KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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'A' Grade 2014

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No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಸೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂರ್ತಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

P. G. Programme

M.Sc. ZOOLOGY

Curriculum Structure

With Effect from 2024-25

Karnatak University, Dharwad

M.Sc. ZOOLOGY **Effective from- 2024-25**

Sem.	Type of Course	Theory/ Practical	Course Code	Course Title	Instruction hour/week	Total hours / sem	Duration of Exam	Marks			Credits
								Formative Assessment	Summative Assessment	Total	
I	DSC-1	Theory	A1ZOO001T	Biosystematics	04	60hrs	03hrs	20	80	100	04
	DSC-2	Practical	A1ZOO002P	Biosystematics Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-3	Theory	A1ZOO003T	Biology of Non Chordates	04	60hrs	03hrs	20	80	100	04
	DSC-4	Practical	A1ZOO004P	Biology of Non Chordates Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-5	Theory	A1ZOO005T	Biology of Chordates	04	60hrs	03hrs	20	80	100	04
	DSC-6	Practical	A1ZOO006P	Biology of Chordates Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-7	Theory	A1ZOO007T	Environmental Biology	04	60hrs	03hrs	20	80	100	04
	DSC-8	Practical	A1ZOO008P	Environmental Biology Practical	04	56 hrs	03hrs	10	40	50	02
								120	**480**	**600**	**24**
II	DSC-9	Theory	A2ZOO001T	Molecular Genetics	04	60hrs	03hrs	20	80	100	04
	DSC-10	Practical	A2ZOO002P	Molecular Genetics Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-11	Theory	A2ZOO003T	Cell Biology and Immunology	04	60hrs	03hrs	20	80	100	04
	DSC-12	Practical	A2ZOO004P	Cell Biology and Immunology Practical	04	56 hrs	04hrs	10	40	50	02
	DSC-13	Theory	A2ZOO005T	Animal Physiology	04	60hrs	03hrs	20	80	100	04
	DSC-14	Practical	A2ZOO006P	Animal Physiology Practical	04	56 hrs	03hrs	10	40	50	02
	OEC - 1	Theory	A2ZOO207T	Animal Behivour	04	60hrs	03hrs	20	80	100	04
								110	**440**	**550**	**22**

Sem.	Type of Course	Theory/ Practical	Course Code	Course Title	Instruction hour/week	Total hours / sem	Duration of Exam	Marks			Credits
								Formative Assessment	Summative Assessment	Total	
III	DSC-15	Theory	A3ZOO001T	Evolutionary Biology	04	60hrs	03hrs	20	80	100	04
	DSC-16	Practical	A3ZOO002P	Evolutionary Biology Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-17	Theory	A3ZOO003T	Animal Biotechnology	04	60hrs	03hrs	20	80	100	04
	DSC-18	Practical	A3ZOO004P	Animal Biotechnology Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-19	Theory	A3ZOO005T	Developmental Biology	04	60hrs	03hrs	20	80	100	04
	DSC-20	Practical	A3ZOO006P	Developmental Biology Practical	04	56 hrs	03hrs	10	40	50	02
	OEC – 2	Theory	A3ZOO207T	Economic Zoology	04	60hrs	03hrs	20	80	100	04
								110	**440**	**550**	**22**
IV	DSC-21	Theory	A4ZOO001T	General and Comparative Endocrinology	04	60hrs	03hrs	20	80	100	04
	DSC-22	Practical	A4ZOO002P	General and Comparative Endocrinology Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-23	Theory	A4ZOO003T	Biology of Reproduction	04	60hrs	03hrs	20	80	100	04
	DSC-24	Practical	A4ZOO004P	Biology of Reproduction Practical	04	56 hrs	03hrs	10	40	50	02
	DSC-25	Theory	A4ZOO005T	Applied Zoology	04	60hrs	03hrs	20	80	100	04
	DSC-26	Practical	A4ZOO006P	Applied Zoology Practical	04	56 hrs	03hrs	10	40	50	02
	Project-1	Practical	A4ZOO007P	Project	04	56hrs		30	120	150	06
								115	**485**	**600**	**24**

One OE each in II and III semester

Karnatak University, Dharwad
Department of Zoology

Program Outcomes, Program Specific Outcomes and Course Outcomes of M.Sc. Zoology

I. Program Outcomes:

After successfully completing of M. Sc. Zoology program, the students will be able to:

PO1- Develop passion towards the Zoology subject.

PO2- Establish self-entrepreneurship based on the knowledge gained in applied Zoological aspects.

PO3- Become successful professionals in academia and research in Universities and other premier Institutions.

PO4- Face and succeed in competitive examinations like NET, K-SET, KPSC and UPSC etc.

PO5- Develop scientific skills and innovative ideas in the field of Zoology.

PO6- Students gain knowledge and skill in the fundamentals of animal sciences, understands the complex interactions among various living organisms.

PO7- Analyse complex concepts of genetics and its importance in human health. Apply ethical principles and commit to professional ethics and responsibilities in delivering his duties.

PO8- Apply the knowledge and understanding of Zoology to one's own life and work.

PO9- Develop empathy, ethics and love towards the animals.

II. Program Specific Outcomes:

After successfully completing of M. Sc. Zoology Program, the students will be able to:

PSO1- Develop in-depth knowledge about the concepts of Zoology from the organism level to the molecular level. Understand the significance of animal taxonomy and systematics.

PSO2- Comprehend and interpret the evolutionary relationships among different animal groups.

PSO3- Learn the skills of handling various scientific equipment and perform the experiments.

PSO4- Explore various applied fields with the knowledge of sericulture, apiculture, fisheries, poultry, vermiculture and dairy farms etc.

M.Sc. Semester–I

Course Title: Biosystematics (Theory)
Course Code: A1ZOO001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-1	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the different species concepts, trends and approaches of taxonomy.
CO2- Study different collection, preservation and identification methods in animal science.
CO3- Understand the components and category of classification, construct phylogenetic tree and its analysis.
CO4- Understand the fundamental principles of animal systematic and their analysis.
CO5- Classify animals according to their characters and understand the theories of classification.
CO6- Highlight the importance of International rules of Zoological nomenclature and classification of animals.

Units	**Course Title: Biosystematics (Theory)** **Course Code: A1ZOO001T**	**60 hrs**
Unit-1	**Science of Biosystematics and Concept of Species:** Concept of Biosystematics, Historical review of taxonomic philosophies, Stages in taxonomy, Aims and Tasks of a taxonomist, Taxonomy as a profession, Problems of taxonomists, Future of taxonomic studies, Importance and significance of taxonomy, Taxonomic organizations in support of biodiversity. Concept of species: Historical perspective of different species concepts (viz. Typological, Nominalist, Biological, Evolutionary, Ecological, Phylogenetic, Recognition), Kinds of species- Sibling, Sympatric, Allopatric, Syntopic, Ring species, Polytypic, Monotypic species. Sub-species and other intra-specific groups (Deme, Variety, Form, Cline and Race).	15 hrs
Unit-2	**Taxonomic Collection, Preservation and Identification of Specimens:** Collection - Purpose, Scope of collection, Collection methods, Data of collection, Significance of museum collections, Legal aspects of collecting animal specimens, post-collection processes. Preparation and Packaging of specimens. Preservation methods of collected materials**:** Methods, Taxidermy, Plastination, Factors responsible for the deterioration of museum specimens. Curating of collections - Museum collection policy, Preparation of material for study, Housing, Mounting and Cataloguing of specimens, Arrangement of specimens, Maintaining quality of collection. Identification of specimens**:** Methods, Systematic process of sorting and Labelling, Procedure and problems of identification; Identification services.	15 hrs
Unit-3	**New Trends, Approaches in Taxonomy and Phylogenetic Analysis::** Morphological approach- General external structures, anatomy, special structures; Embryological approach; Cytological approach-DNA&DNA hybridization, DNA barcoding, Karyological studies; Ecological approach– Habitats and hosts, food, parasitism, seasonal variations. Behavioural approach– Ethological isolating mechanisms, courtship and behavioural patterns; Biochemical approach- Serological proteins, metabolic factors. Molecular approach– Major rRNA genes, Cytochrome-B, Cytochome-C, Cytochrome-C oxidase and other conserved sequences; Chemical and Numerical approaches.	15hrs

	Phylogenetic Analysis: Ways of constructing a phylogenetic tree; Methods of phylogenetic analysis-Phenetic methods- Dendrogram method, Pairwise distance; Cladistics methods-Parsimony, Maximum likelihood.	
Unit-4	**Zoological Classification and Nomenclature:** Components; Kinds of classification-Phenetic, Natural, Phylogenetic, Evolutionary and Omnispective; Future of classification; Phyletic lineages; Linnaean/Taxonomic hierarchy. Zoological Nomenclature: Origin of the code; Biocode; Phylocode; International Code of Zoological Nomenclature (ICZN); Preamble, Rules of Nomenclature-Historical and contemporary situation; Taxonomic keys and their significance; Taxonomic publications; Preparation of taxonomic publications; Taxonomic paper; Taxonomic bottle neck.	15hrs

Suggested References:

- Daniel Prater: *Book of Indian Animals*, Bombay Natural History Society
- Dingle, H.*Migration: The Biology of Life on the Move*.Oxford UnivPress, 1996
- Higgins, D., and Taylor, W. (Eds).*Bioinformatics Sequence, Structure and Databanks*. Oxford UnivPress, 2000
- Kapoor, V. C. *Theory and Practice of Animal Taxonomy*. Oxford IBH Co. Pvt. Ltd., New Delhi, 1998
- Jairajpuri, M. S. (Ed). *Collection and Preservation of Animals.*Zoological Survey of India, 1990
- Mayr, E.andAshlockP. D. *Principles of Systematic Zoology*, 2nd Edition, McGraw-Hill, Inc. 1991
- Keynes, R. *Charles Darwin's Zoology notes and Specimen Lists From H M. S. Beagle*. Cambridge Univ Press, 2000
- Simpson, G. C. *Principles of Animal Taxonomy.* ClumbiaUniv Press, New York, 1961

Course Title: Biosystematics (Practical)
Course Code: A1ZOO002P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-2	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand salient features and systematic position of each and every species.
CO2- Known the taxonomic tools like identification keys to classify organisms.
CO3- Learn about phylogenetic lineages and their hierarchy.
CO4- Acquaint with morphometric and meristic characteristics.
CO5- Learn about preservation and maintenance of museum specimens.

Practical No.	**Course Title: Biosystematics (Practical)** **Course Code: A1ZOO002P**	**56 hrs**
1	Biosystematic position ofPhylum Protozoa to Phylum Platyhelminthes	4hrs
2	Biosystematic position ofPhylum Aschehelminthese to Phylum Echinodermata	4hrs
3	Biosystematic position of Minor Phyla and Protochordates	4hrs
4	Biosystematic position of Cyclostomata to Mammals	4hrs
5	Morphometric measurements of some locally available fishes	4hrs
6	Construction of different types of taxonomic key for the identification of animals	4hrs
7	Scat analysis and Cluster analysis by using suitable example	4hrs
8	Identification and grouping of animals by using identification keys	
9	Construction of phylogenetic trees by taking suitable examples	4hrs
10	Identification of venomous and non-venomous snakes	4hrs
11	Animal preservation techniques (Physical and Chemical methods)	4hrs
12	Statistical applications in biosystematicstudies	4hrs
13	Listing of all the animals found in and around University Campus and try to find out their zoological names.	4hrs
14	Collection of various insect species and their preservation.	4hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–I

Course Title: Biology of Non Chordates
Course Code: A1ZOO003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-3	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the evolution of body plan and design in invertebrates.
CO2- Study the systematic position and phylogeny of few invertebrate minor phyla.
CO3- Learn the morphological adaptations with respect to different physiological functions in invertebrates.
CO4- Understand special features of larva, life history and significance.

Units	**Course Title: Biology of Non Chordates (Theory)** **Course Code: A1ZOO003T**	**60 hrs**
Unit 1	**Body plan:** Status of the Protozoa and the concept of protista; Primitive metazoans and their evolution; Symmetry and evolution of bilateria. **Coelom:** Evolution and significance of coelom – Acoelomate, Pseudocoelomate, coelomate, schizocoel, enterocoel, mesenchymal, Enterocoel theory, gonocoel theory, nephrocoel theory, schizocoel theory; Evolution and significance of metamerism – Pseudometamerism theory, cyclomerism theory, corm theory, embryological theory, locomotory theory; Protostomia and Deuterostomia. **Phylogeny:** Phylogeny and systematic position of minor phyla - Ctenophora, Nemertini, Entoprocta, Sipunculida, Ectoprocta, Phoronida, Brachiopoda and Pogonophora	15hrs
Unit-2	**Locomotion :** Amoeboid, Ciliary and Flagellar movementsinProtozoa;Ultra structuralaspectsofflagella; Principle of hydrostatic skeleton; hydrostatic movement in Cnidaria, Annelida (earthworm and neries), starfish; Flight movement in insect. **Nutrition:** Nutrition in Protozoa and macrophagous feeding in cnidaria, turbellaria; Filter feeding in sponges, polychaeta, mollusca, crustacea and echinodermata; Feeding patterns in insects – types of mouth parts in insects.	15hrs
Unit-3	**Respiration :** Respiratory organs in invertebrates - Simple gills of Annelida, Crustacea, Insecta (tracheal gills, Spiracular gills, blood gills), Mollusca, Echinodermata (papulae and peristomial gills, respiratory podia). Complex gills of merostomata (book gills), crustacea, insecta (simplex undulate, duplex implicate, duplex foliate, duplex papillofoliate, duplex archilamellate, duplex neolamellate, rectal gills), mollusca (bivalvia). Lungs (book lungs); respiratory tree; tracheal system (tracheal lungs, tracheae); Respiratory pigments- haemoglobin, hemocyanin, hemerythrin and chlorocruorin. **Circulation:** Circulation–Patterns (open and closed types) with suitable examples **Excretion:**	15hrs

	Excretory organs–Flame cells, coelomoducts, nephridia and malphigian tubules–Morphology and mechanisms	
Unit-4	**Nervous System and Reproduction** Primitive nervous system in Cnidaria (nerve net) and Echinodermata (circumoral nerve ring and radial nerves); Advancednervous system in Annelida (nerve ring and ventral nerve cord), Arthropoda (brain and ventral nerve cord) and Mollusca (cerebral ganglia, buccal ganglia, pedal ganglia, pleural ganglia, nerve ring, pedal nerve cords, visceral nerve cords). Sense organs in invertebrates (chemoreceptors and mechanoreceptors). **Reproduction**: Asexual (binary fission, budding and parthenogenesis), sexual (conjugation, epitoky and hermaphroditic); Larvalforms and their evolutionary significance – annelida (trocophore), crustacea (nauplius) and echinodermata (dipleurula).	15hrs

Suggested References:

- Barrington, E. J. W. Structure and Function of Invertebrates. ELBS 1971
- Chapman, R. F. The Insects: structure and function – IV Ed. Cambridge Univ. Press. 1998
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- Invertebrate Zoology: Robert Barnes IVth Edition Holt Saunders International Edition Japan..
- The Invertebrates Vol. 1 - 9 Libbie Henrietta Hyman, McGraw Hill Book Company.
- A Text book of Zoology Invertebrate: Parker Haswell, Marshall & Williams. AITBS Publishing & Distributers, Delhi
- The Cambrige Natural History Vol 1 - 9. S F Harmer, A.E. Shipley. Todays & Tomorrows Book agency, N Delhi India.
- Mill P. J. Respiration in Invertebrates. Mac Millan Education.

Course Title: Biology of Non Chordates (Practical)
Course Code: A1ZOO004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-4	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Identify microscopic aquatic organisms.
CO2- Learn various organ systems in invertebrate model animals
CO3- Gain knowledge on locomotors organs in invertebrates.
CO4- Differentiate various larval stages in invertebrates.

Practical No.	**Course Title: Biology of Non Chordates (Practical)** **Course Code: A1ZOO004P**	**56 hrs**
1	Observation of microscopic invertebrates in the water sample.	4hrs
2	Study of Earthworm: External features and Digestive system	4hrs
3	Study of Earthworm: Nervous system	4hrs
4	Study of Earthworm: Ovary, Setae, Nephridia	4hrs
5	Study of Starfish: Digestive system	4hrs
6	Study of Starfish: Water vascular system and tube feet	4hrs
7	Locomotory organs in invertebrates: Setae of earthworm, Tube feet of starfish Leg of cockroach	4hrs
8	Nutrition: Tubular feeding in Hydra, Eversible pharynx in Planaria, Filter feeding in Sponge, Terebella, Sabella and Unio	4hrs
9	Respiration: Branchial cone in Terebella, Ctenidia in Unio, Rectal gills in Naids Tracheae in Cockroach	4hrs
10	Excretion: Nephridium in earthworm, Malphigian tubules in cockroach	4hrs
11	Reproduction: Conjugation in Paramecium, Ovary of earthworm	4hrs
12	Invertebrate larvae: Coelenterate – Ephyra Platyhelminthes –Miracidium, Sporocyst, Redia, Cercaria, Metacerceria, Echinococcus	4hrs
13	Invertebrate larvae: Annelida – Polychaete larva Arthropod – Nauplius, Mysis, Zoea, Phyllosoma, Mosquito larva, Megalopa	4hrs
14	Invertebrate larvae: Mollusca larvae – Veliger, Glochidium Echinoderm larvae – Bipinnaria, Brachiolaria, Pluteus	4hrs
15	Any other practical depending on feasibility	

M.Sc. Semester–I

Course Title: Biology of Chordates
Course Code: A1ZOO005T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-5	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the systematic and phylogenetic position of protochordates and their general organization.
CO2- Gain knowledge on the origin, evolution and adaptive radiations of early vertebrates such as Cyclostomes and Pisces.
CO3- Trace out the origin and evolution of Amphibia, Reptilia, Aves and Mammalia and their adaptive radiations.
CO4- Understand the comparative anatomy of integument and its derivatives, brain, kidney, heart and aortic arches in different vertebrates.
CO5- Compare the organization of endoskeleton in different vertebrates.
CO6- Lean the different modes of adaptations in vertebrates.
CO7- Acquire the knowledge with respect to taxonomic status of the entire chordates and the evolutionary models of the group.

Units	**Course Title:Biology of Chordates (Theory)** **Course Code: A1ZOO005T**	**60 hrs**
Unit-1	**Organization of protochordates, evolution and adaptive radiations in early vertebrates:** Phylogeny and systematic position of Urochordata and Cephalochordata. General organization in urochordates-ascidians, thaliaceans and larvaceans; General organization in amphioxus. Retrogressive metamorphosis. Origin of chordate; origin, evolution and adaptive radiations in cyclostomata; origin, evolution and adaptive radiations in Pisces – ostracoderms; placoderms; chondrichthyans; acanthodians; actinopterygians and sarcopterygians. Adaptations in pisces.	15 hrs
Unit-2	**Origin, evolution and adaptive radiations in Amphibia, Reptilia and Aves:** Origin, evolution and adaptive radiations in Amphibia – Early labyrinthodonts – stegocephalians, temnospondyls and lepospondyls; Lissamphibians. Origin, evolution and adaptive radiations in Reptilia – stem reptiles, pelicosaurs and therapsids. Terrestrial adaptations in amphibians and reptiles. Origin, evolution and adaptive radiations in Aves. Aerial and terrestrial adaptations; Aerodynamics and mechanism of flight in birds (wing as flight surface).	15 hrs
Unit-3	**Zoogeography, Adaptive radiations in Mammals and comparative Osteology:** Zoogeography, origin and evolution of monotremes, marsupials and placentals, adaptive radiations in marsupials; dentition in mammals. Comparative osteology of vertebrates (fish to mammals): Overview of skull - cranium, jaws and hyoid apparatus; Axial skeleton – vertebrae, centra and ribs. Appendicular skeleton – pectoral girdle, pelvic girdle and organization of limb bones.	15hrs
Unit-4	**Comparative anatomy:** Comparative anatomy of integument and its derivatives – organization of dermis and epidermis in vertebrates; teeth, feathers, hair, scales, mammary glands, nails, claws and hooves. Comparative anatomy of heart and aortic arches in anamniotes and amniotes; Comparative anatomy of brain in different vertebrates. Comparative anatomy of urinogenital system in vertebrates; archinephric, pronephric, mesonephric and metanephric kidneys and their ducts.	15hrs

Suggested References:

- Vertebrate life :– William N. Ferland, F. Harvey pough, Tom J Gode, John B. Heiser Collier MacNillem International edition
- Chordate morphology :–Malcom Jollie Reinhold Publishing Corporation NewYork
- Chordate –Structure & Function :- Arnold G. Khage, B.E. Fry JohansonMc Millan Publishing Co. INC. NewYork
- Comparative Animal Physiology :- OrosserSatish Book Enterprises, Agra
- The Vertebrate Body: - Alfred Sherwood Romer • Vakils, Feffer& Simons Publications Ltd.
- Young, J. Z. The Life of Vertebrates –III Ed. (Indian Ed) Oxford Univ Press, 1981
- A Text book of Zoology Vertebrate: Parker Haswell, Marshall & Williams. AITBS Publishing & Distributers, Delhi
- Comparative Skeletal Anatomy, Bradley Adams, Pamella Crabtree, Humana Press 2008.

Course Title: Biology of Chordates Practical
Course Code: A1ZOO006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-6	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Visualize the anatomical, structural organizations in vertebrate model animals.
CO2- Learn adaptive features in different groups of chordates.
CO3- Study the endoskeleton of different groups of vertebrates.
CO4- Compare different organ systems in chordates.

Practical No.	**Course Title: Biology of Chordates (Practical)** **Course Code: A1ZOO006P**	**56 hrs**
1	Study of digestive system in fish and mounting of Ampullae of Lorenzini , Placoid scales	4hrs
2	Study of cranial nerves of fish and mounting of brain in fish.	4hrs
3	Study of male urinogenital system in fish	4hrs
4	Study of female urinogenital system in fish	4hrs
5	Study of digestive system in Rat, mounting of brain	4hrs
6	Study of circulatory system in Rat (Arterial and Venous system)	4hrs
7	Study of male urinogenital system in Rat	4hrs
8	Study of female urinogenital system in Rat,	4hrs
9	Study of Protochordates: *Balanoglossus, Botryllus, Amphioxus, Ascidia, Doliolum.* Study of Cyclostomes: *Petromyzon, Myxine* Study of Pisces: *Scoliodon, Raja raja* (Sting ray), *Echeneis (Sucker fish), Hippocampus, Exocoetus, Clarius*	4hrs
10	Study of Amphibians: *Ichthyophis, Siren, Ambystoma,* Axolotal larva, *Hopalobatrachus tigrinus, Rhacophorus, Bufo*	4hrs
11	Study of Reptiles: Tortoise, *Phrynosoma*, *Varanus,* Chameleon,*Draco* (flying lizard), Typhlops, Krait, Russel's viper, *Naja naja*	4hrs
12	Study of Birds: Cuckoo (male and female), Bhraminy kite, *Gallus gallus* (Hen and Cock), Indian roller, Horn bill, Owl	4hrs
13	Study of Mammals: Pangolin (Ant eater), Flying squirrel, Hystrix, Hedge hog, Loris	4hrs
14	Osteology and Comparative anatomy	4hrs
15	Any other practical depending on feasibility	

M.Sc. Semester–I

Course Title: Environmental Biology (Theory)
Course Code: A1ZOO007T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-7	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand and appreciate the environment and ecological services
CO2- Understand the biotic and abiotic factors of environment, biogeochemical cycle and intraspecific relationships of animals.
CO3- Acquire knowledge of ecosystem, food chain, energy flow and productivity and study pond as a model ecosystem.
CO4- Gain knowledge about pollution and bioremediation and conservation of bioiversity
CO5- Analyze the causes of climate change and its effect on the environment and biodiversity.

Units	**Course Title:Environmental Biology(Theory)** **Course Code: A1ZOO007T**	**60 hrs**
Unit-1	**Environment, Population growth and regulation:** History, definition, importance, scope, divisions and awareness of environmental biology. Ecosystem: Concept, types, structure, components and productivity and functions of different ecosystems; Biogeochemical cycles. Ecological Succession: Definition, primary and secondary succession, influence of anthropogenic activities on succession. Population Growth and Regulation : Types of population growth, physical and biological factors regulating population, population pyramids, population explosion	15hrs
Unit -2	**Natural and energy resources** Concept and classification of natural resources; Non-renewable resources- land, soil and mineral resources; Renewable resources- water, forest, wildlife, range lands, agriculture, livestock, aquaculture; Renewable and non-renewableenergy resources; Conventional sources of energy: Coal, Oil and natural gas, Thermal energy, Hydo-power, Nuclear power. Non-conventional sources : Solar energy,Tidal energy, Geothermal energy, Bio-mass based energyTypes: Resource management and conservation	15hrs
Unit-3	**Animal biodiversity and its conservation**: Global and Indian biodiversity; Levels of biodiversity- genetic, species, ecosystem diversity; Endangered species; Values of biodiversity- consumptive, productive, social, ethical, aesthetic (ecotourism) and health values; Conservation of biodiversity- ex-situ and in-situ; Mega-biodiversity centers- National parks, sanctuaries and biosphere reserves, biodiversity hotspots; Threats to biodiversity; Human-wildlife conflicts; Organizations associated with biodiversity management	15 hrs
Unit -4	**Climate change and its impact on human health**: Composition and structure of atmosphere; Climate- catastrophes and driving forces; Climate change due to human activity - ozone layer depletion, greenhouse gases and global warming, acid rain; Strategies for dealing with global warming. Environment and human health : Types of environmental health hazards- infectious organisms, Toxicants- chemicals, natural and synthetic toxins, heavy metals; Bioaccumulation and bio-magnification; Toxicity measurement; animal testing; environmental legislation and protection.	15 hrs

Suggested References:

- Arora, R. K. Air Pollution: Causes and effective control. Mangal Deep Publications, Jaipur (India), 1999.
- Botkin, D. B., and Keller, E. A. Environmental Science: Earth as a living planet. John Wiley and Sons, Inc, 1995
- Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. Standard methods for the examination of water and waste water – XX Ed. American Public Health Association, 1998
- Cunningham, W. P. Environmental Science – V Ed. WCB McGraw – Hill, 1999
- Kotwal. P. C., and Banerjee, S. Biodiversity Conservation: In Managed Forests and Protected Area. Agro Botanica, 1998
- Kumar, and Asija. Biodiversity: Principles and Conservation. Agrobios (India), 2000
- Ecology with special reference to animal & man S. Charles, Kendeigh Prentice hall of India Pvt. Ltd. New Delhi
- Elements of tropical ecology , YanneyEwusie (English language Book Society, Heine mann educational book publication)
- Fundamentals of Ecology E.P Odum

Course Title: Environmental Biology (Practical)
Course Code: A1ZOO008P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-8	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Analyse physico- chemical parameters in water samples.

CO2- Estimate components of different soil samples.

CO3- Evaluate BOD and COD in different water samples.

CO4- Learn about endangered species.

CO5- Differentiate the variations between different ecosystems.

Practical No.	**Course Title: Environmental Biology (Practical)** **Course Code: A1ZOO008P**	**56 hrs**
1	Estimation of pH of different water and soil samples using digital pH meter	4hrs
2	Estimation of dissolved oxygen (DO) in different water samples	4hrs
3	Estimation of free carbon dioxide in different water samples	4hrs
4	Estimation of chlorides in different water samples	4hrs
5	Estimation of total hardness of different water samples	4hrs
6	Determination of Biological Oxygen Demand (BOD) in different water samples	4hrs
7	Estimation of total alkalinity of different water samples	4hrs
8	Estimation of total dissolved solids in different water samples	4hrs
9	Estimation of dissolved sulphates in water by turbidometric method	4hrs
10	Estimation of dissolved phosphates in different water samples by colorimetric method	4hrs
11	Estimation of organic carbon content of different soil samples	4hrs
12	Estimation of Chemical Oxygen Demand (COD) in water 13.	4hrs
13	Study of endangered species	4hrs
14	Study of different ecosystems	4hrs
15	Any other practical depending on feasibility	

M.Sc. Semester–II

Course Title: Molecular Genetics (Theory)
Course Code: A2ZOO001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-9	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand classical medallion principles of genetics.
CO2- Describe the gene regulation,expression and transfer mechanisms in prokaryotes and eukaryotes.
CO3- Understand the dosage compensation mechanisms in a few invertebrates and vertebrates.
CO4- Explain the molecular basis of mutations and recombination's and their impact.
CO5- Describe the genetic variation through linkage and crossing over, chromosomal aberrations and sex determination.
CO6- Understand the genetic defects, inborn errors of metabolism, genetic and multi-factorial diseases and counseling.
CO7- Understand the molecular structure and functions of genetic materials.

Units	**Course Title: Molecular Genetics(Theory)** **Course Code: A2ZOO001T**	**60 hrs**
Unit-1	**Mendelian and Modern Genetics:** Overview of Mendelian principles and Post-Mendelian Genetics. Concept of alleles, complementation test, cistron, muton and recon. Linkage and crossing over. Non-Mendelian inheritance. DNA structure and functions: DNA as hereditary material – experiments; Watson and Crick model and alternate models of DNA, semi-conservative replication of DNA; DNA repair mechanisms; organization of prokaryotic and eukaryotic genomes. Replication: Enzymology of replication, initiation, elongation and termination; models of replication. Protein synthesis: Genetic code, colinearity hypothesis. Transcription, post-transcriptional modification. Translation: post-translational modification.	15 hrs
Unit-2	**Bacterial Genetics, Genomics and Proteomics:** Bacterial Genetics: Genetics of bacterium and bacteriophage: Transformation, transduction and conjugation in bacteria; F- mediated sexduction, mechanism of recombination in bacteria, Life cycles of bacteriophage, plasmids and episomes. Genomics and Proteomics: Salient features of yeast, *Drosophila* and Human genomes; Types of genomics-structural, functional, mutational, and comparative genomics; expansion of genomics; Proteomics-tools and applications	15 hrs
Unit-3	**Gene regulation and Genome rearrangement:** Gene regulation: Prokaryotes- operon model- positive and negative regulation; Eukaryotes - model of gene regulation, transcription factors, Cis and trans acting elements in eukaryotes. Dosage compensation in human, *Drosophila* and *Caenorhabditis elegans*. Genome imprinting-Angelman syndrome and Prader-Willi syndrome. Genome rearrangement: Variation in chromosome structure: cytogenetic implications of duplication, deletion, inversion, translocation and position effect. Transposons-transposable elements in bacteria and in eukaryotes; Lines and Sines; P-elements. Mutations- spontaneous and induced mutations; Molecular basis of mutation.	15 hrs

Unit-4	**Genetic Diseases:** Genetic diseases: Single gene inheritance; cystic fibrosis, sickle cell anemia, Marfan syndrome, Huntington's disease, and, hemochromatosis. Multifactorial inheritance: heart disease, high blood pressure, Alzheimer disease, arthritis, diabetes, cancer, and obesity. Chromosome abnormalities: Turner syndrome, Klinefelter syndrome, Down syndrome and Cri-du-chat syndrome. Mitochondrial inheritance: Leber's hereditary optic atrophy, epilepsy, myoclonic epilepsy and dementia.	15 hrs

Suggested References:

- Atherly, A. G., Girton, J. R., & McDonald, J. F. (1999).The science of genetics.Fort Worth, TX: Saunders College Publishing. ISBN-10: 0030332222, ISBN-13: 978-0030332227
- Higgins, D., & Taylor, W. (Eds.). (2000). Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (Vol. 236). OUP Oxford. 1-270. ISBN-10: 0199637903, ISBN-13: 978-0199637904
- Tamarin, R. H. (1993). Principles of genetics. Brown (William C.) Co ,U.S.; 4th edition. 1-688. ISBN-10: 0697166589, ISBN-13: 978-0697166586.
- Snustad, D. P., and Simmons, M. J. (2015).Principles of genetics.John Wiley and Sons. 1-648. ISBN: 9781119142287, 9781119232605.
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- Strickberger M. W.Genetics 3rd edition. PearsonIN Publishers.
- Pierce, B. A. (2012). Genetics: a conceptual approach. Macmillan. 1-976. ISBN: 1319050964, 978-1319050962.
- Robertis, D. (2017). Cell and molecular biology. ISBN: 8184734506, 978-8184734508
- Griffiths, P., and Stotz, K. (2013).Genetics and philosophy: An introduction. Cambridge University Press. 1-270. ISBN: 9781107354760, 1107354765.
- Owen, J. A., Punt, J., Stranford, S. A., & Jones, P. P. (2013).Kuby immunology (Vol. 27, p. 109).New York: WH Freeman.ISBN-10; 1319114709, ISBN-13- 978-1319114701.
- Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.ISBN-10- 9781319108243, ISBN-13- 978-1319108243.
- Kingston, H. M. (2002). ABC of clinical genetics. London: BMJ Books.BMA House, Tavistock Square, London WC1H9JR, ISBN 0-7279-1627-0.
- Smith J. M. (1999) Evolutionary Genetics.Oxford University Press. ISBN 0 19 850232 X Hbk, ISBN 0 19 850231 1Pbk. 1-330.

Course Title: Molecular Genetics (Practical)
Course Code: A2ZOO002P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-10	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Recognize the types of chromosomes and their modifications.

CO2- Analyze the inheritance of blood groups in humans.

CO3- Identify and analyze the different chromosomal anomalies.

CO4- Develop the skill of displaying different organs in Drosophila.

CO5- Apply the statistical tool to analyse the data.

Practical No.	**Course Title: Molecular Genetics(Practical)** **Course Code: A2ZOO002P**	**56hrs**
1	Study of polytene chromosomes in *Chironomous* larva	4 hrs
2	Study of polytene chromosomes in *Drosophila* larva	4 hrs
3	Study of genetics of blood group in Man	4 hrs
4	Study of X-chromatin or Barr body in buccal cell of Human	4 hrs
5	Human Karyotype analysis: Normal male, Normal female	4 hrs
6	Human Karyotype analysis: Down syndrome ,Cri-du-chat syndrome, Klinefelter syndrome, Turner syndrome, Translocation	4 hrs
7	Study of *Drosophila* mutants: Normal male, Normal female, Yellow body, Bar eye, White eye, Vestigial wing, Ebony body, Sepia eye	4 hrs
8	Study of of sex comb of different *Drosophila* species	4 hrs
9	Study of genital plate of different *Drosophila* species	4 hrs
10	Study of karyotype of different *Drosophila* species	4 hrs
11	Study of Sternopleural bristles and statistical analysis of *Drosophila*	4 hrs
12	Study of Acrostical bristles and statistical analysis of *Drosophila*	4 hrs
13	Study of eye pigments of *Drosophila* by paper chromatography	4 hrs
14	Study of inversions of *Drosophila.*	4 hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–II

Course Title: Cell Biology and Immunology (Theory)
Course Code: A2ZOO003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-11	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Acquainted with scope of modern cell biology, principles and applications of different microscopes.
CO2- Study the molecular organization of biomembranes, structural and functional aspects of cell organelles
CO3- To know the structure and composition of prokaryotic and eukaryotic cells.
CO4- Understand the molecular structure and functions of chromosome and their significance.
CO5- Understand the concept of cell cycle, apoptosis, cancer biology.
CO6- Know the cells and organs of immune system and their importance

Units	**Course Title: Cell Biology and Immunology (Theory)** **Course Code: A2ZOO003T**	**60 hrs**
Unit-1	**Introduction cell biology**: Cell as basic unit of life, Importance of Cell Biology and its applications, Structure and function of Prokaryotic (E. coli) and Eukaryotic cells (Animal Cell). **Techniques in Cell Biology:** Microscopy: Magnification, Resolution power, Basic Principle and Application of Simple, Compound, Phase contrast, fluorescence and Electron microscopes-TEM and SEM, Micrometry; Stains and Dyes: Types of stain: Acidic, Basic and Neutral stains and Dyes. **Plasma Membrane:**Structure of plasma membrane: Fluid mosaic model, Transport across membranes: Active and Passive transport, Facilitated transport, Exocytosis, Endocytosis, Phagocytosis – Vesicles and their importance in transport; Other functions of cell membrane in brief- Protection, Cell recognition, Shape, Storage, Cell signaling; Cell Junctions: Tight junctions, Gap junctions, Desmosomes.	15 hrs
Unit-2	**Endomembrane System:** Structure, location and Functions: Endoplasmic Reticulum, Golgi apparatus- Protein glycosylation, Protein sorting and transport, Lysosomes and Vacuoles. **Mitochondria and Peroxisomes:** Ultrastructure and function of Mitochondrion- Bioenergetics, Oxidative Phosphorylation, Protein import and Transport of metabolites, Peroxisomes. **Cytoskeleton**: Molecular organization of microfilaments, intermediate filaments and microtubules and their role in cell architecture and functioning.	15 hrs
Unit-3	**Nucleus:** Structure and function of nucleus: Nuclear envelope, Nuclear pore complex, Nucleoplasm, Nucleolus, Chromatin: Euchromatin and Hetrochromatin, Ultra structure of chromosomes, functions of chromosomes, giant chromosomes, chemical composition of chromosomes, Role of histones in Packaging DNA; Non-histone proteins. **Cell Cycle:** Phases of cell cycle, Role of Cyclins and Cyclin Dependent Kinases (CDK) in progression of cell cycle; **Cell division**- Mitosis and Meiosis. **Apoptosis –** Mechanism and significance. **Cancer Biology:** Introduction, Benign and Malignant tumors; Characteristics	15 hrs

	and properties of cancer; Development and causes of cancer; Carcinogens; Oncogenes; Oncoviruses; Tumor suppressor genes; Diagnosis and treatment of cancer.	
Unit-4	**Introduction to immunity:**Types of immunity; Innate and acquired immunity. **Cells and organs of immune system:**Cells: Lymphocytes (T and B cells), Monocytes, Macrophage; Eosinophills, Basophills, Neutrophils and Mast cells. **Primary and secondary lymphoid organs**: Bone marrow, Thymus, Spleen, Lymph nodes **Antigens and Immunoglobulins:**Antigens, factors influencing immunogenicity, epitope, hapten;Basic structure of the immunoglobulin; types and functions of immunoglobulins, **Immune response:**Humoral and cell mediated immune responses, Cytokines; Role of complement system in immune response. **Major Histocompatibility Complex and Hypersensitivity:**Transplantation and Graft rejection, Immediate and Delayed hypersensitivity.	15 hrs

Suggested References:

- Abbas, A. K., Lichtman, A. H., and Pober, J. S. Cellular and Molecular Immunology. IV Ed. W. B. Saunders Company, 2000
- Albert, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. Molecular Biology of the Cell. Garland Science Publishing, New York, 2002
- Alberts, B., Bray, D., Johnson, A., Lewis, I., Raff, M., Roberts, K., and Walter, P. Essential Cell Biology:
- An Introduction to the Molecular Biology of the Cell. Garland Publishing, Inc, New York and London, 1998
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- Lodish, H., Berk, A., Zipuosky, L. S., Matsudaira, P., Baltimore, D. and Darnell, L. Molecular Cell Biology – IV Ed. W. H. Freeman and company, 2001
- Malacinski, G. M., and Freifelder, D. Essentials of Molecular Biology. III Ed. Jones and Barlett Publishers, 1998
- Kuby Immunology 18th edition, 2018
- Essentials of Immunology by Dr. S.K. Gupta
- Basic Immunology, 6th Edition, Abdul Abbas, Adrew H. et al.

Course Title: Cell Biology and Immunology (Practical)
Course Code: A2ZOO004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-12	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Learn basic tissues, their location and functions.

CO2- Understand the process of cell division.

CO3- Acquaint with quantification of nucleic acids.

CO4- Understand importance of different cells and organs of immunity.

CO5- Know about different antigens and immunoglobulins.

Practical No.	**Course Title: Cell Biology and Immunology (Practical)** **Course Code: A2ZOO004P**	**56hrs**
1	Studyof epithelial tissues: Ciliated, Columnar and Squamous.	4 hrs
2	Study of nervous tissue: Myelinated and Non-myelinated nerve cells	4 hrs
3	Study of muscular tissue: Smooth muscle, Striated muscle and Cardiac muscle	4 hrs
4	Study of connective tissues ; Bone and Cartilage; Blood cells – Neutrophils, Basophils, Eosinophils, Lymphocytes and Monocytes	4 hrs
5	Estimation of DNA by Diphenylamine (DPA) method	4 hrs
6	Estimation of RNA by Orcinol method	4 hrs
7	Study of different stages of Mitosis in Onion root tips and observation of permanent slides	4 hrs
8	Study of different stages of Meiosis in Grasshopper testisand observation of permanent slides	4 hrs
9	Localization of mitochondrial DNA	4 hrs
10	Preparation of Stains and Fixatives	4 hrs
11	Histo-pathological examination (HPE)of Normal and Malignant cells.	4 hrs
12	Study of Cells and Tissues of immune system	4 hrs
13	Separation of lymphocytes from blood	4 hrs
14	Study of immunoglobulins	4 hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–II

Course Title: Animal Physiology (Theory)
Course Code: A2ZOO005T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-13	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the entire animal's functions of the body, including nutrition, Respiration, blood circulation, excretion, nerve and muscle physiology etc.,
CO2- Attain knowledge on the mechanism of osmoregulation and thermoregulation in animals.
CO3- Learn different types of feeding methods and enzymes involved in the process of digestion.
CO4- Understands molecular mechanisms involved in muscle contraction and neural transmission

Units	**Course Title: Animal Physiology (Theory)** **Course Code: A2ZOO005T**	**60 hrs**
Unit-1	**Introduction to Physiology:** History and central themes of Animal Physiology and its sub-disciplines. **Physiology of Respiration :** The atmosphere, solubility of gases, respiratory organs in the vertebrates (Gills and lungs); Respiratory mechanisms in aquatic (counter-current flow) and air-breathing fishes (lung fish, mud skipper, garpike, eel and electric eel), birds and mammals; respiration in eggs; Exchange of $O_2$and$CO_2$and transport; Oxygen dissociation curve (haemoglobin, myoglobin and foetal haemoglobin). **Circulation**:Generalprinciple,vertebratecirculation (fish to mammal), thephysicsofflowintubes,Hemostasis. **Blood:** components and functions; acid-base balance regulation.	15 hrs
Unit-2	**Temperature:**Classification of animals based on thermal biology, Temperature relations of ectotherms (behavioural thermoregulation, physiological response to temperature change-acute, chronic and evolutionary changes, enzyme adaptation to temperature, supercooling, antifreeze compounds), heterotherms and endotherms (thermal neutral zone, temperatures below and above thermoneutrality-hypothermia, shivering and non-shivering thermogenesis, evaporative cooling – sweating, panting and gular fluttering);specialized metabolic states–torpor, hibernation, and aestivation. **Water and Osmoregulation**: Properties of water molecules; Osmoregulation, Osmoregulators and Osmoconformers; Obligatory exchanges of ion and water; Osmoregulatory organs in vertebrates and invertebrates; Osmoregulation in aqueous and terrestrial animals.	15 hrs
Unit-3	**Feeding and Digestion**: Feeding methods (suspension and filter feeding); symbioses with microbes (gut microbe); Physiology of digestion(carbohydrate, protein and lipid digestion) and absorption (hydrophilic and hydrophobic molecules), gastro-intestinal secretions, gastro-intestinal hormones (secretin, cholecystokinin and gastric inhibitory polypeptide);nutritional requirements(micro and macro), vitamins	15 hrs

	Enzymes: General properties, Regulation of metabolic reactions, Metabolic production of ATP; Efficiency of energy metabolism. **Basal and standard metabolic rates**: metabolic scaling- relation between metabolic rate and body size, allometry; energetics of food and growth.	
Unit-4	**Muscle and Movement**: Structural organization of a neuron, contractile proteins of muscle- actin and myosin; Mechanism of muscle contraction, Sarcomere length-tension curve; Adaptations of muscle for various activities– jumping in frogs, swimming in fish and sound production in fish and snake and flight mechanism in insects. **Nervous System**: Structural organization and functions of nervous system; Electrochemical, resting and action potential; Transmission of information within neuron, synaptic transmission (electrical and chemical); Neuromuscular junction; Neurotransmitters.	15 hrs

Suggested References:

- Krebs, J. R., and Davies, N. B. An Introduction to Behavioral Ecology. III Ed. Blackwell Science Ltd. 1993
- Neilsen, K. S. Animal Physiology: Adaptation and Environment. IV Ed. Cambridge Univ Press, 1995
- Willmer, P., Stone, G., and Johnston, I. Environmental Physiology of Animals. Blackwell Science Ltd. 2000
- Dingle, H. Migration: The Biology of Life on the Move. Oxford Univ Press, 1996
- Hill Animal Physiology
- Eckert Physiology

Course Title: Animal Physiology (Practical)
Course Code: A2ZOO006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-14	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Analyse the different blood constituents and their measurements.

CO2- Quantify and identify the biomolecules.

CO3- Enumerate the pathological constituents of urine.

CO4- Identify the adulterants in food.

Practical No.	**Course Title: Animal Physiology (Practical)** **Course Code: A2ZOO006P**	**56 hrs**
1	Qualitative analysis of carbohydrates	4hrs
2	Qualitative analysis of polysaccharides	4hrs
3	Qualitative analysis of proteins	4hrs
4	Qualitative analysis of lipids	4hrs
5	Estimation of protein in different animal tissues	4hrs
6	Estimation of glucose	4hrs
7	Total count of RBC	4hrs
8	Total count of WBC	4hrs
9	Differential count of WBC	4hrs
10	Estimation of blood clotting time	4hrs
11	Estimation of hemoglobin	4hrs
12	Estimation of cholesterol and triglycerides	4hrs
13	Analysis of pathological contents of urine	4hrs
14	Identification of adulterants	4hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–III

Course Title: Evolutionary Biology (Theory)
Course Code: A3ZOO001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-15	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the contributions of evolutionary biologists and interpret various theories on evolution.
CO2- Identify the significance of evolution in understanding biology.
CO3- Explain the Hardy-Weinberg principle of genetic equilibrium and various forms of evolutionary forces.
CO4- Grasp the concepts of Neo-Darwinism and Non-Darwinism.
CO5- Get an insight into different mechanisms of speciation and origin of higher categories.
CO6- Understand the evolution of life histories, trade-offs and the evolutionary basis of aging.
CO7- Understand the theories of evolution and highlighted the role of evidences in support of evolution.
CO8- Learn the evolutionary knowledge through the concepts of coloration and mimicry.
CO9- Obtain the knowledge about direct observation of fossils and their evolutionary relationship of animal groups.
CO10- Understand the inheritance of mendelian traits by direct observation among students.
CO11- Acquire knowledge skill development and observation of blood group identification and pedigree chart preparations.

Units	**Course Title: Evolutionary Biology (Theory)** **Course Code: A3ZOO001T**	**60 hrs**
Unit-1	**Introduction to evolution and Theories of evolution:** Evolution of evolutionary thoughts. Lamarckism; Natural Selection (Darwinism), Contributions of Charles Darwin, Alfred Russel Wallace, Thomas Malthus and Hugo de Vries; Postulates of Natural Selection and evidences; Natural Selection in action- Industrial melanism; Darwin's finches, Experimental evidences of Natural selection- Endler's guppies; Concepts of inclusive fitness – altruism and kin selection.	15 hrs
Unit-2	**Neo-Darwinism and Non-Darwinism:** Hardy-Weinberg Law of genetic equilibrium; Genes and genotype frequencies, Concept of Mendelian Population and gene pool; Factors operating against Hardy-Weinberg Law; Selection – types of selection- balancing selection, frequency dependent selection, directional selection, disruptive selection, artificial selection; Random Genetic drift (Bottle neck effect, Founder's effect); Migration. Molecular polymorphism: Nucleic acids and proteins; Molecular clock; Neutral theory of evolution and evolution random walk; Forces in evolution- stochastic vs deterministic	15hrs
Unit-3	**Fossilization, Speciation, Origin of higher categories:** Fossils: Process of fossilization - permineralization; types of fossil preservation - body fossils and trace fossils; fossils through geological time; molecular fossils; living fossils; evolutionary significance of fossils and living fossils.	15hrs

	Reproductive isolation mechanisms – pre- and post-zygotic. An overview of speciation - allopatric, sympatric, peripatric and parapatric modes of speciation; Phyletic gradualism and punctuated equilibrium; micro and macroevolution.	
Unit-4	**The Evolution of Life histories and Darwinian medicine** Basic questions in life history evolution; Life history trade-offs: Optimality arguments, age and size at maturation; clutch size and reproductive investment, empirical evidences of life-history trade-offs; Life span and aging; evolutionary theories for aging. Impact of Darwin's thoughts in understanding human health and diseases (Darwinian medicine); Proximate versus ultimate causes of diseases; Design defects; Defense Mechanisms; Allergy; Evolution of antibiotic / Pesticide resistance; Evolution of behaviors such as anxiety, fear and depression.	15hrs

Suggested References:

- Darwin C. The Descent of Man. John Murray (1979) Penguin Classics
- Futuyma, D. J. Evolutionary Biology. III Ed. Sinauer Associates Inc Massachusetts, 1998 Gadagkar, R. Survival strategies, University press. 1997.
- Gerhart, J., and Kirchner, M. Cells, Embryos and Evolution. Blackwell Science Publisher, 1997
- Keynes, R. Charles Darwin's Zoology notes and Specimen Lists From H M. S. Beagle. Cambridge Univ Press, 2000
- Price, P. W. Biological Evolution. Saunders College Publishing, 1996
- Smith, J. M. Evolutionary Genetics. Oxford Univ Press, 1998
- Strickberger, M. W. Evolution. Jone and Barlett Publishers, Boston, London, 2000

Course Title: Evolutionary Biology (Practical)
Course Code: A3ZOO002P

Type of Course	Theory /Practical	Credits	Instructionhourperweek	TotalNo.ofLectures/Hours /Semester	DurationofExam	FormativeAssessmentMarks	Summative assessment Marks	Total Marks
DSC-16	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Interpret various evidences for evolution.
CO2- Understand the evolutionary significance of fossils and living fossils.
CO3- Understand the principles and applications of Hardy-Weinberg law.
CO4- To prove that overproduction leads to struggle for existence.
CO5- Understand the mechanisms of natural selection through experiments.

Practical No.	**Course Title: Evolutionary Biology(Practical)** **Course Code: A3ZOO002P**	**56 hrs**
1	Evidence for Principle of Evolution-Homologous structures.	4hrs
2	Evidence for Principle of Evolution-Serial homology.	4hrs
3	Evidence for Principle of Evolution-Analogous organs.	4hrs
4	Evidence for Principle of Evolution-Vestigial organs.	4hrs
5	Evidence for Principle of Evolution –Fossilsdepending on feasibility.	4hrs
6	Evidence for Principle of Evolution -Living fossils. practical	4hrs
7	Embryological evidence for evolution: Descent with modification.	4hrs
8	Application of Hardy-Weinberg principle to determine allelic frequency of: PTC trait in man.	4hrs
9	Application of Hardy-Weinberg principle to determine allelic frequency of: Blood group trait in Man.	4hrs
10	Experiment to elucidate the principle of overproduction that leads to struggle for existence.	4hrs
11	Study to elucidate that every individual is unique and variations are universal.	4hrs
12	Experiment to demonstrate how natural selection works: alphabet analogy.	4hrs
13	Experiment to demonstrate how natural selection works: beetle survival.	4hrs
14	Modification of structures for new function that have lost their original role.	4hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–III

Course Title: Animal Biotechnology (Theory)
Course Code: A3ZOO003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-17	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Get knowledge about animal cell culture, growth of cell lines and its applications
CO2- Understand gene and animal cloning through r DNA technology.
CO3- Describe recombinant DNA technology, genetic manipulations and their use in a variety of industrial processes.
CO4- Highlight the importance of transgenic animals and application of gene therapy.
CO5- Understand the applications of animal biotechnology in production of various products, nanotechnology and its applications.
CO6- Attain knowledge about the history, branches, scope of biotechnology and gene transfer technique.
CO7- Understand the recombinant technology, gene integration into the vector and with host genome and creation of transgenic animals.
CO8- Attain knowledge about in-vitro fertilization and embryo transfer.
CO9- Understand the DNA finger printing, blotting technique and micro array.
CO10- Describe the applications of stem cells and biotechnology devices**,** sterilization technique, and DNA isolation from cells and its use in animal identification.

Units	**Course Title: Animal Biotechnology (Theory)** **Course Code: A3ZOO003T**	**60 hrs**
Unit-1	**Introduction to Biotechnology:** Introduction, definition, origin, branches, scope andimportance,current status in India andpotentials of biotechnology. **Animal cell and tissue culture:** History, requirements for animal cell culture**,** Culture media: natural, complex natural media, chemically defined media. Cell culture techniques; Cell types, cell lines, maintenance and storage of cell lines, Applications of animal cell and tissue culture. **Stem cell technology**: Properties/characteristics of stem cells, Types-embryonic and adult stem cells, maintenance of stem cells, differentiation of stem cells, applications of stem cells technology.	15 hrs
Unit-2	**Genetic engineering:** Concepts, methodology of genetic engineering; uses and application of genetic engineering. **Gene cloning:** Method of gene cloning; molecular tools; restriction enzymes, ligases and other enzymes.**Gene cloning vectors**: Properties, different types of cloning vectors. **Introduction of rDNA in to host cells:** Microinjection; Electroporation; Polycations; Lipofection and Retroviral infection; Selection and screening of transformed cells. Applications of gene cloning. **Animal cloning:** Introduction, Somatic cell nuclear transfer (SCNT); Cloning in different animals with special reference to Dolly.	15hrs
Unit-3	**Transgenic Animals:** **Genetically engineered organisms (GEOs):** Risks of releasing GEOs; Transgenic animals; Gene targeting, Gene knock-out and knock-in technology, Gene-silencing; Advantages and disadvantages of transgenic animals, ethical	15hrs

	concerns. **Gene therapy:** Diagnosis of genetic diseases; Gene therapy methods; Somatic cell and Germ line, Gene therapy in animals and embryos. **Application of Animal Biotechnology:** Health care products of GEOs; Production of regulatory proteins- Insulin, Somatostatin, Interferons; Blood products: Thrombolytics, RBC, Blood clotting factors, Albumin; Hemoglobin. Anticoagulants (Heparin, Vitamins, Plasminogen activator). **Monoclonal Antibodies (MCAs):** Production of Hybridoma, Production of MCAs and applications of MCAs. **Recombinant vaccines**; Different types vaccines; DNA vaccines; Biosensors and Biochips.	
Unit-4	**Techniques in Biotechnology:** Polymerase Chain Reaction (PCR), DNA sequencing, DNA finger printing, Electrophoresis and Electrofocussing; Blotting techniques; ELISA –Methods and applications. **Nano-biotechnology:** Introduction, Diagnosis and screening, Nanoparticles: Properties, synthesis, characterization and applications of nanotechnology.	15hrs

Suggested References:

- Chirikjian, J. G. Biotechnology: Theory and Techniques- Vol. – I and II. Jones and Barlett, 1995
- Glick, B. R., and Pasternak, J. J. Molecular Biotechnology: Principles and Applications of Recombinant DNA – II Ed. A. S. M. Press, 1998
- Primrose, S. B. Molecular Biotechnology. II Ed. Blackwell Scientific Publications, London, UK, 1991
- Sasidhara R. Animal Biotechnology. MJP publishers, Chennai,2006
- Smith, J. E. Biotechnology. III ed. Cambridge University Press. 1996

Course Title: Animal Biotechnology (Practical)
Course Code: A3ZOO004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessmen tMarks	Total Marks
DSC-18	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the basic requirements for animal biotechnology laboratory.
CO2- Learn about different sterilization techniques.
CO3- Separate bio-molecules through different techniques.
CO4- Practice the extraction of nucleic acids from the animal tissues.
CO5- Learn to culture different types of cells.
CO6- Prepare buffers and stains required for animal biotechnology experiments.

Practical No.	**Course Title: Animal Biotechnology (Practical)** **Course Code: A3ZOO004P**	**56 hrs**
1	General requirements of animal biotechnology laboratory	4hrs
2	Sterilization Techniques–Physical, Chemical and Radiation	4hrs
3	Separation of Amino acids by paper chromatography	4hrs
4	Identification of bacteria's through Graham's staining method	4hrs
5	Cell viability test by using trypan blue	4hrs
6	Extraction of DNA and RNA from animal tissues	4hrs
7	Isolation of Casein, Lactose, and Albumin from Milk	4hrs
8	Preparation of buffers used in animal biotechnology	4hrs
9	Preparation of different types of culture media.	4hrs
10	Protozoan culture in laboratory as a model for cell culture	4hrs
11	Demonstration of Agarose Gel Electrophoresis and PolyAcrylamide Gel Electrophoresis (PAGE)	4hrs
12	Demonstration of instruments used in animal Biotechnology	4hrs
13	Study of different cell lines and recombinant vaccines	4hrs
14	Cell Death during development (Apoptosis).	4hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–III

Course Title: Developmental Biology (Theory)
Course Code: A3ZOO005T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-19	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the process of development and organogenesis.
CO2- Learn the inducer and inductor role in embryogenesis.
CO3- Gain knowledge about the metamorphosis and the process of regeneration.
CO4- Understand the early development in Amphioxus, frog and chick.
CO5- Understandtechniques and tools of Embryology.

Units	**Course Title: Developmental Biology (Theory)** **Course Code: A3ZOO005T**	**60 hrs**
Unit-1	**Introduction**: Overview of development, Anatomical and experimental approach to developmental Biology: embryological origin of gene theory, Evidence for genomic equivalence. Nuclear transplantation experiments in frog and mammal- the concept of totipotency. Nucleo-cytoplasmic interactions during early development in Ameoba and Frog. **Structure of the gametes**- The sperm (structure of the sperm); the egg (cytoplasm and nucleus, cell membrane and extracellular envelope); recognition of egg and sperm. **Fertilization**-External fertilization in sea urchin (sperm attraction, acrosome reaction, recognition of cell's extracellular coat; fusion of egg and sperm cell membranes); Prevention of polyspermy (one egg, one sperm, the fast and slow block to polyspermy); Activation of egg metabolism(Signal transduction).	15 hrs
Unit-2	**Development of axis formation in Drosophila**: Genetic and molecular analysis of axis formation in *Drosophila*: Life cycle; Development of larva; Establishment of anterior, posterior, dorsal and ventral polarity; Role of maternal effect genes, segmentation genes and homeotic selector genes. **Development of axis formation in Amphibians**: Mechanism of progressive determination of amphibian axes (specification of germ layers, dorsal-ventral and anterior-posterior axis); Hans Spemann and Hilde Mangold experiments on primary embryonic induction; Molecular mechanism of amphibian axis formation (the dorsal signal – part 1Nieuwkoop center, part 2 β-catenin and part 3 synergizing with vegetal pole); Functions of the organizer; Induction of neural ectoderm and dorsal mesoderm; Regional specificity of neural induction along the anterior-posterior axis.	15 hrs
Unit-3	**Cell differentiation and Organogenesis:** Development of somites - Somitogenesis; Differential cell proliferation in shaping organ primordia–Myogenesis– Determination of myotome, specification and differentiation by myogenic bHLH proteins, muscle cell fusion. Differentiation of neural tube - Primary and secondary neurulation, Differentiation of neural tube-Anterior-posterioraxis, dorso-ventral axis; Differentiation of erythrocytes-Hematopoiesis.	15 hrs
Unit-4	**Post-embryonic development:** Metamorphosis in Amphibia- Morphological, biochemical changes and molecular mechanism of hormonal regulation; Regeneration	15 hrs

	in Hydra, Planaria and Salamander.-embryonic development; Teratology-Teratogens; Endocrine disruptors; Growth concept –isometric and allometric. **Eco-Evo-Devo concept:** Developmental plasticity (phenotypic plasticity, polyphenism); Mechanisms of evolutionary change (heterotypy, heterochrony, heterometry and heterotypy).	

Suggested References:

- Gilbert, S. F. and Michael J. F. Barresi. Developmental Biology. 2016. 11th edition By. Sinauer Associates Sunderland, M A.
- Rao, K. V. Developmental Biology: A Modern Synthesis. Oxford and IBH Publishing Company Pvt. Ltd. 1993
- Subramoniam, T. Developmental Biology. Narosa Publishing House, 2002
- Twyman, R. M. Instant Notes: Developmental Biology Bios Scientific Publishers Ltd, 2001
- Wolpert, L., Beddington, R., Brockes, J., Jessen, T., Lawrence, P., and Meyerowitz, E. Principles of Development. Oxford Univ Press, 1998

Course Title: Developmental Biology (Practical)
Course Code: A3ZOO006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-20	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Acquaint with the developmental stages of frog and chick.

CO2- Gain knowledge on the life cycle of *Drosophila* and mosquito.

CO3- Observe the in vivo cultured chick embryo development.

CO4- Visualize the morphological changes in the metamorphosis.

Practical No.	**Course Title: Developmental Biology (Practical)** **Course Code: A3ZOO006P**	**56hrs**
1	Study of life cycle of *Drosophila*: a) Egg b) I Instar c) II Instar d) III Instar and c) Pupal stage	4hrs
2	Study of *Drosophila* developmental mutants: a) Antennapedia b) Bithorax	4hrs
3	Study of developmental stages and halteres in *Drosophila melanogaster*	4hrs
4	Study of imaginal discs of *Drosophila*	4hrs
5	Study of development and life cycle of mosquito.	4hrs
6	Developmental stages in Sea Urchin	4hrs
7	Study of early developmental stages in frog.	4hrs
8	Study of transverse sections of frog embryos and tadpoles	4hrs
9	Study of metamorphosis in frog (Gosner stages)	4hrs
10	Study of different developmental stages of chick embryo in whole mounts	4hrs
11	Study of transverse sections of chick embryos	4hrs
12	Temporary mounting of chick blastoderms, embryos of different developmental stages	4hrs
13	Preparation of permanent slide of whole mount of Chick embryo	4hrs
14	Observation of development of In vivo cultured chick embryo by ‘window method’	4hrs
15	Any other practical depending on feasibility.	

M.Sc. Semester–IV

Course Title: General and Comparative Endocrinology (Theory)
Course Code: A4ZOO001T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-21	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Explain the feedback mechanisms of hormonal action and their significance in homeostasis.
CO2- Discuss the hormonal regulation of calcium, glucose and intermediary metabolism.
CO3- Understand the biological actions of different hormones.
CO4- Describe the comparative anatomy of different endocrine glands.
CO5- Establish a link between immune system and endocrine system and elucidate the hormonal regulation of immune response.
CO6- Have an idea about the glands which works inside the body and secretes a chemical called hormone, their classification and regulation and antibody antigen reaction.

Units	**Course Title: General and Comparative Endocrinology (Theory)** **Course Code: A4ZOO001T**	**60 hrs**
Unit-1	**Insect endocrine system and vertebrate hormones and growth factors:** **Insect endocrine system:** Prothoracic gland, corpora allata, ring gland, epitracheal glands; the neurosecretory system - corpora cardiaca; insect hormones- ecdysteroid, juvenile hormone and prothoracic hormone. Hormones as chemical messengers - Classification of hormones; Growth factors: Insulin, Prolactin, placental lactogen and IGFs; Neurotrophic growth factors; Hematopoietic growth factors; Epidermal growth factors; Transforming growth factors; Fibroblast growth factors; Cytokines, chalone.	15hrs
Unit-2	**Comparative anatomy of Endocrine glands and Immunoendocrinology:** Endocrine hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas; Neurovascular hypohesis Immunoendocrinology: An overview of organization and function of immune system, effect of endocrine ablation and replacement on immune response; Sexual dimorphic immune response and its mechanism; Effect of pregnancy on immune response; Hormonal regulation of immune responses; Immuno-endocrine interactions involved in the immune response.	15hrs
Unit-3	**Hormones – Homeostasis and Biological actions:** Positive and negative feedback of hormone action. Calcium and glucose homeostasis; hormonal regulation of intermediary metabolism: carbohydrate, protein and lipid. Hormones and behaviour. Biological actions of hormones of hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas.	15hrs
Unit-4	**Mechanism of hormone action, Biosynthesis and secretion of hormones:** Hormone receptors- types and structure, regulation; Mechanism of hormone action- peptide hormone, receptor signal transduction, G proteins, Cyclic AMP, other membrane messengers - Protein kinase C; Phospholipase C. Mechanism of action of steroid hormones; Termination of hormone action. Biosynthesis and secretion of steroid hormones - corticosteroids and sex-steroids, Catecholamines, thyroid hormones, Peptide hormones- insulin.	15hrs

Suggested References:

- Bentley, P. J. Comparative Vertebrate Endocrinology – III Ed. Cambridge Univ Press, 1998
- Degroot, L. J., and Neill, J. D. (Ed). Endocrinology- IV Ed, Vol. I-III. W.B. Saunders Company, 2001
- Hadley, Mc. E. Endocrinology – Ed. Prentice Hall Inc, 2000
- Mandal, A. Handbook of Neuroendocrinology. EMKAY Publications, 1994
- Nelson, R. J. An Introduction to Behavioral Endocrinology. Sinauer Associates, Inc, 1995
- Norris, D. O. Vertebrates Endocrinology III Ed. Academic Press, 1996.
- Pablo De, Scanes, C. G., and Weintraub, B. D. Hand book of Endocrine Research Techniques. Academic Press, Inc. 1993
- Turner C.D. and Bugnara, J.T. General Endocrinology. W. B. Saunders 1976

Course Title: General and Comparative Endocrinology (Practical)
Course Code: A4ZOO002P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC-22	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Get an insight into the insect endocrine system.
CO2- Develop skill to remove the pineal and pituitary gland and histological processing.
CO3- Recognize sections of various endocrine glands.
CO4- Perform enzyme histochemistry in endocrine glands.
CO5- Carry out ELISA for quantification of hormones.

Practical No.	**Course Title: General and Comparative Endocrinology (Practical)** **Course Code: A4ZOO002P**	**56 hrs**
1	Study of insect endocrine system.	4 hrs
2	Display of endocrine glands in rat.	4 hrs
3	Study of of pituitary and pineal glands in rat.	4 hrs
4	Study of pituitary and pineal glands in fish.	4 hrs
5	Preparation of fixatives and stains.	4 hrs
6	Fixation of all endocrine glands as per the protocol.	4 hrs
7	Processing of endocrine glands of Insects for histology	4 hrs
8	Processing of Adrenal, Thyroid with Parathyroid and Pancreas for histology	4 hrs
9	Processing of tissue sections for staining.	4 hrs
10	Comparative histoarchitecture of Pituitary gland from fish to mammals.	4 hrs
11	Comparative histoarchitecture of Thyroid and Parathyroid and Pancreas from fish to mammals	4 hrs
12	Comparative histoarchitecture of Adrenal and inter-renal glands from fish to mammals.	4 hrs
13	Enzyme histochemistry - localization of steroid dehydrogenase enzyme activity (Δ^5-3β-HSDH and 17-3β-HSDH) in the adrenal, ovary and testis of rat.	4 hrs
14	ELISA- Quantitative measurement of sex steroid hormones in serum of rat.	4 hrs
15	Any other practical depending on feasibility	

M.Sc. Semester–IV

Course Title: Biology of Reproduction (Theory)
Course Code: A4ZOO003T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-23	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the overview of reproduction, differentiation of sex and gonads and their hormonal regulation.
CO2- Describe the structure of the organs of the male and female reproductive system and their function like, spermatogenesis, oogenesis and folliculogenesis.
CO3- Understand the process of implantation gestation, parturition and lactation
CO4- Describe the biological principles underlying contraceptive technology, compare and contrast the various options for control of fertility.
CO5- Know the sexually transmitted diseases and its control.

Units	**Course Title: Biology of Reproduction (Theory)** **Course Code: A4ZOO003T**	**60 hrs**
Unit-1	**An Overview of Reproduction:** Sex determination and differentiation of gonads, gonadal ducts and their hormonal regulation. **Male Reproductive System:** Anatomy, Histo-architecture of testis, Spermatogenesis, and its hormonal regulation; Spermiogenesis and Spermiation; Stem cell renewal; Seminiferous epithelial cycle; Sertoli and Leydig cells; Testicular cycles in non-mammalian vertebrates – fish, amphibian, reptiles and birds.	15hrs
Unit-2	**Male Accessory Reproductive Organs:** Structure, Function, and hormonal regulation of epididymis, Vas deferens, Prostate gland, Seminal vesicle, Cowper's glands/ bulbourethral gland; Composition of semen; Biology of spermatozoa; Biological actions of androgens.	15hrs
Unit-3	**Female Reproductive System:** Anatomy; Histo-architecture of ovary, Folliculogenesis, Follicular atresia, Ovulation, Corpus luteum; Hormonal regulation of estrous and menstrual cycles; Biological actions of estrogens. Ovarian cycles in non-mammalian vertebrates-– fish, amphibian, reptiles and birds. **Implantation, Gestation, Parturition and Lactation:** Types of implantation, Sequential events and hormonal regulation, Delayed implantation; Placenta – histo-physiology and endocrine function, Endocrine regulation of pregnancy and Parturition; Development of mammary glands, Lactation and its hormonal control.	15hrs
Unit-4	**Fertility and Infertility:** Fertility control in male and females – Natural methods, barrier methods, intrauterine devices, hormonal contraceptives, surgical and immunological approaches. Assisted Reproductive Techniques (ARTs): Hormone replacement therapy; Induction of ovulation; Artificial insemination, IVF, GIFT, ZIFT, Surrogate pregnancy, Gestational carrier; Amniocentesis. Sexually Transmitted Diseases : Gonorhoerea; AIDS	15hrs

Suggested References:

- Knobil, E., and Neil, J. D. (Eds.). Encyclopedia of Reproduction. Vol. I-IV. Academic Press, 1998
- Knobil, E., and Neil, J. D. (Eds.) The Physiology of Reproduction. II Ed, Vol-I and II. Raven Press Ltd, 1994
- Saidapur, S. K. (Ed) Reproductive Cycles of Indian Vertebrates. Allied Publishers Ltd, New Delhi, 1989
- Devaraj Sarkar, .Principles of Vertebrate Reproduction. Informatics Publishing Ltd
- Saidapur, S. K. (Ed) *Reproductive Cycles of Indian Vertebrates*.Allied Publishers Ltd, New Delhi, 1989
- TurnerC.D.andBugnara,J.T.*General Endocrinology*.W.B.Saunders1976
- Young,J.Z.*TheLifeofVertebrates*–IIIEd.(IndianEd)OxfordUnivPress,1981
- Bentley, P. J. *Comparative Vertebrate Endocrinology* – III Ed. Cambridge Univ Press, 1998
- Dingle, H.*Migration: The Biology of Life on the Move*.Oxford UnivPress, 1996
- Degroot, L. J., and Neill, J. D. (Ed).*Endocrinology*- IV Ed, Vol. I-III. W.B. Saunders Company, 2001

Course Title: Biology of Reproduction (Practical)
Course Code: A4ZOO004P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. Of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-24	**Practical**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Recognize the male, female gonads and accessory reproductive organs.

CO2- Understands the reproductive cycle in rats.

CO3- Differentiate the gonadal histo-morphology of different vertebrates.

CO4- Gain knowledge about the pathology of reproductive organs.

CO5- Get an idea about different contraceptive methods.

Practical No.	**Course Title: Biology of Reproduction (Practical)** **Course Code: A4ZOO004P**	**56 hrs**
1	Study of of male and female reproductive system in rat.	4 hrs
2	Study of estrous cycle in rat	4 hrs
3	Study of mammalian ovary- Primordial follicle, primary follicle, antral follicle, Graafian follicle, corpus luteum, corpus albicans and atretic follicles.	4 hrs
4	Study of female accessory reproductive organs in rat - T. S. of Fallopian tube, T.S. of Uterus	4 hrs
5	Induction of pseudopregnancy in rat.	4 hrs
6	Histology of testis and male accessory reproductive organs in rat - Epididymis, Seminal vesicles, Coagulating glands, Ventral prostrate and Cowper's glands / Bulbourethral gland	4 hrs
7	Androgen bioassay in rat.	4 hrs
8	Estrogen bioassay in rat.	4 hrs
9	Study of abnormal spermatozoa in rat.	4 hrs
10	Quantification of number of sperms in rat epididymal fluid	4 hrs
11	Comparative anatomy of the ovary in non- mammalian vertebrates - T. S. of ovary of Fish, Amphibia, Reptilia ovary and Bird.	4 hrs
12	Comparative anatomy of the testis in non- mammalian vertebrates - T. S. of testis of Fish, Amphibia, Reptilia ovary and Bird.	4 hrs
13	Pathology of Reproductive system- Cryptorchid testis, Prostate cancer, Polycystic ovary, Endometriosis	4 hrs
14	Contraceptive methods - Intra-uterine device, Hormonal contraception; Barrier method	4 hrs
15	Any other practical depending on feasibility	

M.Sc. Semester–IV

Course Title: Applied Zoology (Theory)
Course Code: A4ZOO005T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-25	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand use of Earthworm in waste management and agriculture ,
CO2- Explore the benefits of Honey bees in pollination and hive products
CO3- Learn the processes of silkworm rearing and the pathology.
CO4- Learn the modern techniques and methods of fishery and aquaculture and benefits and uses of the byproducts..
CO5- Understand the breeds of poultry and dairy and the economics of their products.
CO6- Gain knowledge about the pathogenic parasites and the importance of Integrated pest management

Units	**Course Title:Applied Zoology (Theory)** **Course Code: A4ZOO005T**	**60 hrs**
Unit-1	**Overview of Applied Zoology** **Vermiculture:** (Life cycle of earthworm; Establishment of vermiculture unit; Earthworm as a tool for conversion of waste material into vermicompost; Types of earthworm; Earthworm as Fish and Poultry feed; Vermiwash. A**piculture:** Life cycle, foraging and colony organization in different species; Bee keeping practices in India. Composition and uses of honey; Bee products; Lac insect- life cycle, cultivation and uses of Lac. **Sericulture**: Classification of silkworms based on moultinism, voltinism and geographical distribution; Popular silkworm breeds and hybrids. Life cycle of *Bombyxmori*; Diseases and pests of silkworm: protozoan, bacterial, viral and fungal diseases (mode of infection, transmission, prevention and control measures)	15 hrs
Unit-2	**Fisheries**: Resources and Distribution of freshwater, brackish water and marine fishes of India and its importance. **Aquaculture**: Definition, history, scope and importance; Induced breeding, fish seed rearing, composite fish culture and integrated fish culture practices. Cold water fisheries and its importance. Principles and methods of preservation and processing of fin fish and shell fish. Fishery by-products and value-added products. Fisheries Research Institutes of India **Ornamental fisheries**: Aquarium construction and management ornamental objects, ornamental plants, important fresh and marine ornamental fishes, ornamental fish diseases and control measures.	15hrs
Unit-3	**Poultry**: Indigenous and Exotic Poultry Breeds. Techniques and methods of breeding; Poultry products; Nutritive value of egg and meat. Poultry diseases: Viral, bacterial, fungal, protozoan and Helminth diseases and their control, vaccines for infections. **Dairy science**: Indigenous and Exotic breeds. Principles and methods of breeding. Modern trends in breeding dairy animals. Dairy products: Processing, preservation and marketing of milk and milk products. Nutritive value of milk.	15hrs

	Dairy pathology: Viral, bacterial and parasitic (Endo-Ecto) infections. Vaccination and control of diseases	
Unit-4	**Parasitology:** Important humans and veterinary parasites (Protozoan and Helminthes), Host- parasite interactions. Kinds of vectors and blood sucking dipterans; **Crop pests:** Life cycle and damaged caused by pests of cotton, sorghum, pulses and fruits. Household pests; **Insect Pest Management**: Types: Biological, cultural and chemical. Mass multiplication of bio-control agents	15 hrs

Suggested Referances:

- Arthur, R and William, H. A. Farming for pleasure and profit: Dairy farming Management of cows. Kessinger Publishing Company, 2010
- Avatar Singh, Joshi and Singh, B K. Dairy farming. ICAR publishers, 2010
- Clive, A. Edwards., Norman, Q. Arancon and Rhonda Sherman. Vermiculture Technology. CRC Press, 2011.
- David, D. V. and Kumarswami, T. Elements of Economic Entomology. Popular Book Depot. Madras. 1988
- Dent, D. Insect Pest Management- II Ed. CABI, 2000
- Dhaliwal, G. S., and Heinrichs E. A. Critical issues in Insect Pest Management. Commonwealth Publishers, New Delhi, 1998
- Dokuhon,Z.S. Illustrated text book of Sericulture. Oxford and IBH publishing Co., New Delhi, 1998.
- Duncan, F. N. (eds). Bee-keeping for Profit and Pleasure, Agrobios (India), 2004.
- Dutta Munshi and Srivastava. Natural history of fishes and systematic of freshwater fishes of India Narendra publishing house, New Delhi, 1988.
- Gupta, P. K. Vermicomposting for sustainable Agriculture. Agrobios (India) 2003
- Howse, P., Stevans, I., and Jones, O. Insect Pheromones and their Use in Pest Management. Chapman and Hall, 1998
- Jadhav and Sidiqui. Handbook of poultry production and management. Jaypee publishers, 2010.
- Jawaid Ahsan and Sinha, S. P. A hand book on Economic Zoology, S. Chand and Co. Ltd. New Delhi. 2000.
- Jhingran, V. G. Fish and Fisheries of India. Hindustan Publishing Corporation (India) New Delhi. 1983
- Mishra, R. C. Perspectives in Indian Apiculture. Allied Scientific Publ. Bikaner, India 1999
- Pedigo, L. P. Entomology and Pest Management. IV ed. Prentice- Hall of India, Pvt. Ltd. New Delhi. 2002.
- Prasad, D and Goutam, R. D. Potential IPM tactics. Westvill Publishing House, New Delhi, 1998
- Rajan, R.K., Hemanth Raju. Text Book on silkworm rearing. Central Silk Board, Bangalore, 2005
- Ratnabir Singh., Shomorendra Singh., Devashish Kar. Parasite Fauna in the wetland fishes of India. Today and tomorrow. Printers and Publishers, New Delhi, 2014.
- Sarker, Dilip. The Silkworm: Biology, genetics and Breeding. UBS publishers, 1998.
- Smyth, J. D. Animal Parasitology. Cambridge Univ Press, 1996
- Srivastava, K. P. Text Book of Applied Entomology- Vol.-I –II. Kalyani Publishers, 1996
- Srivastava, K. P. A text book of Applied Entomology. Vol. I and II, Kalyani Publishers. New Delhi. 1993

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Course Title: Applied Zoology (Practical)
Course Code: A4ZOO006P

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC-26	**Theory**	**02**	**04**	**56hrs**	**3hrs**	**10**	**40**	**50**

Course Outcomes (COs): At the end of the course, students will be able to:

CO1- Understand the importance of earthworm in organic waste management.
CO2- Acquaint with rearing of honey bees and production of hive products.
CO3- Learn different methods involved in silk worm rearing.
CO4- Acquaint with different breeds in poultry and dairy industry.
CO5- Understand indigenous and exotic fresh water and marine fishes.
CO6- Understand pathogenic effects of protozoan and helminth parasites.
CO7- Understand role of IPM in pest management.

Practical No.	**Course Title:Applied Zoology (Practical)** **Course Code: A4ZOO006P**	**56 hrs**
1	Study of Digestive system in Earthworm	4hrs
2	Mounting of setae, blood glands, nephridia and ovary of Earthworm.	4hrs
3	Bee keeping appliances	4hrs
4	Study of digestive system in Honey bee.	4hrs
5	Apiculture: Mounting of poison apparatus, pollen basket, pollen brush, wax glands and mouth parts of Honey bee.	4hrs
6	Silkworm Biology: Life cycle of Bombyxmori. Study of digestive system of larva. Mounting of silk gland and spiracles.	4hrs
7	Study of Silkworm pathogens.	4hrs
8	Fisheries: Aquarium construction and management; Economically important freshwater fishes: (*Catla catla*, *Labio rohita*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Wallago attu*, *Clarius batrachus*, *Mystus seenghala* and *Channa punctatus*). Locally avelable ornamental fishes	4hrs
9	Fisheries: Marine fishes: Sardine, Mackerel, Trygon, Scoliodon, Bombay duck and Pomfret). Shell fishes: Prawn, Pearl oyster and Sepia.	4hrs
10	Poultry: Study of Different breeds: Study of Ecto and endo parasites. (Mode of infection, prevention and control measures).	4hrs
11	Dairy Science: Study of Different breeds: Study of Ecto and endo parasites (Mode of infection, prevention and control measures).	4hrs
12	Parasitology I: Study of protozoan pathogenic parasites.	4hrs
13	Parasitology II: Study of pathogenic helminth parasites.	4hrs
14	Insect pest management: Study of agricultural and horticultural pests and bio control agents.	4hrs
15	Any other suitable practical	

OPEN ELECTIVE

M.Sc. Semester–II

Open Elective

Course Title: Animal Behaviour (Theory)

Course Code: A2ZOO207T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	TotalMarks
OEC-1	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): After completion of Animal behavior paper students will be able to:

CO1- Learn a wide range of theoretical and practical techniques used to study animal behavior

CO2- Develop skills, concepts and experience all aspects of animal behavior.

CO3- Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.

CO4- Evaluate the role of behaviour in the protection and conservation of animals in the wild.

CO5- Consider and evaluate behavior of all animals, including human in the complex ecological world including the urban environment.

Units	**Course Title:Animal Behaviour (Theory)** **Course Code: A2ZOO207T**	**60 hrs**
Unit-1	**Ethology: Introduction to Animal Behaviour:**Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour **Development o fBehavior** Behavior and genes; Innate behavior; Parent-offspring interaction; Imprinting- Filial Imprinting andSexual imprinting; Instinct- Interaction between instinct and learning	15 hrs
Unit-2	**Learning** Definition and forms learning**:** The classical conditioning **(**Pavlov experiment**),** Acquisition , Extinction and habituation, Generalization, Instrumental learning (Operant conditioning, Skinner), Reinforcement, **Biological aspect of learning**: Evolutionary aspect, Constrains of learning, Learning to avoid enemies,, Learning to avoid sickness, Stimulus relevance, The biological and psychological prospective **Cognitive aspect of learning**: Hidden aspects of conditioning, insight learning, Associative learning, Animal thinking , Social learning; Cognitive maps; Observational learning/imitation	15hrs
Unit-3	**Evolution of Social Behaviour**: Profile of Sir Ronald Fisher Sexual and Social Behaviour: Sexual selection: Sexual strategy, Altruism, Parental care, Cooperation, Society, benefits and costs of sociality; Social interactions of groups- Altruism – concept of inclusive fitness, (Kin selection, parental care); Reciprocal Altruism, selfish, spite, conflict and infanticide; Insect eusociality: a case of altruism and cooperation (honey bee); Vertebrate societies; Human sociobiology; Biological and cultural evolution	15hrs
Unit-4	**Communication**: Sign and normal stimuli; Channels of communication; Pheromones and acoustic signals; Evolution of display and mimicry, aposematic coloration, deception and honesty; communication in social groups, alarm calls, alarm pheromones, trail pheromones; Dance language in honey bee; Primate language.	15 hrs

Suggested References:

- An Introduction to animal behaviour :Aurbrey Manning and Marian S. Dawkins, Cambridge University Press 1995.
- Essentials of organizational behaviour 5thed : Stephan Robbins, Prentics Hall of India New Delhi, 1997.
- Animal Behaviour : McFarland D. ELBS With Longman, 1985.
- Ethology : Barnett.
- Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA
- Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, Sinauer Associate Inc., USA, 2009
- The Wisdom of the Hive. Thomas D. Seeley, Harvard University Press, 1995.
- Honeybee Democracy. Thomas D. Seeley, Princeton University Press, 2010.
- The Selfish Gene. Richard Dawkins, Oxford University Press, 2016. MS ZOOLE 307
- Neuroscience of Emotion: A New Synthesis. Ralph Adolphs and David J. Anderson, Princeton University Press, 2018.

M.Sc. Semester–III

Open Elective

Course Title: Economic Zoology (Theory)
Course Code: A3ZOO207T

Type of Course	Theory /Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours /Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
OEC-2	**Theory**	**04**	**04**	**60hrs**	**3hrs**	**20**	**80**	**100**

Course Outcomes (COs): After completion of Economic Zoology paper students will be able to:

CO1- Understand the methods involved in vermiculture, beekeeping, apiary management and Lac culture
CO2- Learn methods involved in silk worm rearing and pathology and understand dairy animals management
CO3- Understands economically important fishes and harvesting the byproducts and gain knowledge on different aspects of poultry.
CO4- Understand concepts involved in Insect pest management

Units	**Course Title:Economic Zoology (Theory)** **Course Code: A3ZOO207T**	**60 hrs**
Unit- 1	**Introduction**: Importance of Economic Zoology, An over view of animal Industry **Vermiculture:** Establishment of vermiculture unit; Earthworm as a tool for the conversion of biodegradable waste into vermicompost; Earthworms as poultry and fish feed; Vermiwash. **Beekeeping:** Beekeeping practices in India; Foraging and colony organization in honeybees; Composition and uses of honey and bee products. **Lac culture**: Cultivation and uses of lac.	15hrs
Unit- 2	**Sericulture**: Importance of sericulture as a rural industry; Life cycle of *Bombyxmori*; Modern rearing methods, reeling, grading and marketing. Silk worm diseases **Dairy Technology**: Over view of Dairy industry in India, Important Cattle breeds: Indigenous breeds, Exotic breeds. Buffalo breeds . Nutritive value of milk , Milk by products, Diseases that affect the dairy animals and the control measures.	15hrs
Unit- 3	**Fisheries:**Culture of major carps and exotic carps; Composite fish culture; Ornamental fishes;Off-shore fisheries- Sardine, Mackerel, Pearl culture; Fish by-products. **Poultry:** Different breeds of chicken and different breeding systems; Egg production and economics.	15hrs
Unit- 4	**Pest management and Parasitology**: Pests of economically important crops; Household pests; Damages caused by pests; Integrated Pest Management (IPM)- Different components and general idea about the bio-control agents; Vertebrate (birds and rodents) pest management. Definition and types of parasites and vectors; Blood sucking dipterans; Important human and veterinary parasites (protozoans and helminthes); Host-parasite interactions.	15hrs

Suggested References:

- Owse, P., Stevans, I., and Jones, O. Insect Pheromones and their Use in Pest Management. Chapman and Hall, 1998.
- Imms, A. D., General Textbook of Entomology, Vol. 1 and 2 Chapman and Hall, London, 1977.
- Jadhav and Sidiqui. Handbook of poultry production and management. Jaypee publishers, 2010.
- JawaidAhsan and Sinha, S. P. A hand book on Economic Zoology, S. Chand and Co. Ltd. New Delhi. 2000.
- Jhingran, V. G. Fish and Fisheries of India. Hindustan Publishing Corporation (India) New Delhi. 1983.
- Gupta, P. K. Vermicomposting for sustainable Agriculture. Agrobios (India) 2003.
- Dokuhon,Z.S. Illustrated text book of Sericulture. Oxford and IBH publishing Co., New Delhi, 1998.
- Duncan, F. N. (eds). Bee-keeping for Profit and Pleasure, Agrobios (India), 2004.
- DuttaMunshi and Srivastava. Natural history of fishes and systematic of freshwater fishes of India Narendra publishing house, New Delhi, 1988.
- Avatar Singh, Joshi and Singh, B K. Dairy farming. ICAR publishers, 2010

P. G. Programme: 2024-25

GENERAL PATTERN OF THEORY QUESTION PAPER FOR DSC/ OEC

(80 Marks for Semester end Examination with 3hrs duration)

Part-A

I. Question number 1-05 carries 2 marks each. 5x2=10 marks

1.

2.

3.

4.

5.

Part-B

II. Question number 06- 13 carries 05 marks each. Answer any 06 questions 6x5= 30 marks

6.

7.

8.

9.

10.

11.

12.

13

Part-C

III. Question number 14-17 carries 10 marks each. Answer all questions : 4x10=40 marks
(Minimum 1 question from each unit and 10 marks question may have sub questions for 7+3 or 6+4 or 5+5 if necessary)

14. a OR b

15. a OR b

16. a OR b

17. a OR b

Note: Proportionate weightage shall be given to each unit based on number of hours prescribed

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