitochondria and chloroplasts and their genetic organization; Cellular energy transaction: role of Mitochondria and chloroplast

Unit II

Biomembranes: Molecular composition and arrangement functional consequences; Model membranes; Liposomes. Transport across cell membrane-Diffusion, active transport and pumps, uniports, symports and antiports; Membrane potential; Co-transport by symporters or ant porters; Transport across epithelia. Cytoskeleton: Microfilaments, Intermediate filament and microtubules-structure and dynamics; Microtubules and mitosis; Cell movements-intracellular transport, role and kinesin and dynein; Cilia and Flagella.

Unit III

Cell-Cell signaling: Signal transduction mechanisms; Cell surface receptors; Second messenger system; MAP kinase pathways; Cell-cell interaction.

Cell-Cell matrix, adhesion and communication, Ca++ dependent & independent homophilic cell-cell adhesion; Gap junctions and connexins.
Cell matrix adhesion: Integrins, Collagen, Non-collagen components & Cellulose fibril synthesis and orientation.

Unit IV

Cell cycle: Mechanism of cell division including (mitosis and meiosis) and cell differentiation Cyclins and cyclin dependent kinases and Regulation of CDK-cyclin activity.
Biology of cancer, Biology of aging and Apoptosis-definition, mechanism and significance

List of Recommended Sources:

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B.Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Garland Publishing Inc., New York.
3. Cell and molecular biology, Phillip Sheeler, Donald E. Bianchi Wiley, 1987
4. Cell and Molecular Biology 8thEdition, Robertis, EDP De &Robertis, EMF De(2002) lippincott Williams & Wilkins international student edition, Philadelphia.
5. Cell and Molecular Biology: concepts and experiments. Karp, Gerald (2012) John Wiley and sons, New York.

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/CC2												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1	1	1.5	1.5	1	1	1	1.5	2	3	3	2
CO2	1	2	2	1.5	1	1	1	1.5	2.5	1	1.5	3
CO3	2	1	1.5	1	2	1	2	3	2.5	2	1.5	3
CO4	2	1	1	2	1	1	1	1	2	3	3	3
Avg	1.5	1.25	1.5	1.5	1.25	1	1.25	1.75	2.25	2.25	2.25	2.75

M. Sc. (Zoology) – 1st Semester

MSc/ZOO/1/CC3-Comparative Animal Physiology (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course Objectives: Animal physiology is the study of animal structure and function. This course on Comparative Animal Physiology 'helps understand how animals work at all levels, ranging from individual cells to the whole integrated organism. The scope of physiology includes elucidation of the function of all cells in all organs and all animals related to nervous, respiratory, circulatory and other physiological systems. This course especially focuses on the modifications/adaptations found in different physiological systems of various organisms across the animal kingdom. The course also has a strong lab component, where certain classical and interesting exercises will be conducted to answer various practical queries in animal physiology.

Course outcomes:	
CO1	An appropriate understanding of functioning of each system of different groups of animals with their comparison will be acquainted in the applied area of zoology
CO2	Communicate experimental data and a theoretical understanding of animal physiology via the production of scientific.
CO3	The students will be able to learn that how the physiology of different groups of organisms is influenced by the different environments of their niches.
CO4	Students would gain competences and professional skills by performing experiment and answer various queries of animal physiology

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Digestion- Feeding mechanisms and regulation, Comparative physiology of digestion and absorption in different animal groups.

Respiration- Respiratory organs, Types of respiration, mechanism of breathing. Transport of respiratory gases. Respiratory pigments through different phylogenetic groups. Physiological response to oxygen deficient stress.

Excretion- Functional anatomy of renal unit; mechanisms of ultra-filtration, Counter Current mechanism, Dialysis. Patterns of nitrogen excretion among different animal groups.

Osmoregulation in different animal groups. Definition and basic classification of organisms on the basis of osmoregulation. Osmotic challenges of different environments. Mechanism of Osmoregulation in fresh water, Estuarine and Marine animals. Osmoregulation in migratory organisms, Control and regulation of osmoregulation.

Unit II

Thermoregulation- Homeothermic, Poikilotherms, Hibernation and Aestivation, Physical, chemical, neural regulation, Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature

Circulation- Systems of circulation, heart beat and blood pressure, Cardiac cycle, Cardiac output and its regulation, Lymphatic system. Body fluids and their regulation among different animal groups.

Neuronal physiology- Structure and classification of neurons and ganglial cells. Synaptic action, dendritic properties and functional operation of spinal cord, Brain stem Autonomic nervous system.

Receptor physiology – A comparative study of Mechanoreception, Photoreception, Chemoreception and Equilibrium reception.

Unit III

Muscle and Contractile physiology - Contractile elements, cells and tissues among different phylogenic groups; Muscle structure and function-correlation; Electric organs and tissues.

Comparative testicular physiology Morphology, Differentiation, Function and its regulation

Comparative ovarian physiology and differentiation in vertebrates Morphology, Endocrinolgy, Oogensis and vitellogensis

Unit IV

Principles of synaptic transmission- Ca2+ and transmitter release, post synaptic transmission mechanism. Diversity of neurotransmitters acetylcholine, catecholamine, serotonin, GABA, glycine, histamine, peptides, NO, and opiods.

Physiological adaptations- Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature, physiological adaptation at high altitude and in deep sea environment**.**

Stress Physiology Concept of Stress and Strain, Stress hormones and stress regulatory mechanisms.

List of Recommended Sources:

1. Guyton and Hall, Text Book of Medical Physiology, 13th edition, Saunders Company (2015).
2. Comparative Animal Physiology, Withers., Brooks/Cole (1992).
3. Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Dantzler, W.H. (ed.) Oxford University Press, New York, USA.
4. Animal Physiology: Adaptation and Environmental, Nelson K. S. (ed.) Cambridge University Press, Cambridge, UK.
5. Comparative Animal Physiology, Prosser, C.L. & Brown Jr., F.A.(ed.), Saunders.
6. Eckert: Animal Physiology 5th Ed by Randall, David, Burggern, Warren, French, Kathleen (2001)
7. Vander, A.J., Sherman, J.H. and Luciana, D.S., Human Physiology, McGraw Hill Publ.Co. Gillian Pocock and Christopher D. Richards. Human Physiology. The Basis of Medicine Oxford University Press (2001).

CO-PO-PSO mapping matrix for MSc/ZOO/1/CC3												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	1.5	1	1	1	1	1	1	3	2.5	2.5	2
CO2	1.5	1.5	1	3	1	3	3	2	2	1.5	1.5	3
CO3	1.5	2	2	1	1	1	1	1	1	1.5	3	2
CO4	2	1	1	1	2	1	3	3	3	2.5	3	3
Avg	2	1.5	1.25	1.5	1.25	1.5	2	1.75	2.25	2	2.5	2.5

M. Sc. (Zoology) – 1st Semester

M.Sc./Zoo/1/SEC1 – Introduction of Biotechniques (SEC)

Credits: 2 (Lectures: 30) **Marks: 50**

Duration of Exam: 3 Hrs. **Theory: 30, IA: 20**

Course objective: The objective is to enrich students' knowledge about various techniques used in biological research and also their implementation in various fields of research.

Course outcomes:	
CO1	Students would be trained in various microscopic tools and techniques used to gain in sight in to biological processes by understanding vital connection.
CO2	Students would be expertise in various spectroscopic techniques used for imaging of biological substances, which is beneficial for health and medicine sector.

Note for the paper setter: The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

Unit I

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. Fixation and staining; cryotechnology and flow cytometry, Confocal Microscopy**.**

Polymerase chain reaction (PCR), Real time PCR and reverse transcriptase PCR.

Units II

Spectroscopy: Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction. Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC).

List of Recommended Sources:

1. Animal Cell Culture - A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. Shukla and Upadhyaya. Experimental Science
4. Randhir Singh. Practicals in Biochemistry
5. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/SEC1												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	3	2	2	2	3	1.5	2	2.5	2.5	3
CO2	3	2	2	3	2	2	3	1.5	2	2.5	2.5	2
Avg	2.5	2	2.5	2.5	2	2	3	1.5	2	2.5	2.5	2.5

M. Sc. (Zoology) – 1st Semester

M.Sc/Zoo/1/SEC2– Lab Biotechniques (SEC)

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course Objective: To gain hands on experience on various laboratory equipments and learning their handling.

Course outcomes:	
CO1	Students will get hands on experience of various equipment and techniques, these technique will be helpful in different industries.
CO2	They will understand through demonstration how instrument works and results are obtained and analysed, this will aid in their career development.

Experiments:

1. Demonstration of working of weighing balances autoclaves, incubators, laminar flow, and waterbath.
2. Principle and demonstration of various analytical techniques:
   a) Simple and Compound Microscope
   b) Transmission electron microscope/Scanning electron microscope
   c) Chromatography (HPLC, TLC, Paper Chromatography, Column chromatography, Ion exchange Chromatography)
   d) Centrifugation
   e) UV-visible spectrophotometer
   f) Nanodrop
   g) ELISA reader
   h) Sonicator
   i) Microtome
   j) PCR / Real Time PCR
   k) Electrophoresis (AGE and PAGE)
   l) NMR
   m) XRD
3. Demonstration of Hybridization techniques:
   a) Colony Hybridization
   b) Southern Hybridization

c) Northern Hybridization
d) Western Hybridization

4. Demonstration of preparation of permanent mount of various tissues.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Hamms GD, Spectroscopy for the Biological Sciences, Wiley Interscience, USA, 2005.
2. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
3. Bophysical Chemistry: Principle and Techniques, 2nd eddition by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalya Publication House, Delhi.
4. Nalwa HS. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Beckatt, A.H. and Stenlake, J.B., Practical Biochemistry, the Athlone Press, London (1988).
6. Bacq, Z.M. and Alexender, P, Fundamentals of Radiography, Pergamon Press, London (1989).
7. Benett, A.H. and Usterbere, H, Phase Microscopy: Principle and applications, John Wiley and Sons, London (1951).
8. Dawes, C.J.,Techniques for Transmission and Scanning Electron Microscopy, Ladd Rew. Ind.,Inc.,Publishers (1981).
9. Freefelder, D, Practical Biochemistry: Application to Biochemistry and Molecular Biology, W.H.Freeman, (1982).
10. Freshney, R.I., Culture of Animal Cells: A manual of basic technique, 5th Ed., Wiley Liss Inc., New York. (2006).
11. Watt, J.M., The Principles and Practice of Electron Microscopy, Watt (1985).
12. Michael G, Flow Cytometry: A Practical Approach, 3rd Edition Edited Michael G. Ormerod Oxford University Press (2000).
13. Kuby, Janis, Immunology, W.H. Freeman and Company (2000).

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/SEC2												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	2.5	2.5	2	2	2	3	2	2	2.5	2.5	2
CO2	2	2.5	2.5	2	2	2	3	3	2	2.5	2.5	2
Avg	2.5	2.5	2.5	2	2	2	3	2.5	2	2.5	2.5	2

M. Sc. (Zoology) – 1st Semester

M.Sc/ZOO/1/CC4-Lab Pertaining to Theory CC1,CC2,CC3(CC)

Credits: 4 (Lectures: 120) **Marks: 100**

Duration of Exam: 4 Hrs.

Practical

Course Objective: This course will aid students to learn about practical aspects of invertebrates, cell biology and physiology.

Course outcomes:	
CO1	To get to relate theoretical knowledge with live demonstration of slides and specimens
CO2	Students will be able to differentiate the cells of various living organisms and get awareness of physiological processes of cell e.g. cell divisions
CO3	Students will be able to observe and correctly identify different cell types, cellular structures using different microscopic techniques.
CO4	Students will understand application of histological studies in clinical and medical sciences and will be able to prepare these slides.

Experiments:

1. General Laboratory-safety and Bio-safety measures in Zoology laboratory.
2. Introduction to various instruments and their working principles used in Zoology laboratory.
3. Preparation of normal and molar solutions, serial dilution, buffers, pH setting etc.
4. To study various parts of microscope and demonstration of microscopic techniques
5. To discriminate between viable and non-viable cells using staining techniques
6. Effect of solution concentration on cells (RBCs)
7. To study the structural diversity of animal cells.
8. Cell division: mitosis and meiosis, Preparation of mitotic and meiotic chromosomes.
9. Microtomy
10. Estimation of Hemoglobin.
11. Determination of TLC, DLC & RBC.
12. Determination of bleeding and clotting time.
13. Determination of blood groups.
14. Measurement of blood pressure.
15. Estimation of ESR.
16. Preparation of tissues for microtomy and demonstration ofcryo techniques
17. Histochemistry: Methods of fixation of different tissues.
18. Demonstration of live gametes and their staining procedure.
19. Determination of optimum pH, temperature and concentration for optimum activityof salivary amylase.
20. To demonstrate that the optimum activity of trypsin enzyme is pH temperaturedependent.
21. Qualitative test of vitamins and Quantification of vitamin A and C.
22. Live demonstration of Amoeboidal movements, conjugation in paramecium and flaggelar moments in euglena.
23. Slides and Museum specimens:
    (a) PROTOZOA: *Gregarina, Monocystis, Ceratium, Euplotes, Didinium, Noctiluca, Radiolaria, Stentor,Opalina*.

(b) PORIFERA: Sectional view of Sycon (T.S., L.S.), *Grantia*(T.S.)
(c) CNIDARIA: *Obelia* polyp and Medusa, *Pennaria*, *Aurelia*-Tentaculocysts, *Virgularia*, *Spongodes*, *Zoanthus*,*Favia.*
(d) ANNELIDA: *Ozobranchus*,*Glossiphonia*, *Eunice*,*Chloea Flava*,*Polynoe*,*Terebella*.
(e) ARTHROPODA: *Cyclops, Daphnia*,*Chelifer*, section of *Peripatus*, *Balanus*, *Lepas*, *Palinurus, Uca*,*Pyna*,*Hippa, Gongylus*,*Bellostoma, Limulus, Squilla*,*Eupagurus.*
(f) MOLLUSCA: Museum specimens of *Dolabella, Pteria, Nertie, Sanguinolaria, Chicoreus, Ficus*,*Lambis, Tridacna*,*Onchidium*,*Olcia, Murex, Turritella, Bulla*,*Cardium*.
(f) ECHINODERMATA: Museum specimen of *Linckia*,*Echinodiscus*,*Holothuria, Antedon.*
(h) Study of Slides of *Bugula, Plumatella*,*Cristatella*,*Pectinatella*

24. Study of mouth parts of different insects.
25. Mounting: Trachea, Crustacean Larva, *Cyclops*, *Nauplius, Daphnia, Zoea, Mysis*,*Cercaria.*
26. Demonstration of dissection of Loligo/Sepia, grass-hopper, Prawn, Cockroach, Earthwarm to expose various systems.

List of Recommended Sources:

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York.
5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Culture of animal cells(2003).Freshney R.T.John Wiley and sons,NewYork.
7. Animal Cell Culture (1987).Freshney R.T.IRL Press Oxford, Washington.
8. Animal Cell Culture and Technology: Basics from back ground to bench. ButlorM (2004).Taylor & Francis.
9. Recent reviews in scientific journals
10. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
11. Smith and Wood. Cell Biology, Chapman and Halls 1996

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/CC4												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	2.5	2.5	2	2	1.5	3	2.5	3	1	1	1.5
CO2	3	1.5	2.5	1	1.5	2.5	3	1.5	3	1	1	3
CO3	3	1.5	1.5	1	1.5	1.5	3	2.5	3	2	2	3
CO4	3	2.5	1.5	3	2	2.5	3	1.5	3	1	2	1.5
Avg	3	2	2	1.75	1.75	2	3	2	3	1.25	1.5	2.25

M. Sc. (Zoology) – 1st Semester

MSc/ZOO/1/ SEC3 Fundamentals of Vermiculture (SEC)

Credits: 2 (Lectures: 30) **Marks: 50**

Duration of Exam: 3 Hrs. **Theory: 30, IA: 20**

Course Objectives: To inculcate concepts of biofertilizers like vermicomposting, understand techniques in vermicomposting. To increase employability of the students and improve the soil quality by promoting the biofertilizers.

Course outcomes:	
CO1	Students will learn how to deal with practical problems arising during Vermiculture. Also understand the taxonomic position, habit and habitats of worm and their ecological importance.
CO2	Students will be able to know the potential of vermicompost as an alternative to chemical fertilizers and role of vermiculture in maintaining the health of soil and humans.Procedures followed during vermiculture will aim at team building skills.

Note for the paper setter: The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

Unit I

Earthworms – Taxonomic position and diversity; types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species; Ecological role and economic importance of earthworms.
Applications of vermiculture – Vermicomposting – use of vermicastings in organic farming, Earthworms for management of municipal organic solid wastes.

Unit II

Vermiculture – definition, scope and importance; Local and exotic species for culture; Environmental requirements; Culture methods – wormery – breeding techniques; indoor and outdoor cultures – monoculture and polyculture.
Nutrient value of worm cast/vermicompost – Effect of vermicompost on plants.

List of Recommended Sources:

1. Edwards CA & Bater JE. 1977. Biology of Earthworms. Chapman & Hall.
2. Edwards CA. 1998. Earthworm Ecology. CRC Press.
3. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
4. Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm ;Vermiculture and Vermicomposting ,Kalyani Publishers India.

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/SEC3												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	2.5	2.5	2.5	3	3	2	2.5	3	2.5	2	2.5
CO2	2.5	2.5	2.5	2.5	3	3	2	2.5	3	2.5	3	2.5
Avg	2.5	1.5	2.5	2.5	3	3	2	2.5	3	2.5	2.5	2.5

M. Sc. (Zoology) – 1st Semester

MSc/ZOO/1/ SEC4- Lab Vermiculture (SEC)

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course Objectives: Practical course in vermiculture has an objective for enhancing students knowledge base regarding course vermiculture.

Course outcomes:	
CO1	The skill of vermicomposting can encourage entrepreneurship in the students and help in generating employment.
CO2	Students will be aware about the impact of soil pollution on earthworm and can come with innovative ideas to prevent it. Holistic practical aspects of vermiculture are being delivered.

Experiments

1. Study of systematic position, habit, habitat of an earthworm species and its life cycle.
2. Preparation of vermiculture; maintenance of culture; preparation of vermicompost.
3. Nutrient profiling of soil before and after introduction of worms.
4. Estimation of biomolecular composition of earthworms.
5. Identification and morphological study of different earthworm species.
6. Extraction of coelomic fluid using different methods.
7. Study of gut microbiota of earthworm *Eisenia fetida.*
8. Study of heavy metal and agrochemicals toxicity in earthworms.
9. Dissection and demonstration of different parts of earthworm.
10. Methods of sampling/collection and population estimation.
11. Estimation of antioxidative enzymes of earthworm.
12. A study of food preferences of earthworms.
13. Visit to vermicomposting and preparation of report.
14. Study of cocoon, vermin wash and vermicast.
15. Recycling of waste through vermicomposting.

List of Recommended Sources:

1. Edwards CA &Bater JE. 1977. Biology of Earthworms. Chapman & Hall.
2. Edwards CA. 1998. Earthworm Ecology. CRC Press.
3. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
4. Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm ;Vermiculture and Vermicomposting ,Kalyani Publishers India.

CO-PO-PSO mapping matrix for M.Sc/ZOO/1/SEC4												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	3	2.5	1.5	1.5	2.5	1	3	2.5	1.5	2	3
CO2	2.5	3	2.5	1.5	1.5	2.5	3	2	2.5	1.5	2	3
Avg	1.5	3	2.5	1.5	1.5	2.5	2	2.5	2.5	1.5	2	3

Semester II

M. Sc. (Zoology) – 2rd Semester

M.Sc/Zoo/2/CC5 Biology of Vertebrates (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: This paper deals with the comparative and evolutionary trends in structure and function of the organ systems of the vertebrate series.

Course outcomes:	
CO1	Students will be getting introductory glimpse of vertebrates and essential connection between various chordates.
CO2	Understand the various systems evolved in different groups of organisms.
CO3	Students will enrich their knowledge by comparing evolutionary research in vertebrates.
CO4	Students will get to know about higher kingdoms of vertebrates along with their related anatomy and physiology.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Introduction to chordates with their general characters:
Origin of chordates in the light of recent theories Classifications of vertebrate‘s upto order

Unit II

Comparative account on Skeletal system: form function, body size and skeletal elements of the body Digestive system: dentition stomach, digestive glands, anatomy of gut in relation to feeding habits Respiratory system: compare respiratory organs of various phyla

Unit III

General plan of circulation in reptiles, birds, mammals, evolution of heart, aortic arches
General account: lateral line system, Migration of fishes; Parental care in fishes and amphibians

Unit IV

Comparative anatomy of brain and spinal cord, sense organs origin and evolution of Mammals General account: Flight adaptation in birds; Migration of birds.

List of Recommended Sources:

1. Boolotian and Stiles: College Zoology (Macmillan)

2. Campbell: Biology (Benjamin)
3. Marshall and Williams: Text Book of Zoology
4. Wolfe: Biology the Foundations (Wadsworth)'
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
6. Prescott: Cell (Jones & Bartlett).
7. M.Kato. The Biology of Biodiversity, Springer.
8. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. E.O. Wilson. Biodiversity, Academic Press, Washington.
10. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
11. E. Mayer. Elements of Taxonomy.
12. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

CO-PO-PSO mapping matrix for M.Sc/ZOO/2/CC5												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	1.5	3	1.5	1.5	1.5	2.5	1.5	3	1.5	1.5	2.5
CO2	1.5	1.5	2	1.5	1.5	1.5	2.5	1.5	3	1.5	1.5	1
CO3	1.5	3	2	1.5	1.5	3	2.5	3	2	1.5	3	2.5
CO4	1.5	2	2	1.5	1.5	2	2.5	2	2	1.5	2	3
Avg	1.75	2	2.25	1.5	1.5	2	2.5	2	2.5	1.5	2	2.25

M. Sc. (Zoology) – 2rd Semester

M.Sc/Zoo/2/CC6 Molecular Biology (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To make students learn the deeper aspects of cell structure and function at molecular level.

Course outcomes:	
CO1	Students would gain expertise in knowledge pool complex molecular mechanisms occurring in cell and the applications of molecular technologies for betterment of life.
CO2	This course will enhance opportunities of student in medicine and research technology, thus developing contextual knowledge
CO3	The study of biology stands as a tribute to human curiosity for seeking to discover at gene level.
CO4	It will aid students in developing innovative technology and increase their competence in research methodology.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Nucleic acid –structure: DNA and RNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Supercoiled DNA, Forces stabilizing nucleic acid structure, properties of DNA, Renaturation and denaturation of DNA. T_m and Cot curves, Structure of RNA.

DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, of replication, Prokaryotic and eukaryotic replication mechanism. Replication in phages, Replication in retroviruses.

Unit II

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5′ capping, 3‘ polyadenylation and splicing). RNA editing, Nuclear export of mRNA, mRNA stability arabinose operon .

Unit III

Translation: Genetic code, General features, Deciphering of genetic code, Code in mitochondria. Translational mechanism in prokaryotes and eukaryotes. Post translational modification and transport, Protein targeting (in brief), Non ribosomal polypeptide synthesis, Antibiotic inhibitors and translation.

Transport of Protein: Co- and Post-translational transport of proteins, Co- and Post-translational modifications of protein, Protein trafficking/sorting

Unit IV

Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, lac, trp operon. Catabolite repression, attenuation, regulation of gene expression in eukaryotes (a brief account).

Homologous recombination: Holiday junction, FLP/FRT and Cre/Lox combination, RecA and other recombinases

List of Recommended Sources:

1. Adams et al. (1992) Biochemistry of Nucleic Acids, 11th ed., Chapman and Hall, NY
2. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
3. Karp G. (2010) Cell and Molecular Biology -Concept and Experiments, 5th Edition, John Wiley, NY.
4. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher.
5. Gardener et al. (2001) Principles of Genetics, 8th ed., John Weley, New York.
6. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education
7. Cooper G.M. and Hausman R.E (2013) The Cell: A molecular approach. Sinnaur Associates Inc. Publisher, USA, 6th edition.
8. Alberts B. and Johnson A (2016). Molecular Biology of Cell. Garland Science Publisher

CO-PO-PSO mapping matrix for M.Sc/ZOO/2/CC6												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	1	1	1	1.5	1.5	1	1.5	3	2.5	3	2.5
CO2	2	3	2.5	1.5	2.5	1.5	3	3	2.5	2	2.5	2.5
CO3	1	1	1	1	1.5	2	1.5	1.5	1.5	2.5	2	2
CO4	1	2	2.5	1.5	2.5	3	1.5	3	3	3	2.5	3
Avg	1.75	1.75	1.75	1.25	2	2	1.75	2.25	2.5	2.5	2.5	2.5

M. Sc. (Zoology) – 2nd Semester

MSc/ZOO/2/CC7 Fundamentals of Animal Genetics (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To acquaint students with organization of genome and specialized chromosomes. An overview of the principles of plant and animal genetics including Mendelian and modern concepts of heredity.

Course outcomes:	
CO1	Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
CO2	To solve transmission genetics problem, make accurate predictions about inheritance of genetic traits, and map the location of genes
CO3	Demonstrate Knowledge and practical skills of molecular genetic analysis of genetic diseases
CO4	Be able to apply inheritance concepts to explain the occurrence of common problems or opportunities for genetic improvement in animals and animal production, including genes which contribute to increased susceptibility to disease, increased resistance to disease, resilience to disease, or cause disease directly

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Principle of heredity and variation: Mendle's law and his experiment, penetrance and expressivity, phenocopy.

Concept of gene: Classical concept, Fine structure of gene, Molecular concept of gene, pseudogenes, overlapping genes, repeated genes, gene amplification.

Unit II

Genes and chromosomes: General features of chromosome, chromosomal theory of inheritance, sex determination. Sex linked, sex limited and sex influenced inheritance, chromosomal aberrations.

Extra-chromosomal inheritance, sex chromosomal abnormalities-syndrome and autosomal abnormalities.

Unit III

Mutation: Types of mutation and molecular mechanism, nonsense, missense and frameshift mutation, DNA repair mechanisms – excision, mismatch, SOS, recombination repair.

Methods of genetic transfers: Transformation, Conjugation, Transduction. Pedigree analysis, Lampbrush chromosomes and Polytene chromosomes.

Unit IV

Gene Linkage and Chromosome Mapping: Complete and incomplete linkage, recombination of genes in a chromosome, crossing over, gene mapping by 2-point and 3-point test crosses, somatic cell hybridization.

Population Genetics and Evolution: Allele frequencies and genotype frequencies, random mating and Hardy- Weinberg principle, inbreeding, mutation, migration, natural selection, random genetic drift, quantitative inheritance

List of Recommended Sources:

1. Principles of Genetics, 8th ed., Gardener et al. (2001), John Weley, New York.
2. Genetics, 6th ed., Snusted P.D. and Simmons M.J.(2012), John Weley, New York.
3. Concept of Genetics, 10th ed., Klug and Cummings (2012), Pearson Education, Singapore.
4. Genetics: Analysis and Principles (2016), Broker, RJ, McGraw Hill, New York.
5. ModernGeneticAnalysis:IntegratingGenesandGenomes,Griffiths,J.F.,Gilbert,M.,Lewontin,C.and Miller,W.H.FreemanandCompany,NewYork,USA[Latest edition].
6. Genetics, J. Russell, Benjamin-Cummings PublishingCompany, SanFrancisco, California, USA [Latest edition] .
7. Genetics: B.D. Singh(2004), Kalyani Publishers.
8. Genetics principles and analysis, 4th Edition (2012) DL Hart and EW Jones, Jones and Bartett Publishers, Massachusetts, USA

CO-PO-PSO mapping matrix for MSc/ZOO/2/CC7												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	1.5	1.5	2	1.5	1.5	1.5	1.5	2	1.5	2	3
CO2	2	1.5	1.5	1	1.5	1.5	1.5	1.5	2	1.5	2	3
CO3	3	1	1.5	3	1.5	1.5	1.5	2	2	1	2	3
CO4	2	2	2.5	2	1.5	2.5	2.5	2	3	3	3	3
Avg	2.25	1.5	1.75	2.25	1.5	1.75	1.75	2.75	2.25	1.75	2.25	3

M. Sc. (Zoology) – 2nd Semester

MSc/ZOO/2/ SEC5 Basics in Biostatistics, Computer and Bioinformatics (SEC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course Objective: This course is meant for students who do not have sufficient background of Statistical Methods. The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation. The students would get an exposure to presentation of data, probability distributions, parameter estimation, tests of significance, regression and multivariate analytical techniques. Course introduces the basic concepts of computing with introduction to OS, graphics, networking and client-server technologies. To impart an introductory knowledge about the subject of Bioinformatics to the students studying any discipline of science.

Course outcomes:	
CO1	Biostatistics helps to generate a hypothesis from a set of observation and then design experiment to test the hypothesis, which helps in research methodology.
CO2	Students would get exposure to various statistics tools and able to acquire, analyses and understand the significance of scientific data. Also help in learning evolutionary relationships of different animal group by graphical representation.
CO3	Students get the confidence to use computer programs for the daily design of experiments, data collection, and analysis of results, which develops solution centric approach.
CO4	Learning about computer science and its implementation, obtaining theoretical understanding and gaining practical experience in this domain.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Classification, tabulation and graphical representation of data. Box-plot, Descriptive statistics. Exploratory data analysis. Theory of probability, Random variable and mathematical expectation. Discrete and continuous probability distributions: Binomial, Poisson, Negative Binomial, Normal distribution, concept of sampling distribution: chi-square, t and F distributions, Tests of significance based on Normal, chi-square, t and F distributions.

Unit II

Introduction to theory of estimation and confidence-intervals. Correlation and regression. Simple and multiple linear regression model, correlation, partial correlation coefficient, multiple correlation coefficient, rank correlation, test of significance of correlation coefficient and regression coefficients. Coefficient of determination. Polynomial regression models and their fitting. Non-parametric tests- sign, Mann-Whitney U-test. Kruskal-Wallis test, run test, Friedman two-way ANOVA by ranks.

Unit III

Fundamentals of Computing; Introduction to Operating Systems: WINDOWS, UNIX/Linux operating systems; Computer Security, Computer Viruses. Visualization techniques - Software and Hardware, Interactive Graphics, Image Processing with emphasis on biological systems. Computer Networking, Security of the network, Fire-walls, Network Goals, Applications Network, Network architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols. Use of INTERNET and WWW, Internet services.

Unit IV

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, GenBank, DDBJ. Specialized genomic resources. DNA sequence analysis, cDNA libraries and EST, EST analysis, pair wise alignment techniques, database searching, multiple sequence alignment. Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR. Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

List of Recommended Sources:

1. Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.
2. Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.
3. Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.
4. Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.
5. Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.
6. Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.
7. Siegel S, Johan N &Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.
8. David FR. 1997. *Procedural Elements for Computer Graphics*. WCB/McGraw-Hill.
9. Foley JD & Van Dam A. 1982. *Fundamentals of Interactive Computer Graphics*. Addison-Wesley.
10. James FK & Keith WR. 2006. *Computer Networking: A Top-Down Approach Featuring the Internet*. Prentice Hall.
11. Siever E. 2005. *Linux in a Nutshell*. O'Reilly.
12. Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Edu.
13. Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

CO-PO-PSO mapping matrix for MSc/ZOO/2/SEC5												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	2.5	1.5	3	2	3	3	3	2.5	2	2.5
CO2	2	1.5	2.5	1.5	1.5	2	3	3	2.5	1.5	2	1.5
CO3	2	2	1.5	1.5	3	2	3	1	2	2.5	2	2.5
CO4	2	1.5	1.5	1.5	1.5	2	3	1	2.5	2.5	2	1.5
Avg	2	1.75	2	1.5	2.25	2	3	2	2.5	2.25	2	2

M. Sc. (Zoology) – 2nd Semester

MSc/ZOO/2/SEC6 Lab Basics in Biostatistics, Computer and Bioinformatics (SEC)

Credits: 4 (Lectures: 120) **Marks: 100**

Duration of Exam: 4 Hrs.

Practical

Course objective: This course will introduce the students to practical intricacies pertaining to biostatistics, computer and bioinformatics.

Course outcomes:	
CO1	Exploratory nature of student mind is given a torque with help of practical which help in making student professionally sound.
CO2	Students will learn about better usage of software relating to computers
CO3	Students will get to know about usage of powerful weapon that is data.
CO4	Variety of practical exercises will help students to understand concepts in better way which play a pivotal role in developing scientific temperament.

Experiments

1. Exploratory data analysis, Box-Cox plots.
2. Fitting of distributions – Binomial, Poisson, Negative Binomial and Normal.
3. Large sample tests, testing of hypothesis based on exact sampling distributions-chi-square, t and F.
4. Confidence interval estimation and point estimation of parameters of binomial, Poisson and Normal distribution.
5. Correlation and regression analysis.
6. Non-parametric tests.
7. MS-Windows, Linux, UNIX Network design Internet search Graphics and animation.
8. Usage of NCBI resources
9. Retrieval of sequence/structure from databases
10. Visualization of structures
11. Docking of ligand receptors
12. BLAST exercises.

List of Recommended Sources:

1. Dillon WR & Goldstein M. 1984. *Multivariate Analysis - Methods and Applications*. John Wiley.
2. Goon AM, Gupta MK & Dasgupta B. 1977. *An Outline of Statistical Theory*. Vol. I. The World Press.
3. Goon AM, Gupta MK & Dasgupta B. 1983. *Fundamentals of Statistics*. Vol. I. The World Press.
4. Hoel PG. 1971. *Introduction to Mathematical Statistics*. John Wiley.
5. Hogg RV & Craig TT. 1978. *Introduction to Mathematical Statistics*. Macmillan.
6. Morrison DF. 1976. *Multivariate Statistical Methods*. McGraw Hill.
7. Siegel S, Johan N &Casellan Jr. 1956. *Non-parametric Tests for Behavior Sciences*. John Wiley.
8. David FR. 1997. *Procedural Elements for Computer Graphics*. WCB/McGraw-Hill.
9. Foley JD & Van Dam A. 1982. *Fundamentals of Interactive Computer Graphics*. Addison-Wesley.

10. James FK & Keith WR. 2006. *Computer Networking: A Top-Down Approach Featuring the Internet*. Prentice Hall.
11. Siever E. 2005. *Linux in a Nutshell*. O'Reilly.
12. Attwood TK & Parry-Smith DJ. 2003. *Introduction to Bioinformatics*. Pearson Edu.
13. Rastogi SC, Mendiratta N & Rastogi P. 2004. *Bioinformatics: Concepts, Skills and Applications*. CBS.

CO-PO-PSO mapping matrix for MSc/ZOO/2/SEC6												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	3	1.5	3	2.5	3	2.5	3	3	3	3
CO2	2	1.5	1	1.5	1.5	2	3	1.5	2	2.5	2	1.5
CO3	2	1.5	1	1.5	1.5	2	3	1.5	2	1.5	1	1.5
CO4	2	2	2	1.5	3	2.5	3	2.5	3	2	3	3
Avg	2	1.75	1.75	1.5	2.25	2.25	3	2	2.5	2.25	2.25	2.25

M. Sc. (Zoology) – 2nd Semester

MSc/ZOO/2/ CC8 Lab Pertaining to Theory CC5,CC6,CC7 (CC)

Credits: 4 (Lectures: 120) **Marks: 100**

Duration of Exam: 4 Hrs.

Practical

Course Objective: This practical course will enrich knowledge bank of students with practical related molecular biology.

Course outcomes:	
CO1	Students will be able to understand the sex linked inherited characters and diseases
CO2	Students will understand about the genetic material at molecular level.
CO3	Individual will be able to perform various molecular biology techniques by themselves
CO4	Provide knowledge of various systems of vertebrates via dissection

Experiments

1. Study of mutant phenotypes of *Drosophila*.
2. Demonstration of law of segregation and in dependent assortment using *Drosophila* mutants.
3. Demonstration of sex-linkage by using sex link ed mutation in *Drosophila*.
4. Statistical analysis of genetic crosses.
5. Demonstrationofdosagecompensationbystudyofsexchromatininhumanbuccal smear.
6. Preparation and study of meta phase chromosomes: Chromosome banding (C, G, H banding).
7. Preparation of human karyotype and study of chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided.Study of transcriptional activity in polytene chromosome of *Drosophila* up on heat shock.
8. Museum specimens and slides :
   Chondrichthyes: Zygaena, Pristis, Narcine, Trygon, Rhinobatus, Chimaera.
   Actinopterygii: Polypterus, Acipenser, Lepidosteus, Muraena, Mystus, Catla, Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Tetradon, Echeneis and Solea.
   Dipneusti (Dipnoi): Protopterus (Lung fish)
   Amphibia: Uraeotyphlus, Necturus, Amphiuma, Ambystoma and its Axolotl larva. Triton, Salamandra, Hyla, Rhacophorus.
   Reptilia : Hemidactylus,,Calotes, Draco, Varanus, Phrynosoma,Chamaeleon. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera,Crocodilus, Gavialis, Chelone and Testudo.
   Aves: Casuarius, Ardea, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo.
   Mammalia : Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca, Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra,Pteropus.
9. Demonstration of dissection of Labeo through video clipping/models/charts
10. Study of the skeleton of Labeo, Rana, Varanus, Gallus & Oryctolagus.
11. Demonstration of dissection of chick and white rat through video clipping/models/charts. Chick: Digestive, arterial, venous and urinogenital systems. White rat: Digestive, arterial, venous and urinogenital systems.

12. Study of the histology of different organs of frog and rat/rabbit through permanent mount.
13. Study of poison apparatus in snakes through charts.
14. Temporary /permanent mounts of hair and scales
15. Isolation of Genomic DNA.
16. Isolation of RNA.
17. Quantitative analysis of DNA.
18. Ligation of DNA fragments.
19. Molecular weight analysis using agarose gel electrophoresis.
20. Isolation of plasmid DNA.
21. Preparation of competent cell.
22. To perform restriction mapping
23. Preparation of liquid culture medium (LB) and raise culture of E. coli.
24. Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking.
25. Study and interpretation of electron micrographs/ photograph showing: DNA replication, Transcription.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Sambrook J, EF Fritech and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
2. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
3. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
4. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
5. Smith and Wood. Cell Biology, Chapman and Halls 1996
6. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
7. Sambrook J, EF Fritech and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
8. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
9. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd.
10. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
11. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
12. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot,
13. Kent, C.G. Comparative anatomy of vertebrates.
14. Milton H. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc.,New York.

CO-PO-PSO mapping matrix for M.Sc/ZOO/2/CC8												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	2	2.5	1.5	1.5	2	1.5	1.5	2	2	3
CO2	2	1	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1	3
CO3	2	1	1	1.5	1.5	1.5	3	2.5	1	1.5	3	1
CO4	2	2	3	1.5	1.5	1.5	1.5	1.5	3	2	1	1
Avg	2	1.5	2	1.75	1.5	1.5	2	1.75	1.75	1.75	1.75	2

M. Sc. (Zoology) – 2nd Semester

MSc/ZOO/2/SEC7 Summer Training

Credits: 1 **Marks: 25**

Course Objective: To build up the relation between the university and the various integrated farming as well as knowing the needs and expectations of these fields for the students.

Course outcomes:	
CO1	Allow students to correlate the classroom learning outcomes at the field level in either governmental or private sectors. Build up the student's disciplinary, ability and personality to communicate effectively through team work with the most updated in various research fields. Also Introducing students for first time to their expecting careers.

CO-PO-PSO mapping matrix for MSc/ZOO/2/ SEC7												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2	2	3
Avg	3	3	3	2.5	2.5	2.5	2.5	2.5	2.5	2	2	3

Semester III

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/CC9 Principles of Ecology and Evolution (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To understand the origin and progression of life on earth with conventional and novel evidences and techniques. In depth knowledge of process of speciation with concept of ecology & evolution.

Course outcomes:	
CO1	To provide students the basic insight about the mechanism of evolution and to make them able to relate different forms of life on our planet earth. It will also provide them in-depth knowledge about the changing frequency and distribution of alleles within the population.
CO2	To get knowledge about branch of biological science and applies it, identify the ecosystems by experiencing and see the working field by joining technical excursions when the students became environmental engineers. They learn that their aim of duty is nature and living thing and they always make plans how to contribute to the earth ecosystems in a good way.
CO3	To understand and explain the main forces of evolution (natural selection, sexual selection, genetic drift) and the interplay among them, both over ecological and evolutionary time
CO4	To understand all biotic and abiotic factors those are related to individual, population, community and ecosystem and define the relationships between them.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Emergence of evolutionary thoughts and mechanisms: Lamarck; Darwin's concepts of variation, Adaptation, struggle, fitness and natural selection; Modern concept/Synthetic theory of evolution. Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; experiment of Miller and Urey.

Unit II

Evolution of Cell: Prokaryotic and Eukaryotic cells. Palaeontology and evolutionary history: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale. Stages in primate evolution including Homo, origin and evolution of horse.

Unit III

Concept of Ecology - Introduction to ecology, evolutionary ecology, environmental concepts–laws and limiting factors, ecological models. Characteristics of population, populations ize and

exponential growth, limits of population growth, population dynamics, life history pattern (*r* and *K* selection); fertility rate and age structure. Competition and coexistence, intra- specific and inter-specific interactions, mutualism and commensalism, prey-predator interactions.

Unit IV

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Ecosystem - Nature of ecosystem, production, food webs, energy flow through ecosystem, bio-geochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes. Lotka-Volterra equations.

List of Recommended Sources:

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia Unvieristy Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
4. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution-The role of chromosomar change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston, Inc.
8. Smith, J.M. Evolutinary Gentics. Oxford University Press, New York.
9. Principles and Standards for Measuring Primary Production. 2007. Fahey, T. J. and Knapp, A.K. Oxford University Press,UK.
10. Ecological Modeling.2008.Grant,W.E.and Swannack,T.M., Blackwell.
11. Fundamental Processes in Ecology: An Earth system Approach.2007.Wilkinson,D.M.Oxford University Press,UK.
12. PrinciplesofTerrestrialEcosystemEcology.2011.Chaplin,F.S.,Matson,P.A.and Vitousek, P.M.Springer.
13. Freshwater Ecology: A Scientific Introduction.2004.Closs, G.,Downes,B.andBoulton,A. Wiley-Blackwell publisher, Oxford.
14. Odum, E.P. Fundamental of Ecology, W.B. Sunders, New Delhi

CO-PO-PSO mapping matrix for MSc/ZOO/3/CC9												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1	2.5	2.5	2	1.5	2	1.5	2	3	2	1.5	1.5
CO2	3	2.5	2.5	3	2.5	2	2	3	2	3	3	3
CO3	2	2.5	2.5	2	1.5	2	1.5	1.5	3	1.5	1.5	3
CO4	2	2.5	2.5	1	1.5	2	1	1.5	1	1.5	3	1.5
Avg	2	2.5	2.5	2	1.75	2	1.5	2	2.25	2	2.25	2.25

M. Sc. (Zoology) – 3rd Semester

M.Sc/Zoo/3/CC10 Developmental Biology (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: The main objective of Developmental Biology course is to provide four-dimensional thinking of students to truly understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences. The relevance of Developmental Biology to the study of human disease will be exemplified throughout using different model organisms.

Course outcomes:	
CO1	Based on learning contents of embryology, students can have a systematic and organized learning about the knowledge and concepts of growth and development and their vital connection.
CO2	Developmental biology displays a rich array of material and conceptual practices that can be analyzed to better understand the scientific reasoning exhibited in experimental life sciences
CO3	To understand biological processes that take place in between cells organisms in nature.
CO4	Developing new ideas and innovation to understand the basis of life.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; teratogenesis ; ageing; Programmed cell death

Unit II

Molecular biology, cytology and biochemistry of oogenesis: ovulation and its hormonal control in mammals. Structure, chemistry, dynamics and regulation of sperm activity, capacitation and egg-surface targeting. Molecular and cellular biology of fertilization: acrosome reaction and signal transduction monospermy and species-specificity.

Unit III

Cell fate and Cell lineages; Stem cells; Cleavage types; Mechanism and regulation of cleavage;Blastula; Fate maps; Comparative account of Gastrulation (Sea urchin, Chick), Neurulation, Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

Unit IV

Organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development, Pattern forming genes and expression in Drosophila . Growth Factors and Signal Cascades, BMP, Nodal, Wnt, Notch signaling during gastrulation.

List of Recommended Sources:

1. Developmental Biology (2003) - Gilbert S. F, Sinauer Asso.
2. Principles of Development (2002) - Wolpert L et al., Oxford University Press
3. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
4. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
5. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.
6. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2012, Academic Press.
7. R. Lanza, J. Gearhart et al (Ed), Essential of Stem Cell Biology, Elsevier Academic press.

CO-PO-PSO mapping matrix for M.Sc/ZOO/3/CC10												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	2.5	3	2.5	1.5	1.5	2	1.5	3	3	1.5	2
CO2	1	1.5	1.5	1.5	1.5	1.5	2	1.5	2.5	2	1.5	2
CO3	1.5	3	1.5	2.5	1.5	2	1.5	1.5	2.5	1	2	2
CO4	2	3	3	1.5	1.5	3	1.5	1.5	2	2	2	2
Avg	1.75	2.5	2.25	2	1.5	2	1.75	1.5	2.5	2	1.75	2

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC1,A Aquaculture (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: The purpose of this course is for the student to develop a basic knowledge and understanding of ecosystem of aquatic bodies and methods of pearl culture and fish culture.

Course outcomes:	
CO1	To enable the students understands the different fresh water habitats, the classification of wa bodies based on various physiochemical and biological parameters
CO2	This core elective paper will generate knowledge about various methods and significance of aquaculture and other aquaculture practices.
CO3	To enable the students with desirable traits for fish-culture and induced breeding of fish.
CO4	To enhance the skills required for undertaking aquaculture of fish and pearl at a professional level.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Freshwater habitat: Types of Freshwater habitats – Lotic and Lentic Waters. Zonation in Lentic habitat. Hydrobiological characteristics – Temperature, penetration of light, turbidity, dissolved gases, pH, biogenic salts etc. Water problems in aquatic and amphibious situations.

Ecological classifications of freshwater organisms other than fishes : On the basis of trophic status, On the basis of mode of life – Benthos, Periphyton, Plankton, Nekton and Neuston, On the basis of zonation in lentic and lotic habitats.

Unit II

Classification of lakes: Trophic classification of lakes – Oligotrophic, eutrophic and dystrophic lakes.

Productivity: Concepts of productivity – Biomass, biotic potential, standing crop, carrying capacity, yield, productivity, primary and secondary productivity. Estimation of Primary production – Harvest method, oxygen production method, carbon dioxide assimilation method, radioisotope method, chlorophyll method, disappearance of raw materials and pH method.

Pearl culture in India: Species involved in pearl culture, implantation procedure, water quality, pearl composition, kinds of pearl, economics and enemies of oysters

Unit III

Eutrophication*:* Definitions and types - natural and cultural eutrophication. Causes and impact of eutrophication. Control of eutrophication – Mechanical, Chemical and Biological control.

Bioassay– Terminology, methodology, calculation of LC 50 and EC 50 values and threshold concentrations.

Methods in Field Biology: Methods of estimating population density of animals.

Unit IV

Estuarine Habitat: Characteristics of estuarine habitat. Classification of estuaries. Estuarine fauna – Temporary and permanent. Adaptations of estuarine fauna.

Ecological succession: Definitions and types of ecological succession. Succession of animal communities through Hydrarch

Fishculture: Integrated fish culture (Paddy/Duck/Piggery/Diary/Plants), monoculture and polyculture (composite) and sewage fish farming

List of Recommended Sources:

1. Jhingran, V.G., *Fish and Fisheries of India,* Hindustan Publishing House (India), New Delhi (1991).
2. *Aquaculture Production*. FAO. Fisheries Circular No.815, No.4, Rev.FAO Rome (1998).
3. Mohan Joseph, M, Aquaculture in Asia, Asian Fisheries Society, Manglore (1990).
4. Talwar, P.K., & Jhingran, A.G., Inland Fishes of India, Vols.I& II, P.K. Talwar & Jhingran, A.G., Oxford & IBH, New Delhi (1991).
5. Lagler Karl F., *Freshwater Fishery Biology*, Wm.C.Brown Company Publ., Dubuque, Iowa (1969).
6. Bangenal,T., *Methods for Assessment of Fish Production in Freshwaters* 3rd Ed , IBH Handbook No.3 Blackwell Scientific Publication, Oxford (1970).
7. Johal, M.S., and Tandon, K.K., *Monograph on the Fishes of reorganized Punjab,* Parts I & II. Punjab Fisheries Bulletin (1979, 1980).
8. Odum, E.P., *Fundamentals of ecology*, W.B. Saunders Co. Philadelphia (1971).
9. Welch, P.S., *Limnology,* Mcgraw Hill Book Co. New York (1952)
10. Wetzel, R.G., *Limnology*,.W.B.Saunders Co. Philadelphia (1983).
11. Hynes, H.B.N., *The Biology of Polluted Waters*, Liverpool Univ. Press, Liverpool (1978).
12. Ruttner, F., *Fundamentals of Limnology,* Univ. Press, Toronto (1975).
13. Tandon,K.K. &Johal, M.S., *Age and growth in Indian Freshwater Fishes*, Narendra Publishing House, Delhi (1995).
14. Johal, M.S., Aggarwal, S.C., *Fishery Development,* Narendra Publishing House, Delhi(1997).
15. Peter B. Moyle &Jseph J. Cedh, *Fishes* :*An Introduction to Ichthyology*, Prentice – Hall, Inc. Jersey, U.S.A. (1986).

CO-PO-PSO mapping matrix for MSc/ZOO/3/DSC1, A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	2	3	1.5	1.5	1.5	1.5	1	3	3	3	1
CO2	1.5	1.5	1	1.5	1.5	1.5	1.5	1.5	2	3	2	2
CO3	2	1.5	1.5	1.5	2	3	1.5	2.5	1.5	3	2	2
CO4	3	1	1.5	1.5	3	2	1.5	3	1.5	3	2	3
Avg	2	1.5	1.75	1.5	2	2	1.5	2	2	3	2.25	2

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC1,B Entomology (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course Objectives: Insect diversity society and evolution introduce students to the various orders and some families of insects which form the basis of entomology. Insect Physiology is the study of the properties, processes and functions of insect systems. Study of Pesticides that are agrochemicals and used for preventing, repelling, mitigating or destroying any pests. The Agricultural Entomology describes adverse effects of pesticides and management of crop pests by an Integrated Pest Management (IPM) approach. Medical Entomology will highlight the direct injuries and diseases caused by arthropods (phobias, annoyance, allergies, toxins, venoms and myiasis, arthropod transmission of vertebrate parasites and pathogens).

Course outcomes:	
CO1	Following completion of this course, they would acknowledge the value and importance of insects and the students would be able to sight identify different orders of insects. They will also know the basic biology and the significant identification characters of the insects.
CO2	Become familiar with the various physiological systems operating in insects. Develop asense of how physiology can be infused in major research to pics in entomology.
CO3	The students having this course will study various types of insecticides and understand their mode of action to kill/control the insects. The students will understand their crucial role in ecosystems and their biota. May appreciate the insects as bio-indicators of ecological changes/disturbances.
CO4	Agricultural Entomology plays a major role in training students in understanding the interaction of nature, plants and insects in order to ensure crop protection by controlling economically important insect pests of various crops and bio-rational methods in an integrated approach (IPM).

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Insect Diversity, Society and Evolution: Insect's morphology external features and their articulation. Comparative study of head-antennae, mouth parts; thorax – legs, wings; abdominal appendages, genitalia of the different orders of insects. Basis of insect classification up to orders and up to super families in economically important groups; fossil history, origin and evolution of insects. Social organization and social behavior in honey bee, ants, termites, aphids and wasps.

Unit II

Insect Physiology: Structure, function & formation, Growth, Moulting and Metamorphic development, Sclerotization. Insect hormones- with reference to metamorphosis. Physiological system of insects:

Digestive and excretory physiology, Malpighian tubules, osmoregulation. Circulatory system of insect, hemolymph, hemocytes, Immunity and thermoregulation. Tracheal system and physiology of gas

exchange. Components of the nervous system, sensing the environment- Sensory receptors and vision. Female & Male reproductive systems and hormonal influence in reproduction.

Unit III

Insect Toxicology and Ecology: Definition of pesticides, history, types of pesticide and their functions. Toxicology of pesticides, LD_{50} and LC_{50}, Dose-response relationship. Mode of action on CNS, Acetylcholinesterase. Metabolism of insecticides Phase I and Phase II reactions and metabolism of other pesticides. Toxicological symptoms of different pesticides. Next generation molecules to be used as safer pesticides for plant protection and their chemistry. Insect biodiversity and their functioning in Terrestrial and aquatic ecosystem.

Unit IV

Agricultural and Medical Entomology: Agricultural pests status and factors responsible for achieving the status of pest, EIL, ETL secondary pest outbreak, pest surveillance and sampling. Role of allele-chemicals in host plant mediation, tri-tropic interaction, host- plant selection & establishment of insect population on a plant surface. Biological control and IPM in pest management. Introduction-Vector biology, medical importance and management of the medically important insects (fleas, lice, bugs, mosquitoes and flies); Modes of transmission of arthropod borne communicable diseases.

Forensic Entomology: Forensically important insects, role of insects/arthropods in criminal investigation, by predicting time and cause of death.

List of Recommended Sources:

1. A general text book of entomology, Imms,A.D.,Chapman & Hall,UK
2. Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson,
3. N. F.,M Saunders College Publication,USA
4. Principles of Insect Morphology, Snodgrass, R.E.,Cornell Univ. Press,USA
5. The Principles of Insect Physiology, Wigglesworth, Vincent B, Chapman & Hall Ltd.USA.
6. The Insects: Structure and function, Chapman, R. F., Cambridge University Press,UK
7. Physiological system in Insects,Klowden,M.J.,Academic Press,USA
8. Toxicology and Risk Assesssment:AComprehensive Introduction, GreimH., and Snyder, R. (ed), John Wiley and Sons,UK
9. The Complete Book of pesticide management,Whitford,F.,WileyInterscience, John Wiley and Sons,UK.
10. InsectPlantBiology,Schoonhoven,L.M.,vanLoon,J.A.,&Dicke,M.,Publisher Oxford University Press, USA
11. InterrelationshipbetweeninsectsandPlants,Jolivet,P.,CRCPress,USA
12. Entomology&PestManagement,Pedigo,L.P.,PrenticeHall,NewJersey,USA
13. Concepts of IPM, Norris, Caswell-Chenand Kogan, Prentice-Hall,USA

CO-PO-PSO mapping matrix for MSc/ZOO/3/DSC1,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	1.5	1.5	2	1.5	2	2	1	2	2	1	1
CO2	2	2.5	2	1	1.5	1.5	3	2	2	2	3	1.5
CO3	2	2.5	1.5	1	1.5	1.5	3	1	1	2	2	1
CO4	1.5	1.5	3	2	1.5	1	2	2	2	3	1	2.5
Avg	1.75	2	2	1.5	1.5	1.5	2.5	1.5	1.75	2.25	1.75	1.5

M. Sc. (Zoology) – 3rd Semester

M.Sc/Zoo/3/CC11 Lab Pertaining to Theory Papers CC9 and CC10 (CC)

Credits: 4 (Lectures: 120) **Marks: 100**

Duration of Exam: 4 Hrs.

Practical

Course Objective: This practical course will enrich knowledge bank of students with practical related to ecology and evolution and developmental biology.

Course outcomes:	
CO1	Describe the Isolating mechanisms, modes of speciation, Biological & Evolutionary Species Concept
CO2	Gain experience developing ecological hypothesis and designing observational and experimental studies in field and laboratory settings
CO3	Course participants will come in terms with various aspects of sustainable development in biology
CO4	They will develop their practical knowledge and understand the ethical value for experimental Work

Experiments

1. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e. transect, quadrate etc.
2. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-and macro-fauna in decomposition.
3. Understanding ecosystem succession by studying various stages of vegetation/community assemblage‘s development.
4. Insect diversity in soil.
5. Identification of aquatic organisms of different trophic levels and construction of food chain and food web.
6. Comparison of skeletons for listing evolutionary trends through pictures/line drawings.
7. Study of ancestory of man, horse, camel and elephant through charts/models.
8. Comparison of homologous and analogous structures (Insect antennae, insect legs, limbs of vertebrates etc.) through pictures/line drawings.
9. Demonstration of kinds of mimicry in various groups of animals through pictures/line drawings.
10. Study of origin of invertebrate and vertebrate groups through charts.
11. Mapping of geographic distribution of birds, insects, fishes etc.
12. Study of various evolutionary phenomena using slides / photographs.
13. Visit to a Fossil park/Geology and Anthropology museums.
14. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
15. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours,

Stage 5 (Head Process)-21 hours, Stage 7-24 hours, Stage 8-28 hours, Stage10-33 hours, Stage 11-40 hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation.

16. Demonstration of culture of chick embryo from fertilized eggs to study various developmental stages.
17. Study of the developmental stages and life cycle of Drosophila from stock culture.
18. Study of different sections of placenta (photomicrographs/ slides).
19. Project report on Drosophila culture/chick embryo development.
20. A visit to Poultry Farm/IVF Centre

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Sambrook J, EF Fritech and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
2. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
3. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
4. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
5. Smith and Wood. Cell Biology, Chapman and Halls 1996
6. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
7. Sambrook J, EF Fritech and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
8. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
9. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
10. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
11. Smith and Wood. Cell Biology, Chapman and Halls 1996
12. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
13. Developmental Biology (2003) - Gilbert S. F, Sinauer Asso.
14. Principles of Development (2002) - Wolpert L et al., Oxford University Press
15. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
16. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
17. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.
18. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2012, Academic Press.

CO-PO-PSO mapping matrix for M.Sc/ZOO/3/CC11												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	1.5	1.5	1.5	1.5	1.5	1.5	1.5	3	1	2.5	1
CO2	3	1.5	1.5	2	1.5	3	1.5	1.5	2	3	2.5	2
CO3	1.5	1.5	1.5	3	2	1.5	1	1.5	1.5	1	2	3
CO4	1.5	1.5	1.5	1.5	3	1	3	1.5	1.5	1	1	2
Avg	2	1.5	1.5	2	2	1.75	1.75	1.5	2	1.5	2	2

M. Sc. (Zoology) – 3rd Semester

M.Sc/Zoo/3/DSC2,A Wildlife and their Conservation (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course Objectives: In depth knowledge of Theory and practice of wildlife conservation. Concept of wildlife and understanding of wildlife conservational approaches.

Course outcomes:	
CO1	Students will be aware and understand the concept of wildlife and protected area system
CO2	Explain wildlife trade, conservational approaches and organizations
CO3	To know about the concept of wildlife census techniques and wildlife tourism
CO4	Systematically organize the understanding of wildlife conservation and approaches in wild

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Wildlife: Definition, significance and Biogeographic/wildlife zones of India, Bio-diversity of the Indian Subcontinent and World.

Protected Area Systems: Concept, Historical background, categories and management objectives of protected areas, world growth of protected areas, and Present status of National PA-Systems.

Natural Heritage Sites of the world, Natural Heritage sites in India. Important National Park and Wildlife Sanctuaries of India

Unit II

Biosphere Reserves: Biosphere Reserves of the world, India. Wildlife conservation techniques.

Wildlife and livelihood: Wildlife and illegal trade & control; Role of WWF, IUCN, UNEP, Red Data Book; Categories of Endangered Wildlife Species.

Unit III

Wildlife Census: Planning a wildlife census, understanding sample counts, Block counts, Road side counts, Dung counts, Pugmark census, Water-hole census.

Study of signs and symptoms: A practice of recording field observations, Bio-telemetry, Ageing and Sexing techniques.

Wildlife Tourism: Definition scope and range; Popular Wildlife Tourist Sports of the world, Popular Wildlife spots in India, Sustainable use of wildlife spots.

Unit IV

Wildlife Damage, its nature and definition, electric fences for wildlife damage control, Basic electric fence design, Trench design, live trapping, Mist netting, Rocket netting Chemical capture: Equipment, Drugs, Plan of operation.

Poaching: Its definition and implications, conducting anti-poaching operations, evidence in poaching cases.

National Projects: Project Tiger, Project elephant, Project Rhinoceros, Project Crocodiles, Project Hangul, Manipur Brow Antlered Deer.

List of Recommended Sources:

1. Techniques for wildlife Census in India by W.A. Rogers (A field mannual); Wildlife Institute of India, Dehradun.
2. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
3. Wildlife in India by V.B. Saharia Natraj Publishers, Dehradun.
4. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
5. Ali, S. Ripley S.D. Handbook of Birds of India, Pakistan 10-Vols. Oxford University Press, Bombay.
6. E.P. Gee, The Wildlife of India.

CO-PO-PSO mapping matrix for M.Sc/Zoo/3/DSC2,A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	2	2.5	1	1.5	1	2.5	1	1.5	1	1	1
CO2	1	2	2.5	3	1.5	1	1	1	2.5	2	1.5	3
CO3	1	2	2.5	1	1.5	1	1.5	2.5	1.5	1	1.5	1
CO4	1	2	2.5	1	1.5	3	1	1.5	1.5	1	1	1
Avg	1.5	2	2.5	1.5	1.5	1.5	1.5	1.5	1.75	1.25	1.25	1.5

M. Sc. (Zoology) – 3rd Semester

M.Sc/Zoo/3/DSC2,B Reproductive Health in Animals (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: This course will deal with fundamental as well core aspects of reproductive biology.

Course outcomes:	
CO1	Basics of reproduction are being covered for introduction.
CO2	Students will be awarded about the disorders related to reproductive system
CO3	Students will be familiar with ART techniques and their advances.
CO4	Ethical issues related to ART are made clear to students.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Basics of reproduction: Gametogenesis: Conversion of germ cells into male gametes, Gametogenesis: Conversion of germ cells into female gametes, Development of male reproductive system I (Gonads, genital ducts, glands) Development of male reproductive system II (External genitalia, descent of testis) Development of female reproductive system I (Gonads, genital ducts, glands) Development of male reproductive system II (External genitalia, descent of ovaries)

Unit II

Disorders: Menstrual disorders – Precocious, delayed or absent puberty; Amenorrhea Fertility disorders – Sexual dysfunction; Infertility; Spontaneous pregnancy loss, Genetic disorders (mutations and syndromes), Cancers and biomarkers – Testicular; Prostate; Ovarian; Endometrial; Cervical; breast, thyroid disorders.

Unit III

Assisted Reproductive Techniques& Recent Advances: History of ART, Gonadotropins in ART : FSH , LH , estradiol, progesterone Ovulation induction; Oocyte retrieval; In vitro maturation In vitro fertilization ICSI, GIFT etc. Cryopreservation of gametes & embryos; Vitrification Embryo biopsy; Embryo hatching, Pre-implantation genetic diagnosis (PGD).

Unit IV

Ethics; Regulatory laws& Guidelines Ethical practices: National & International guidelines for ART , Laws regulating gamete donors & surrogacy: surrogacy bill , Preconception Pre- natal diagnostic techniques Act , Ethics in ART .

List of Recommended Sources:

1. Jones, R.E. and Lopez, K.H. (2014) Human Reproductive Biology.IV Edition, Elsevier.
2. Johnson, M.H. and Everitt, B.J. (1995) Essential reproduction. IVEdition, London, Blackwell Science (Eighth edition by Johnson, MH., 2018)
3. Austin, C.R. and Short R.V. (Eds) (2012). Reproduction in Mammals. Cambridge University Press. (online edition)
4. De-Groot, L.J. and Jameson, J.L. (eds) (2001). Endocrinology. W.B. Saunders and Company.
5. Franklyn F. Bolander (2012). Molecular Endocrinology. III Edition, USA, Academic Press.
6. Knobil, E. and Neil, JD (eds.) (2014). The Physiology of Reproduction. IV Edition, Elsevier.
7. Hatcher, R.A. et al. (1997). The Essentials of Contraceptive Technology. Population Information Programme. John Hopkins School of Public Health.
8. Robert Martin (2013). How We Do It: The Evolution and Future of Human Reproduction. Basic Books.
9. Peter T. Ellison (2001). On Fertile Ground: A Natural History of Human Reproduction. Harvard University Press.

CO-PO-PSO mapping matrix for M.Sc/ZOO/3/DSC2,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1	1.5	1.5	1	1.5	2	1.5	1.5	1	1	1	3
CO2	1	1.5	1.5	3	1.5	1	1.5	1.5	1	3	1	3
CO3	3	1.5	1.5	2	2	1.5	2.5	1.5	2	1	3	1.5
CO4	1	1.5	1.5	2	3	1.5	2.5	1.5	2	1	3	1.5
Avg	1.5	1.5	1.5	2	2	1.5	2	1.5	1.5	1.5	2	2.25

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC3,A Lab Pertaining to Theory DSC1,A

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course Objectives: Practical knowledge of important concept in wildlife and practice in wildlife conservation and significance of aquaculture

Course outcomes:	
CO1	Students will be able to analyse physico- chemical status of water of lotic and lentic Components. And also know about the career-oriented research in fish culture.
CO2	Students will be able to conduct qualitative and quantitative analysis of Phyto- and Zooplanktons. Team practicals will help to inculcate leadership qualities.

Experiments

1. Qualitative study of biotic components of aquatic ecosystem.
2. Quantitative study of biotic components of aquatic ecosystem.
3. Study of different types of Phytoplankton (Bacillariophyceae Chlorophyceae, Euglenophycea & Cyanophyceae).
4. Study of different types of Zooplankton (Protozoa, Rotifera, Cladocera, Copepoda).
5. Study of Benthic fauna.
6. Study of Neuston.
7. Study of Nekton.
8. Study of Macrophytes.
9. Estimation of Nitrates in water.
10. Estimation of Phosphates in water.
11. Estimation of dissolved oxygen by modified winklen method in water.
12. Determination of Primary productivity in an aquatic habitat.
13. Study of impact of Heavy metals on productivity.
14. Identification of the following fishes up to species level of Punjab, Haryana and Himachal Pradesh using already prepared field keys. Noting down their important characters, making sketches, and economic importance of each fish species along with ecological notes: *Notopterus notopterus, N.chitala, Schiozothoraxri chardsonii. Plagiostomus, Hypophthalmi chthysmolitrix, Cyprinu scarpio, Ctenopharyng odonidella, Puntius, Labeorohita, Catlacatla, Cirrhinus mrigala,Torputitora, Garragoty lagotyla, Noemecheilus botia, Botiaberdi., Mystusseenghala, Aorichthys* spp., *Wallagoattu, Heteropneustes fossilis, Channa, Mastacembelus armatus*

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Environmental Microbiology –A laboratory manual, L.L. Gerba, C.P. and Brendeeke. J.W. (1995) Academic Press, New York.

2. Experiments in Microbiology, Plant Pathology and Biotechnology 4th edition Aneja K.R. (2010) New Age International Publisher –New Delhi.
3. Microbiology –A laboratory manual 4th edition. Cappuceino J. and Sheeman N. (2000) Addison Wesley, California.
4. Environmental Microbiology –A laboratory manual. Pepper, I.L.; Gerba, C.P. and Brendecke, J.W. (1995) Academic Press, New York

CO-PO-PSO mapping matrix for M.Sc/ZOO/3DSC3,A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	2	1	1	1.5	2.5	3	3	3	3	3
CO2	2	2	2	2	3	1.5	2.5	2	2	3	3	2
Avg	2	2	2	1.5	2	1.5	2.5	2.5	2.5	3	3	2.5

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC3,B Lab Pertaining to Theory DSC1,B

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Course objective: Objective of this practical course to develop more insights into practical work of entomology.

Course outcomes:	
CO1	Develop an understanding of distribution and abundance of organisms including insects and their vital connections with each other and environment.
CO2	Attain a solid foundation in theoretical and practical understanding of different descriptive and inferential statistical tools and techniques in entomology.

Experiments

1. Morphology: Study of head and its sclerites of honeybee and cockroach.
2. Study of mouth parts of cockroach, housefly, honeybee, mosquito and butterfly.
3. Study of stinging apparatus of honey bee.
4. Taxonomy: Identification of insects belonging to different groups up to orders and sub orders.
5. Social Insects: Morphological studies of various castes of Polistes, Apis, Camponotus, and Odontotermes.
6. Dissection of alimentary canal of Cockroach and grasshopper.
7. Reproductive system: Dissection of male & female reproductive system of moths; Apyrene&Eupyrene sperm in moths.
8. Respiratory system: dissection of butterfly and grasshopper.
9. Nervous system: dissection of Dysdercus, butterfly, honey bee and locust, stomodeal nervous system of cockroach and grasshopper.
10. Insect Toxicology: Estimation of LD50 and LC 50 using insects.
11. Studies on dissipation of pesticides from soil and half life estimation.
12. Life tables/population dynamics modeling
13. Agricultural Entomology: Collection and identification of economically important insects and various stages of their life history.
14. Methods of rearing insects in the laboratory.
15. Identification of important insect pests of different crop plants and stored products.
16. Vector Biology: Study of life history stages of medically important arthropods, Diptera, Phthiraptera, Siphonoptera.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. General Entomology, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Calcutta, Bombay by M.S. Mani,1990.

2. The Insects, Structure & Function, English Language Book Society Hodder and Sloughton, G. Britain by R.F. Chapman,1978.
3. Imms Text Book of Entomology Methuen & Co. Ltd. New York: EP. Dutton & Co. INC. by Richards & Davies, 10th edition (1997).
4. Honey bees and their management in India, ICAR Publications by R.C. Mishra,1995.
5. Agricultural Pests of India and South East Asia by A.S. Attwal, Kalyani Publishers, New Delhi, 1991.
6. Insects and Mites of Crops in India by MRGK. Nair, ICAR, N.Delhi, 1975.
7. Economic and Applied Entomology by Kumar and Nigam, Emkay Publications, Delhi, 2000.

CO-PO-PSO mapping matrix for MSc/ZOO/3/DSC3,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	3	1.5	2.5	1.5	1.5	2	2	3	3	1.5	2
CO2	1	1	1.5	2.5	1.5	1.5	3	2	1	2	2.5	2
Avg	1.5	2	1.5	2.5	1.5	1.5	2.5	2	2	2.5	2	2

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC4,A Lab Pertaining to Theory DSC2,A

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course Objectives: Practical knowledge of important concept in wildlife and practice in wildlife conservation.

Course outcomes:	
CO1	Students will know about the practical approaches of protected area system in India
CO2	Detail understanding of residential and migratory nature of avian fauna and their status in the field

Experiments

1. Determination of species, Dominance and frequency using quadrate/ plot method.
2. Sampling of evidences and samplings methods in wild and skills in wildlife photography.
3. Preparation of sampling designs for population estimation.
4. To prepare charts of wildlife zones of India and the world.
5. Comparison of several techniques for quantitative habitat survey and mapping.
6. Evaluating habitat availability and utilization. Uses of GIS technology.
7. Survey of animal diversity in university campus
8. Preparation of field diary on the basis of observations regarding habitat, habits of common available avian and rodent fauna of the region.
9. Zoogeography of mammals of Indian sub-continent; Distribution of (i) Primates: Rhesus macaque (ii) Carnivores: Tiger, panther, hyena, sloth bear (iii) Ungulates: Sambar, chital, wild boar.
10. Field visit to a Zoo or wildlife part/sanctuary and preparation of field report.

List of Recommended Sources:

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria; Tecpress Services, L.P., 487/42-SOL-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
4. Wildlife in India by V.B. Saharia. Natraj Publishers, Dehradun.
5. Wildlife in India by Saharia, V.B. Natraj Publ. Deharadun (U.P.).

CO-PO-PSO mapping matrix for MSc/ZOO/3/DSC4,A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	3	2	1.5	1.5	1.5	1.5	2	3	3	2.5	2
CO2	2	1	3	1.5	1.5	1.5	1.5	2	3	2	1.5	2
Avg	2	2	2.5	1.5	1.5	1.5	1.5	2	3	2.5	2	2

M. Sc. (Zoology) – 3rd Semester

MSc/ZOO/3/DSC4,B Lab Pertaining to Theory DSC2,B

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course objective: Objective of this practical course to develop more insights into practical work of reproduction health.

Course outcomes:	
CO1	Demonstrate understanding of reproductive health from clinical, epidemiological and social perspectives. Various concepts are plated to students with the help of photomicrographs.
CO2	Work effectively as an individual and in groups in the pursuit of scientific knowledge related to reproductive health. Students will learn through miniprojects various aspects of reproductive health.

Experiments

1. Study of animal house: Set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.
2. Examination of vaginal smear of rats (from live animals).
3. Surgical techniques: principles of surgery in endocrinology. Ovariectomy, hysterectomy, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology through micrographs.
6. Sperm count and sperm motility in rat.
7. Study the effect of cryptorchidism on sperm count and motility in rats.
8. Study of modern contraceptive devices.
9. Mini projects involving survey, data collection, statistical analysis and submission of a project report on reproductive health of a small human community.

List of Recommended Sources:

1. Hatcher, R.A. et al. (1997). The Essentials of Contraceptive Technology. Population Information Programme. John Hopkins School of Public Health.
2. Johnson, M.H. and Everitt, B.J. (1995) Essential reproduction. IVEdition, London, Blackwell Science (Eighth edition by Johnson, MH., 2018)
3. Franklyn F. Bolander (2012). Molecular Endocrinology. III Edition, USA, Academic Press.
4. Knobil, E. and Neil, JD (eds.) (2014). The Physiology of Reproduction. IV Edition, Elsevier.
5. Peter T. Ellison (2001). On Fertile Ground: A Natural History of Human Reproduction. Harvard University Press.
6. Jones, R.E. and Lopez, K.H. (2014) Human Reproductive Biology.IV Edition, Elsevier.
7. De-Groot, L.J. and Jameson, J.L. (eds) (2001). Endocrinology. W.B. Saunders and Company.

8. Robert Martin (2013). How We Do It: The Evolution and Future of Human Reproduction. Basic Books.
9. Austin, C.R. and Short R.V. (Eds) (2012). Reproduction in Mammals. Cambridge University Press. (online edition)

CO-PO-PSO mapping matrix for MSc/ZOO/3/DSC4,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2	3	2	1	1.5	3	1	3	2.5	2	3
CO2	3	2	2	2	2	1.5	3	3	3	2.5	3	3
Avg	2.5	2	2.5	2	1.5	1.5	3	2	3	2.5	2.5	3

Semester IV

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/CC12 Immunology (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: The primary objective of this course is to help students develop skills necessary for critical analysis of contemporary literature on topics related to health and disease and role of immune system.

Course outcomes:	
CO1	The students will be able to identify the cellular and molecular basis of immune responsiveness.
CO2	The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
CO3	The students will be able to describe immunological response and how it is triggered and regulated.
CO4	The students will be able to transfer knowledge of immunology into clinical decision-making through research methodology.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Introduction: Phylogeny of immune System, innate & acquired Immunity, clonal nature of immune system, primary & secondary lymphoid organs

Cells of Immune System: Haematopoiesis& differentiation, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic Cells, Natural Killer &lymphokine activated Killer Cells, Eosinophils, Neutrophils & Mast Cells, lymphocyte trafficking, humoral & cell mediated immune response.

Unit II

Immune System: Nature & Biology of antigens & superantigens, Immunoglobulins- structure & functions of different classes, Antigenic determinants (Isotype, Allotype & Idiotype), Antigen-antibody interactions, Antibody engineering.

MHC, Antigen processing & presentation, structure of MHC I & II, Genomic organization and MHC polymorphism.

Unit III

Regulation of Immune Response: Genomic organization and generation of diversity of B-Cell and T-Cell receptors, B-Cell and T-cell Regulation.

Antibody dependent cell mediated cytotoxicity & macrophage mediated cytotoxicity, cytokines & their role in immune regulation, Complement system

Unit IV

Immunological Techniques: Immunoprecipitation reactions, Agglutination reactions, Complement tests, ELISA, RIA, Immunofluorescences.

Immune System in Health & Diseases: Hypersensitive Reactions, Auto immunity, AIDS and other immunodeficiencies.

List of Recommended Sources:

1. Immunology, 8th Edition.,Goldsby, R.A., Kindt T.J., Osborne B.A. (2012) W.H. Freedom & Comp, NY.
2. Essential of Immunology, 10th Ed. Riott, Ivon, Delves, Peter (2001) Blackwell Scientific Publications, Oxford.
3. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
4. Immunology – A short course – Eli Benzamini, R Coico, G Sunshine (Wiley-Liss).
5. Immunology – An introduction 5th Edition (2013) Tizard I.R. Philadelphia Sauders College Press.
6. Basic Immunology, Sharon J (1998) Williams and Wilkins, Battimore.
7. Janeway et al., Immunobiology, 8th Edition, Current Biology publications, 2012.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/CC12												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	2	1.5	1.5	1.5	1.5	1.5	1.5	1	1.5	1.5	1
CO2	1.5	1.5	1.5	3	1.5	2.5	1.5	2.5	1	3	1.5	2
CO3	2	1.5	1.5	1.5	2	3	2	1	1	1.5	1	2
CO4	3	3	1.5	2	3	1	2	3	2	3	3	3
Avg	2	2	1.5	2	2	2	1.75	2	1.25	2.25	1.75	2

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/CC13 Endocrinology and Animal Behaviour (CC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: to provide an understanding to structures and function of **endocrine** glands. It also provides an understanding of the common endocrine disorders, metabolic regulations, and metabolic abnormalities, and their management and several aspects of animal behaviour.

Course outcomes:	
CO1	Make students adhere to basic concepts of endocrinology and learn its various malfunctioni disorder.
CO2	Concept clarity about various signalling pathways will be achieved.
CO3	Students will be able to picturize fundamentals of animal behaviour.
CO4	Students will discover about various relations pertaining to animal behaviour, behaviour which perquisite for approaching problems.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Basic concept of endocrinology and its scope. Mechanism of action of peptide hormones and steroid hormones Cell Signalling; concept of second messengers, cAMP, cGMP, Ca^{++},
Calmoduline, IP_3, DAG, NO, signal transduction mechanisms. Biosynthesis of peptide hormones transcriptional and post transcriptional modifications. Nuclear receptors, orphan genes and receptors and their role in metabolism and development, Prostaglandins

Unit II

Hormonal regulation of Metabolism: Role of Insulin & Glucagon in regulation of Carbohydrate metabolism. Metabolic regulatory hormones in Lipid & Protein metabolism. Role of Parathyroid Hormone in Ca^{++}& PO_4^{---} regulation. Gastrointestinal hormones, reproductive hormones, thyroid hormones . Regulatory substances – Erythropoietin, growth factors, Thymus gland &Kinins , Anterior pituitary and posterior pituitary hormones.

Unit III

Feeding , Learning , reasoning , instinctive and motivative behaviour ,social and sexual behaviour of animals , sexual selection ,mating systems ,parental care ,communications , evolution of animal signals , circadian rhythms , hormonal genetics of behaviourMimicry and protective colouration : definition and types of mimicry with examples

Unit IV

Migration of fishes and birds, parental care, intra and inter-specific relationships decision making, predator prey relationships, social organization: altruistic behaviour and concept of inclusive fitness

List of Recommended Sources:

1. Benjamin Lewin, Genes VII, Oxford University Press.
2. Lodish et al. Molecular Cell Biology.
3. Ethan Bier. The Coiled Spring, Cold Spring Harbor Press.
4. L.P. Freedman. Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhauser.
5. G. Litwack. Biochemical Actions of Hormones, Academic Press.
6. *General Endocrinology* by Turner, C.D. and Bagnars, W.B. Saunders Company; 1976.
7. *Comparative Endocrinology of Invertebrates* by Highnam, K.C. and Hill, L. Enwaral Arnold Ltd., London; 1981.
8. *Endocrinology* by Golds -Worthy, G.J. Robinson, J. and Mordue, W. John Wiley and Sons, New York; 1981.
9. *An Introduction to Invertebrates Endocrinology* by Tombes, A.S. Academic Press, New York; 1970.
10. *Comparative Vertebrate Endocrinology* by Bentley, P.J. Cambridge Univ. Press; 1998.
11. *Endocrinology* (4^{th} ed) by. Hadley, M. E. Prentice Hall; 1996
12. Davson H & Segal MB. 1978. Introduction to Physiology. Academic Press
13. Dewsbury Donald A. 1978. Comparative Animal Behaviour. McGraw-Hill.
14. Ewrt JP. 1980. Neurophysiology. Springer Verlag.
15. Hill RW & Wise GA. 1989. Animal Physiology. Harper & Row.
16. Mohan P Arora 2003. Animal Physiology. Himalayan Publ.
17. Peter Marler & amp; William J Hamilton 1966. Mechanisms of Animal Behaviour. John Wiley & Sons.
18. Proccer EL. 1973. Comparative Animal Physiology. WB Saunders.

CO-PO-PSO mapping matrix for MSc/ZOO/4/CC13												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	2	1	2	3	3	2	1	2.5	3	2	1.5
CO2	1.5	2	2	1.5	1.5	2	2	1	2.5	2	2	1.5
CO3	1.5	2	3	1.5	1.5	2	3	1	3	2.5	3	3
CO4	1.5	2	3	2	3	3	3	2	2	2.5	2	2
Avg	1.5	2	2.25	1.75	2.25	2.5	2.5	1.25	2.5	2.5	2.25	2

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/CC14 Cardinal Principles of Academic Integrity and Research Ethics (CC)

Credits: 2 (Lectures: 30) **Marks: 50**

Duration of Exam: 3 Hrs. **Theory: 30, IA: 20**

Course Objective: To enrich the student with ethics and principles of academic integrity.

Course outcomes:	
CO1	Understand and define the concepts of integrity and ethics.
CO2	Academic Integrity, Plagiarism (prevention and detection) and UGC regulations.

Note for the paper setter: The question paper will consist of five questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, four more questions will be set unit-wise comprising of two questions from each of the two units. The candidates are required to attempt two more questions selecting at least one question from each unit.

Unit I

Academic Integrity: Introduction, Academic Integrity Values- Honesty and Trust, Fairness and Respect, Responsibility and Courage, Violations of Academic Integrity-types and consequences, Plagiarism - definition, Plagiarism arising out of misrepresentation-contract cheating, collusion, copying and pasting, recycling, Avoiding Plagiarism through referencing and writing skills, UGC Policy for Academic Integrity and prevention, Some Plagiarism detection tools

Unit II

Research and Publication ethics: Scientific misconducts- Falsifications, Fabrication and Plagiarism (FPP), Publication ethics- definition, introduction and importance, Best practices/standard setting initiatives and guidelines-COPE, WAME etc. Violation of publication ethics, authorship and contributor-ship, Identification of publications misconduct, complains and appeals, Conflicts of Interest, Predatory publisher and journals,

List of Recommended Sources:

1. MacIntyre A (1967) A short History of Ethics, London
2. Chaddah P (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized. ISBN: 978-9387480865
3. National Academy of Sciences, National Academy of Engineering and Institute of Medicine (2009) On being a Scientist: A guide to Responsible Conduct in research: Third Edition. National Academics press.
4. Resnik D. B. (2011) What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10.
5. Beall J (2012). Predatory publishers are corrupting open access, Nature, 489 (7415), 179.
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019). ISBN: 978-81-939482-1-7.
7. UGC regulations (2018) for Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutes.

8. Ulrike kestler, Academic Integrity, Kwantlen Polytechnic University.

CO-PO-PSO mapping matrix for MSc/ZOO/4/CC14												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	2	1.25	2	3	3	3	2	1.5	3	2	2
CO2	2.5	2	1.25	2	3	2	3	2	2.5	2	2	2
Avg	2.5	2	1.25	2	3	2.5	3	2	2	2.5	2	2

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/CC15 Lab Pertaining to Theory CC12, CC13

Credits: 4 (Lectures: 120) **Marks: 100**

Duration of Exam: 4 Hrs.

Practical

Course Objective: Develop a holistic approach in the world of animals, concept of endocrinology and immunology.

Course outcomes:	
CO1	The students will have practical knowledge to diagnose the various disorders of immune system. Students will adhere to industrial microbiology based medicine for treatment.
CO2	Students would understand the various mechanisms of inflammatory response/autoimmune disorders etc.
CO3	To acquire knowledge and skills necessary for the critical analysis of endocrine systems
CO4	Enable pupils to develop and understanding of basic animal behavior

Experiments

1. General Laboratory-safety and Bio-safety measures in immunology laboratory.
2. Introduction to various instruments and their working principles used in immunology laboratory.
3. Blood film preparation and identification of cells
4. Lymphoid organs and their microscopic organization
5. Preparation and administration of antigens.
6. Isolation and purification of Immunoglobulins.
7. Quantification of immunoglobulins.
8. Immunodiagnostics (demonstration using commercial kits)
9. Immunodiffusion techniques:
   a) Ouchterlony double diffusion
   b) Radial immunodiffusion.
10. Immunoelectrophoresis:
    a. Counter current Immunoelectrophoresis
    b. Rocket Immunoelectrophoresis.
11. Latex agglutination technique.
12. To demonstrate response of animals to light .
13. To demonstrate antennal grooming behaviour in cockroach .
14. Field study of nesting behaviour of common available fauna of the region.
15. Demonstration of food preferences in insects/pests.
16. Study of migratory birds.
17. To study mobbing behaviour in birds.
18. To show endocrine glands in rat through charts/modeis/video clipping
19. To study the histology of endocrine glands through permanent slides.
20. To study the effect of insulin administration on the blood sugar level in rat.
21. To identify the stage of oetrous cycle

List of Recommended Sources:

1. GuptaP.K.(2004)MolecularBiologyandGeneticEngineering,RastogiPublicationsMeerut.
2. **Pharmaceutical biotechnology**, by M J Groves 2nd ed. (2006), Boca Raton, FL : Taylor & Francis
3. A handbook of Practical Immunology (1983). Edited by G.P. Talwar, Vikas Publishing House Pvt. Ltd. New Delhi-110002.
4. Practical Immunology (1980), Hudson L. and Franks, C.H. Blackwell scientific Publication, Oxford.
5. Fundamental techniques in immunology and serology (2002) Singh A. International Book Distributing Co., Lucknow.
6. Current protocols in immunology, (1997), Marjorie, M. John Wiley and sons, Inc. USA.
7. Handbook of experimental immunology (1986). Bewesly, P. Blackwell Scientific publications, London.
8. Davson H & Segal MB. 1978. Introduction to Physiology. Academic Press
9. Dewsbury Donald A. 1978. Comparative Animal Behaviour. McGraw-Hill.
10. Ewrt JP. 1980. Neurophysiology. Springer Verlag.
11. Hill RW & Wise GA. 1989. Animal Physiology. Harper & Row.
12. Mohan P Arora 2003. Animal Physiology. Himalayan Publ.
13. Peter Marler& William J Hamilton 1966. Mechanisms of Animal Behaviour. John Wiley& Sons.
14. Proccer EL. 1973. Comparative Animal Physiology. WB Saunders.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/CC15												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	2	2	1.5	1.5	1.5	2.5	2.5	2.5	3	2	2.5
CO2	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2	2.5	1.5	1	1.5
CO3	2	2	1.5	2.5	3	2.5	2.5	3	2.5	1.5	2.5	1.5
CO4	1.5	2.5	3	1.5	1	2.5	2.5	1.5	2.5	2	2.5	1.5
Avg	2	2	2	1.75	1.75	2	2.5	2.25	2.5	2	2	1.75

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/DSC5,A Parasitology (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course Objectives: To provide students with knowledge concern biological, epidemiological and ecological aspects of parasites causing diseases to humans. To enable students to understand the pathogenesis, clinical presentations and complications of parasitic diseases.

Course outcomes:	
CO1	To have an understanding of parasitism, including the diversity of symbiotic associations and their populational, dynamic and contextual nature.
CO2	Demonstrate through quizzes, class activities and tests an understanding of the taxonomic diversity of parasites, and the universality and variety of symbiotic associations.
CO3	Demonstrate familiarity with common protozoan and helminth parasites of humans as well as some related parasites of livestock and companion animals
CO4	Demonstrate an understanding the roles of parasites and infectious diseases on the ecology and evolution of their hosts, and the role of symbiosis in the evolution of life on earth.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Introduction to parasites of man, scope and definition of parasites/parasitology Animal Association, Types of Parasites and Hosts Interrelationship between Host and Parasites responses and hosts to parasitic infection Mode of transmission of parasite, Host specificity and parasitic adaptation

Unit II

Protozoa and Cestoda: Classification, Geographical distribution, Morphology, Life - cycle, Transmission, Pathogenecity, Treatment and Prophylaxis of: Protozoan parasites: EntamoebaSps,TrypanosomaSps., LeishmaniaSps. Intestinal flagellates Giardia Sps, TrichomonusSps

Cestodes: TaeniaSps ,DiphilabothriumSps . Classification of Parasitic Protozoans and parasitic cestodes

Unit III

Trematoda and Nematoda: Classification, Geographical distribution, Morphology, Life - cycle, Transmission, Pathogenecity, Treatment and Prophylaxis of Trematodes: SchistosomoSps,FaciolaSps, EchinococcusSps. Nematodes: WuchereriaSps,AncylostomaSps, DracunculusSps. Plant & Soil nematodes: Cyst nematode, citrus nematode Biodiversity & Taxonomic overview of Helminth Parasites

Unit IV

Immunology, Genetics & Molecular Biology of Parasites Trypanosoma: Diploid & Sexual stage, Molecular characteristics of surface coat, Variable surface glycoprotein (VSG) and VSG gene expression. Plasmodium: Diploid & haploid stages, Chromosome polymorphism, gene encoding Circumsporozoite protein &merozoites S - antigens, surface antigen diversity. Resistance of Malaria to drugs, its mechanism & assessment. Platyhelminthes: Inseminativebehaviour, parthenogenesis and polyspermy, sex determination, sex linked inheritance in Schistosomes. Nematoda: chromosome germ line limited DNA & chromatin diminution in Ascaris.

List of Recommended Sources:

1. Chandler, A. C. & Read. C. P. (1961). Introduction to Parasitology, 10th ed. John Wiley &Sons Inc.
2. Chandra, G. (2000). Mosquito. SreeBhumi Publication Co. Kolkata.
3. Cheng , T. C. &Bogitsch. Human Parasitology.
4. Cheng , T. C. (1986). 2nd ed. General Parasitology Academic Press, Inc. Orlando.U.S.A.
5. Cox, F. E. G. (1993). Modern Parasitology. 2nd ed. Blackwell Scientific Publications.ed. LeaandFebiger, Philadelphia.
6. Hati, A. K. (2001). Medical Entomology. Allied Book Agency, Kolkata.
7. Noble, E. R. & Noble G. A. (1982). Parasitology. The Biology of animal Parasites. 5th ed.
8. Schmidt, G. D. & Roberts, L. S. (2001). Foundation of Parasitology, McGraw HillPublishers, 3rd ed.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC5,A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	2	2	1	1.5	1.5	1.5	1.5	1.5	1	2.5	2
CO2	1.5	2	2	3	1.5	1.5	1.5	1.5	2	2.5	2.5	1
CO3	1.5	1	1	3	1.5	1	1.5	1.5	1.5	2.5	2	1
CO4	1.5	2	2	2	1.5	2	1.5	1.5	3	2	1	2
Avg	1.5	1.75	1.75	2.25	1.5	1.5	1.5	1.5	2	2	2	1.5

M. Sc. (Zoology) – 4th Semester

M.Sc./4/DSC5,B Biochemistry (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To develop understanding of biological processes at chemical, biochemical and molecular level to perform wide range of analytical techniques to explore biological activities.

Course outcomes:	
CO1	Students would gain general understanding of the major types of biochemical molecules, including small, large and super molecular components found in cells
CO2	Students would be expertise in basic to advance concepts of amino acids and proteins of cells.
CO3	Students would be expertise to develop understanding of lipid sat chemical, biochemical and molecular level.
CO4	Students will come in terms with complexities of nucleic acids and enzyme.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Biomolecules: An introduction, general structure of biomolecule.

Carbohydrates: Structure, occurrence and biological importance of important monosaccharides, oligosaccharide and polysaccharide. Ring structure and anomeric forms, mutarotation, reactions of monosaccharides, homo and hetero polysaccharides and mucopolysaccharides.

Unit II

Amino acid and proteins: Structure and properties of amino acids. Essential and nonessential amino acids, peptide bond. Type of proteins and their classification. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins. Structure of hemoglobin and myoglobin, Ramachandran plot.

Unit III

Lipids: Classification, structure of lipids and their general function. Essential fatty acids. Hydrolysis of fats, saponification value, rancidity of fats iodine number and acid value. Cholesterol-its structure and biological function.

Metabolism :Glycolysis, citric acid cycles its regulation, Hexose monophosphate pathway.

Unit IV

Nucleic acids: Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Double helix model of DNA structure, structural polymorphism of DNA [A, B & Z] and RNA. Biological function of nucleotides.

Classification and nomenclature of enzymes; Regulation of enzymatic activity; Coenzymes: Activators and inhibitors, isoenzymes, allosteric enzymes; Ribozyme and abzyme, Enzyme Kinetics, Immobilised enzymes and their applications.

List of Recommended Sources:

1. Lehninger; Principle of Biochemistry, 6th Edition by David L. Nelson and M.M Cox [2013] Free and company. New York.
2. Fundamental of Biochemistry. D. Voet and J. G. Voet [2013] John Wiley and Sons New York.
3. Biochemistry 8th Edition by L. Stryer [2015], W.H Freeman and New York
4. Biochemistry 4th edition by G. Zubay [1998] Wm .C Brown Publishers.
5. Outline of Biochemistry by Conn E.E, Stumpf P.K. Bruening G. and Dvi

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC5,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	3	2	1.5	1.5	1	1.5	1.5	2	1.5	1.5	1.5
CO2	1.5	1.5	1.5	1.5	1.5	1	1.5	1.5	1	1.5	1.5	3
CO3	2	1.5	1.5	1.5	1.5	1	1.5	1.5	3	1.5	3	2
CO4	2	2	1	1.5	1.5	1	1.5	1.5	2	1.5	2	1.5
Avg	1.75	2	1.5	1.5	1.5	1	1.5	1.5	2	1.5	2	2

M. Sc. (Zoology) – 4th Semester

M.Sc/Zoo/4/DSC5,C Microbiology (DSC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: To impart knowledge of the basic principles of bacteriology, virology, mycology, immunology and parasitology including the nature of pathogenic microorganisms, pathogenesis, laboratory diagnosis, transmission, prevention and control of diseases.

Course outcomes:	
CO1	Students will have basic knowledge about microbiology and its diversity.
CO2	Students will know about nutritional and maintenance aspects of bacterial culture.
CO3	Conclusive knowledge about bacterial genetics and its physiology.
CO4	Getting in depth with industrial microbiology and knowing various aspects of environmental biology.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

History of Microbiology: Discovery of the microbial world. Development of microbiology in the twentieth century. Scope of microbiology.

Microbial Diversity: Prokaryotic and Eukaryotic cells. Morphology and cell structure of major groups of microorganisms *e.g.*archaea, bacteria, fungi, algae, protozoa and viruses. Classification of viruses. Retroviruses, viroids and prions.

Unit II

Cultivation and Maintenance of Microorganism: Methods of isolation, purification and preservation of microorganisms. Theory, principles and methods of sterilization.

Concepts of Microbial Nutrition: Culture media, requirement for carbon, nitrogen, phosphorus, sulfur and growth factors. Nutritional categories of microorganisms.

Unit III

Microbial physiology: Definition of growth. Growth curve and generation time. Mathematical expression of growth. Measurement of microbial growth and factors affecting growth. Synchronous, batch, fed batch and continuous cultures, bacterial endospores.

Bacterial genetics: Transformation, conjugation, transduction, recombination, plasmids and transposons.

Unit IV

Industrial microbiology: Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology.

Environmental microbiology: significant applications of microbes in solving environmental pollution problems, Sewage treatment, bioleaching of copper and gold, solid waste management.

List of Recommended Sources:

1. Microbiology 9th Revised Ed. Prescott L.M.; Harley J.P. (2013) Tata McGraw Hill
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. (2010) Tata McGraw Hill, New Delhi.
3. Brock Biology of Microorganisms 14th Edition. Madigan, M.T.; Martinko, J. M. and Parker, J. (2015), Prentice Hall, New Jersey.
4. General Microbiology. Stainer et al. (2003) The MacMillan Press.
5. Tortora, G.J., Funke, B.R., Case, C.L. (2012) Microbiology -An Introduction, 11th Edition, Pearson education Pvt. Ltd. Singapore.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC5,C												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	1	1.5	2	1.5	1.5	1.5	1.5	3	2	1.5	2.5
CO2	1	1	1.5	2.5	2.5	1.5	2.5	1.5	2	1.5	2.5	2.5
CO3	2.5	3	2	2	2.5	1.5	1.5	2	3	1.5	1.5	2.5
CO4	3	3	2	2.5	1.5	1.5	1.5	3	3	3	1.5	2.5
Avg	2.25	2	1.75	2.25	2	1.5	1.75	2	2.75	2	1.75	2.5

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/DSC6,A Pertaining to Theory DSC5,A

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course objective: This course is aimed to provide the students with an introduction to the field of medical parasitology. It focuses on the parasitological terms, classification, types of parasites, habitats, hosts and different life cycles.

Course outcomes:	
CO1	Students will be able to understand the pathogenicity and epidemiology of different kind of parasites present in our surrounding.
CO2	Investigate the different ways by which the parasites damage their hosts and the response of the host. Also assess the reasons of infection with parasites and their cure.

Experiments

1. Study of prepared slides and museum specimens of selected parasites of representative groups of protozoans, helminthes and arthropods
2. Smear preparation for protozoa
3. Study of life cycle, role as vector & control measures of:
   i. Ticks (Argas, Boophilus)
   ii. Mosquito - anyone from - Anopheles/ Aedes/ Culex
   iii. Any two flies: Tabanus/ Phlebotomus/ Sarcophaga.Cyclops
4. Ectoparasites & Endoparasites of wild rat, cattle, dog, chick & human including stages in excreta.
5. Culturing insect parasitic nematode, and chasing the lifecycle of the nematode on the insect host.
6. Preparation of whole mounts for helminthes
7. Collection of Parasites from digestive tract of Cockroach gut / parasites of hen and their identification and preservation.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Parasitology : The Biology of Animal Parasites, 5th edition by Noble, E.R. and Noble, G.A., Lea & Febiger, Philadelphia; 1982.
2. Physiology of Parasites by Chapell, L.H., Blackie, Glosgow, London; 1979.
3. Immunology of Infection by Kaufmann, S., Academic Press; 1999.
4. An Introduction to Animal Parasitology by Smyth, J.D., Hodder & Stoughton, London; 1976.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC6,A												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	2.5	3	2	2	2.5	1.5	2	3	3	3	2
CO2	2	2.5	2	3	2	2.5	1.5	2	2	2	1	2
Avg	2	2.5	2.5	2.5	2	2.5	1.5	2	2.5	2.5	2	2

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/DSC6,B Pertaining to Theory DSC5,B

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course objective: To analyse, appreciate, understand the basic concepts of chemical reactions that occur in living systems, which enable them to understand the various perspectives of applied sciences that benefit the mankind.

Course outcomes:	
CO1	Provide students with the knowledge and skill base that would enable them to undertake further studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry and help develop a range of generic skills that are relevant to wage employment, self-employment and entrepreneurship.
CO2	Ability to work independently in terms of organizing laboratory, and critically analysing research literature.Ability to postulate hypothesis, questions and search for answers.

Experiments

1. Preparation of Molar, Normal solutions and Buffers
2. Determination of pH and use of pH meter
3. Estimation of carbohydrates by phenol sulphuric method.
4. Estimation of proteins by Micro-kjeldahl method.
5. Estimation of lipids by Soxhlet extraction method.
6. Separation of macromolecules from small molecules by dialysis.
7. Paper chromatography- Separation of sugars by ascending or descending chromatography
8. Thin layer chromatography - Separation of sugars on thin layer of silica gel, Separation of lipids on silica gel.
9. Electrophoresis- Separation of proteins by polyacrylamide gel electrophoresis.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Plummer DT. 1998. An Introduction to Practical Biochemistry. 3rd Ed. Tata McGraw Hill.
2. Rickwood D. (Ed.). 1984. Practical Approaches in Biochemistry. 2nd Ed. IRL Press, Washington DC.
3. Wilson K &Goulding KH. 1992. A Biologist‘s Guide to Principles and Techniques of Practical Biochemistry. 3rd Ed. Cambridge Univ. Press.
4. Wilson K & Walker J. 2000. Principles and Techniques of Practical Biochemistry. 5th Ed. Cambridge Univ. Press.
5. Clark JM. 1977. Experimental Biochemistry. 2nd Ed. WH Freeman.
6. Sawhney SK & Singh R. 2000. Introductory Practical Biochemistry. 2nd Ed. Narosa.

7. Willard M, Merritt LL & Dean JA.1981. Instrumental Methods of Analysis. 4th Ed. Van Nostrand. 8.William BL & Wilson K. 1975. Principles and Techniques of Practical Biochemistry. Edward Arnold.
8. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)-Narosha Publishing House, New Delhi.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC6,B												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2	3	2.5	2.5	3	2.5	3	3	2.5	2	3	3
CO2	2	3	2.5	2.5	3	2.5	2	3	1.5	2	3	3
Avg	2	3	2.5	2.5	3	2.5	2.5	3	2	2	3	3

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/4/DSC6,C Pertaining to Theory DSC5,C

Credits: 2 (Lectures: 60) **Marks: 50**

Duration of Exam: 3 Hrs.

Practical

Course objective: The objective of the Microbiology Program is to equip the students to gain bimolecular knowledge and analytical skills at an advanced level.

Course outcomes:	
CO1	Demonstrate practical skills in the use of tools, technologies and methods common to microbiology, and apply the scientific method and hypothesis testing in the design and execution of experiments
CO2	Utilize microbiological concepts to summarize, analyse, and synthesize scientific and microbiology-related literature, describe methodological information.

Experiments

1. Microscopy: Care, handling and use of microscopes
2. Micrometry: Calibration, microscopic measurement of microorganisms.
3. Staining methods
4. Preparation of liquid and solid culture media for growth of microorganisms.
5. Pure Culture Techniques: Streak plate, pour plate, spread plate
6. Demonstration of antibiotic sensitivity/resistance of E. coli to antibiotic pressure and interpretation of results.
7. Isolation and enumeration of microorganisms from soil and water.
8. Measurement of microbial growth and study of effect of various factors on growth of microorganisms: temperature, pH, U.V. and carbon and nitrogen sources on growth.
9. Biochemical characterization of selected microbes.
10. Milk Microbiology-SPC, testing the quality of milk using MBRT test.

***Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

List of Recommended Sources:

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Microbiology-a laboratory manual 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
3. Environmental Microbiology –A laboratory manual. Pepper, I.L.; Gerba, C.P. and Brendecke, J.W. (2015) Academic Press, New York.

CO-PO-PSO mapping matrix for M.Sc/ZOO/4/DSC6,C												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	3	2.5	2.5	2.5	3	3	3	3	2.5	2	3
CO2	2	2	2.5	1.5	1.5	2	2	2	3	1.5	2	2
Avg	2.5	2.5	2.5	2	2	2.5	2.5	2.5	3	2	2	2.5

M. Sc. (Zoology) – 4th Semester

MSc/ZOO/2/ SEC8 Credit Seminar

Credits: 1 (Lectures: 15) **Marks: 25**

Course objective: Student will acquire the knowledge for collection of literature and its presentation.

Course outcomes:	
CO1	To develop capability of critical thinking based on the contextual knowledge of zoology. Report writing and presentation skill of student will improve. Also, interdisciplinary knowledge of student will increase.

CO-PO-PSO mapping matrix for MSc/ZOO/2/ SEC8												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	2.5	2.5	2.5	2	3	3	2.5	2.5	3	2	2	2.5
Avg	2.5	2.5	2.5	2	3	3	2.5	2.5	3	2	2	2.5

M. Sc. (Zoology) – 1st Semester

M.Sc/ZOO/9/OEC-I Economic Zoology–I (OEC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: This course offers students an understanding of experiential learning on the methodology of fish culture, sericulture, Lac-culture, Vermiculture and apiculture. It will also provide information about economic aspects of culturing animals. It would promote Community and Youth Development.

Course outcomes:	
CO1	Students will be aware of applications of applied biology to meet the challenge of food storage during recent times.
CO2	It increases socio-economic status and self-employment with rural development.
CO3	Will provide awareness about the strategies used for the culture of economically important animals and their applications for human as well as animal welfare.
CO4	Further studies will help in improving product and by-products of cultured animals both quantitative and qualitatively

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Sericulture: Types of silk, species of silk moth (scientific names), Silkworms and their host plants, mulberry silk worm culture, agricultural aspects of mulberry plant cultivation, extraction and reeling of silk, natural enemies and diseases of silkworm and their control.

Unit II

Apiculture: Species of honey bees in India, life history of *Apiscerana indica*, agriculture techniques, bee products and their uses, natural enemies and diseases of honey bee and their control.

Unit III

Lac culture: lac insect (Scientific name), composition of lac, strains of lac insect, Life cycle and Host plantscultivation of lac host plants (in brief), processing of lac and uses of lac. Lac insects: species, Enemies of Lac insect and host plants, Lac industry in India

Unit IV

Vermiculture: species of vermiculture, culture methods, significance of vermicomposting Economic status of Vermiculture.
Aquaculture (Fresh water fishes andPrawn culture). Economic importance of mammals

List of Recommended Sources:

1. Insect Pest Management by Dent, D.
2. Agricultural Entomology by Hill, D.S., Timber Press.
3. Entomology and Pest Management by Pedigo L. P. Prentice Hall, India
4. Agricultural Pests: Biology and Control Measures by B. M. Deoray and T. B. Nikam, Nirali Publication, Pune.
5. Concepts of Insect Control by Ghosh M. R. Wiley Eastern Ltd. New Delhi.
6. Jhingran, V.G. 1995. Fish and Fisheries of India, Hindustan Publ. Corp., New Delhi.
7. Lagler, K.F. Bardach, J.E. Miller, R.R. and Pasina, D.R. M. 1987. Inohthology John Wiley and Sons, New York.
8. Deshmann, R. F. 1992. Wild life biology. Wiley Eastern Publisher, New Delhi.
9. Sharia, V.B. 1995. Wildlife in India. Natral Publisher, Dehradun.
10. Verman, L.R. 19990 Beekeeping in integrated mountain development. Oxford & IBH Publ. Co., New Delhi.
11. Stine, K.E and Brown, T. M. 1996. Principles of Toxicology. Lewis Publishers London.
12. Atwal, A. S. 2000, Essentials. Of beekeeping & Pollination. Kalyani Publ. New Delhi.
13. Hassal, A.K. 1990. The Biochemistry and uses of Pesticides EELBS Editions
14. Atwal, A.S. and Dhaliwal G.S. 1997. Agriculture pests of South Asia and their management. Kalyani Publishers New Delhi.
15. Aruga, H. 1998. Principles of Sericulture. Oxford & IBH Publishing Co. New Delhi.
16. Harper, Physiological Chemistry
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CO-PO-PSO mapping matrix for M.Sc/ZOO/9/OEC-I												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	3	1	1.25	3	1	1	2	2	2.5	2.25	1	3
CO2	1	1	1.25	3	1	2	2	3	2.5	2.25	1	3
CO3	2	1	1.25	3	2	1	3	2	2.5	2.25	1	3
CO4	2	1	1.25	3	3	2	2	2	2.5	2.25	1	3
Avg	2	1	1.25	3	1.75	1.5	2.25	2.25	2.5	2.25	1	3

M. Sc. (Zoology) – 2nd Semester

M.Sc/ZOO/9/OEC-II Economic Zoology–II (OEC)

Credits: 4 (Lectures: 60) **Marks: 100**

Duration of Exam: 3 Hrs. **Theory: 70, IA: 30**

Course objective: This **course** offers students an understanding of experiential **learning** on the methodology of fish culture, sericulture and apiculture. It will also provide information about economic aspects of culturing animals. It would promote Community and Youth Development.

Course outcomes:	
CO1	Create the self-employment opportunities to rural students through, aquaculture Vermiculture and pisciculture.
CO2	Students will learn intricate aspect of fur and leather industry and developments in this arena.
CO3	They will learn about elements of traditional animal husbandry and relate them with recent development in animal husbandry and its management.
CO4	Information pertaining to piggery sector and Pharmaceuticals from animals is obtained by students.

Note for the paper setter: The question paper will consist of nine questions in all. First question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions of 15 marks each selecting at least one question from each unit.

Unit I

Aquaculture: Principle, scope, techniques and importance of culturing, economically important aquatic organism, brief account of culturing of Indian major exotics corps and fresh water prawn, induced breeding of major carps and seed fish, pearl – culture (brief note) composite fish culture (polyculture).

Pisciculture: Economically important fresh water and marine fishes

Fish culture: aims and evolution, Fish Farming Technologies, Factors affecting fish culture.

Vermiculture (Brief over view)

Unit II

Fur Industry: Fur producing animals, Fur farming, dressing, processing and dyeing, Fur industries in India.

Leather Industry: Animals of leather industry, Processing of skin, flaying, Curing, salting and tanning, Enemies of skin industry.

Unit III

Dairy Farming: Milching animals, Breeds, Housing and raising and Tools of management, Artificial insemination and IVF for improvement of stock, Milk composition and dairy products.

Poultry: Nomenclature and breeds of poultry birds, Poultry products, Egg structure and quality, nutritive values, abnormalities in eggs, factors affecting size and egg processing, Broilers, meat processing and meat products, Poultry Rearing / Farming, Nutritional Requirements, Housing and equipment, Problems in poultry production, Poultry diseases, Poultry by products.

Unit IV

Piggery: Characteristics of swine and their products, Breed selection, management and housing and nutritional needs, Products (Pork, Bristles, Lard, Sausages) and by products, Diseases of Pigs Other Utilities of Animals: Pharmaceuticals from animals (in brief), Vaccination, Different types of vaccine, Immunization (Introduction).

List of Recommended Sources:

1. Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
2. Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, NewDelhi.
3. Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
4. Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co., India.
5. Khanna, S. S. (1986), An Introduction to Fishes, Central Book Depot, Allahabad.
6. Mustafa, S. (1990), Applied and Industrial Zoology, Rastogi publications, Meerut.
7. Sarkar, K. T. (1991), Theory and Practice of Leather manufacture. The Author, Madras.
8. Shami, Q. J. and Bhatnagar, S. (2002) Applied Fisheries .Agrobios India.
9. Shukla, G. S. &Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
10. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
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12. Yadav, M. (2003) Economic Zoology, Discovery Publication House, New Delhi.

CO-PO-PSO mapping matrix for M.Sc/ZOO/9/OEC-II												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PSO1**	**PSO2**	**PS03**	**PSO4**
CO1	1.5	2	1.25	3	2.5	1	3	3	2.5	3	2	1.25
CO2	1.5	2	1.25	2	1.5	1	3	3	2.5	3	1.5	1.25
CO3	3	2	1.25	2	1	1	3	3	2.5	3	3	1.25
CO4	1	2	1.25	3	1	1	3	3	2.5	3	1.5	1.25
Avg	1.75	2	1.25	2.5	1.5	1	3	3	2.5	3	2	1.25