

Maharishi Dayanand Saraswati University Ajmer
B.Sc. (Multidisciplinary)
Zoology Syllabus

B.Sc. (Multidisciplinary) Programme

(ZOOLOGY DISCIPLINE)

SEMESTER –I and II

Scheme:

Core Course	Semester	Credits	Duration of Exam	Maximum Marks		Minimum Marks	
				Semester Exam	Continuous Assessment [#]	Semester Exam	Continuous Assessment [#]
ZOO5101T-C	I	4	3 hrs	70	30	25	11
ZOO5102P-C		2	3 hrs	50*		18	
Total		6			150		54
ZOO5201T-C	II	4	3 hrs	70	30	25	11
ZOO5202P-C		2	3 hrs	50*		18	
Total		6			150		54

**See scheme of Examination*

Scheme of examination

"Scheme of examination for end of semester examination applicable to undergraduate courses (Pass course)"

The question paper of Theory Paper for the semester Examination for the Disciplinary Centric Core Course (DCCC), Discipline specific elective (DSE), Ability Enhancement Course (AEC), Value Added Course (VAC) and Skill Enhancement Course (SEC) will be of 70 marks and it will be divided in two parts i.e. Part A and Part-B.

Part-A will consist of 10 compulsory questions. There will be at least three questions from each unit and answer to each question shall be limited upto 50 words. Each question will carry two marks. Total 20 Marks.

Part-B will consist of 10 questions. At least three questions from each unit be set and student will have to answer five questions, selecting at least one question from each unit. The answer to each question shall be limited to 400 words. Each question carries 10 Marks. Total 50 Marks.

Score for continuous assessment for Discipline Specific Theory Core Course includes: Maximum six marks for attendance (**06**) and maximum twelve marks for each of the two class tests (**12+12**) conducted by the subject teacher (s). These marks to be submitted by the subject teacher (s) to HoD (in case of University Department) / Principal and finally to the MDS University, Ajmer or any guideline given by the University to be followed.

***Score for continuous internal assessment for Discipline Specific Practical Core Course includes:** Maximum three marks for attendance (**03**), maximum five marks for a class test (**5**) conducted by the subject teacher (s) and maximum two marks for performance of the student in laboratory (**02**) assessed by the subject teacher (s). These marks to be submitted by the subject teacher (s) to HoD (in case of University Department) / Principal and finally to the Practical Internal Examiner before Semester Practical Examination to award in the Semester Practical Examination. It has been included in the Scheme of Practical Examination given along with syllabus of Practical Paper. Semester Practical Exam will be Jointly conducted by the External (from the External Examiner Panel of the University) and Internal Examiners.

Note: A student will have to pass in theory Exam, Practical Exam and Continuous Assessments Separately

- **For attendance**, the distribution of marks is as follow:

		For Theory	For Practical	
▪	75 to 85% attendance	-	2 Marks	1 Marks
▪	85 to 90% attendance	-	4 Marks	2 Marks
▪	90 to 95% attendance	-	6 Marks	3 Marks

Year	Semester	Discipline Specific Core (DSC) Course	Discipline Specific Elective (DSE) Course	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Multidisciplinary (courses from any other discipline)	Value Addition Course	Total credits	
1 st	I	Discipline-I (i) Non-chordate Biology and Cell Biology (4) (ii) Practical (2)	--	English / Hindi / Modern Indian Language (MIL) and	--	--	--	20	
		Discipline -II (6)	--	Communication					
		Discipline -III (6)	--	(It will be as per decided by the University) (2)					
	II	Discipline -I (i) Chordate Biology and Developmental Biology(4) (ii) Practical(2)	--	English / Hindi / Modern Indian Language (MIL) and	--	--	--		20
		Discipline -II (6)	--	Communication					
		Discipline -III (6)	--	(It will be as per decided by the University) (2)					
EXIT - Undergraduate Certificate in Science will be awarded as per University Norms								40	
2 nd	III	Discipline -I (i) Genetics, Evolutionary Biology and Ecology (4) (ii) Practical (2)	--	--	Skill Enhancement Course (i) Environmental Impact Analysis or (ii) Basics of wetland conservation or (iii) Bio-fertilizer(2)	--	--	20	
		Discipline -II (6)	--						
		Discipline -III (6)	--						
	IV	Discipline -I (i) Biochemistry,	--	--	Skill Enhancement Course	--	--		20

		Physiology and Ethology (4) (ii) Practical (2)			(i) Human Health and Hygiene or (ii) Toxicology or (iii) Dairy Production and Technology (2)			
		Discipline –II (6)	--					
		Discipline -III (6)	--					
EXIT -Undergraduate Diploma in Science will be awarded as per University Norms								
80								
3 rd	V	--	Elective of Discipline - I (i) Microbiology, Parasitology & Immunology / Molecular Biology/ Vectors, Diseases & Management / Wildlife Conservation & Management/ Structure and Functions of Invertebrates (3) (ii) Practical (2)		Skill Enhancement Course (i) Vermi-composting or (ii) Poultry Farming or (iii) Apiculture or (iv) Ecotourism in Rajasthan (2)	Core or elective course of any other discipline <i>(not any that has already been chosen)</i> (5)	Environmental Wisdom in Indian Knowledge System / Animal Conservation in Indian Knowledge System (3)	20
	VI	--	Elective of Discipline - I (i) Biostatistics & Bioinformatics / Aquatic Biology / Food Nutrition & Health / Applied Zoology/ Biotechniques/ Biotechnology/ Structure and Functions of Vertebrates(3) (ii) Practical(2)		Skill Enhancement Course (i) Aquaculture or (ii) Computer Application in Biology or (iii) Intellectual Property Right or (iv) Biosafety Measures (2)	Core or elective course of any other discipline <i>(not any that has already been chosen)</i> (5)	Traditional ways of water conservation in India / Bio-Ethics (3)	20

			<i>Elective of Discipline – II or III or any other discipline (5)</i>					
EXIT - Award of Bachelor of Science								120

Note: Number in parenthesis depict credits.

B.Sc. (Multidisciplinary) Programme

(ZOOLOGY DISCIPLINE)

(i) Title of the Program of Learning:

- **Undergraduate Certificate in Science:**
 - *Minimum 40 credits* :1 year (2 semesters) of UGDP (Undergraduate Degree Program) + An Exit 4 credit SEC (Skill Enhancement Course)
- **Undergraduate Diploma in Science:**
 - *Minimum 80 credits* :2 years (4 semesters) of UGDP + An Exit 4 credit SEC
- **Bachelor's Degree in Science (B.Sc.):**
 - *Minimum 120 credits* : 3 years (6 semesters) of multidisciplinary UGDP with 3 major disciplines of choice

(ii) Introduction about the Program(Zoology Discipline):

With ever evolving understanding in the biological paradigm, upto the level of atomic interactions, study of various living organisms and their comparative study through the prism of integrated chemical, physical, mathematical, and molecular entities to appreciate the inner working of different organisms at morphological, cellular, molecular, interactive and evolutionary levels became necessary. The syllabi of zoology discipline of this programme cater learners with all these needs in an integrated and cross-disciplinary manner with comprehensive understanding of living systems.

(iii) Objectives of the Program (Zoology Discipline):

Key objectives in the zoology discipline are

1. to impart and assess the quality of critical thinking, analytical and scientific reasoning, reflective thinking, information and digital literacy, and problem-solving capacity of the learner.
2. to enable learner to understand inner working of living-beings.
3. to develop a comprehensive understanding and appreciation of the differences through various tools (including ICT) and well-designed hands-on practical exposures

(iv) Employment and Entrepreneurial Scope :

1. The program help learner to understand socio-economic capital of biological diversity and to explore possibilities of entrepreneurship through applied aspects
2. With the Courses and their practicals, the learner will be able to develop a range of generic skills that are relevant to wage employment, self-employment, and entrepreneurship.

(v) Learning outcome of the Program (Zoology Discipline):

1. The learner will be able to understand various concepts, mechanisms, biological designs & functions, interactions and evolutionary significance across organisms of various groups at different hierarchical levels.
2. Courses in Zoology discipline and their practicals demonstrate procedural knowledge, that aid in creating different types of professionals in the field of Zoology related fields such as, apiculture, aquarium fish keeping, medical diagnostics etc.
3. With the knowledge and skill base catered in the program, the learner will be able to undertake further studies in Zoology and related areas or in multidisciplinary areas that involve advanced or modern biology

(vi) Minimum Eligibility:

As per University/ State Government Guidelines OR Senior Secondary School Leaving Certificate or Higher Secondary (12th Grade) Certificate obtained after successful completion of Grade 12th or equivalent stage of education corresponding to Level-4 with minimum 50% of OGPA/CGPA on any Grade Point Scale. It will be 5% lower for SC and ST category and

Persons with Different Abilities. Student must have Biology / Agriculture / Mathematics as a course in Senior Secondary or Higher Secondary (12th Grade) or equivalent stage.

(vii) **Criteria for Selection of Students for Admission:** Based on Merit (as per CCE / University rules / institute prospectus)

(viii) **Permissible Number of Seats for one section:** as per CCE / University rules / institute prospectus

Semester wise scheme

Course Code	Course Title	Credits	Contact Teaching Hours per Week
YEAR 1 SEMESTER I			
ZOO5101T-C	Non-chordate Biology and Cell Biology	4	As Per University/ State Govt. guidelines/NEP Guidelines
ZOO5102P-C	Practical	2	As Per University/ State Govt. guidelines/NEP guidelines
DSCC of Discipline 2		6	
DSCC of Discipline 3		6	
Ability Enhancement Course: English / Hindi / MIL		2	
Total Credits		20	
YEAR 1 SEMESTER II			
ZOO5201T-C	Chordate Biology and Developmental Biology	4	As Per University/ State Govt. guidelines/NEP Guidelines
ZOO5202P-C	Practical	2	As Per University/ State Govt. guidelines/NEP guidelines
DSCC of Discipline 2		6	
DSCC of Discipline 3		6	
Ability Enhancement Course: English / Hindi / MIL		2	
Total Credits		20	
YEAR 2 SEMESTER III			
ZOO6301T-C	Genetics, Evolutionary Biology and Ecology	4	
ZOO6302P-C	Practical	2	
DSCC of Discipline 2		6	
DSCC of Discipline 3		6	
One Skill Enhancement Course from the pool, including ZOO6304-S (Environmental Impact Analysis) / ZOO6305-S (Basics of wetland conservation) / ZOO6306-S (Biofertilizer)		2	
Total Credits		20	

YEAR 2 SEMESTER IV			
ZOO6401T-C	Biochemistry, Physiology and Ethology	4	
ZOO6402P-C	Practical	2	
DSCC of Discipline 2		6	
DSCC of Discipline 3		6	
One Skill Enhancement Course from the pool, including ZOO6404-S (Human Health and Hygiene) / ZOO6405-S (Toxicology) / ZOO6406-S (Dairy Production and Technology)		2	
Total Credits		20	
YEAR 3 SEMESTER V			
Any one Discipline Specific Elective Course of Discipline 1 among the following along with corresponding practical			
ZOO7501T-E	Microbiology, Parasitology & Immunology	3	
ZOO7502T-E	Biotechniques		
ZOO7503T-E	Vectors, Diseases & Management		
ZOO7504T-E	Wildlife Conservation & Management		
ZOO7501P-E	Practical - Microbiology, Parasitology & Immunology	2	
ZOO7502P-E	Practical – Biotechniques		
ZOO7503P-E	Practical - Vectors, Diseases & Management		
ZOO7504P-E	Practical - Wildlife Conservation & Management		
Discipline Specific Elective Course of Discipline 2 / 3/ any other discipline		5	
One Skill Enhancement Course from the pool, including ZOO7505-S (Vermi-composting) / ZOO7506-S (Poultry Farming) / ZOO7507-S (Apiculture) / ZOO7508-S (Ecotourism in Rajasthan)		2	
Core or elective course of any other discipline		5	
One Value Added Course from the pool, including ZOO7609-V (Environmental Wisdom in Indian Knowledge System) / ZOO7610-V (Animal Conservation in Indian Knowledge System)		3	
Total Credits		20	
YEAR 3 SEMESTER VI			
Any one Discipline Specific Elective Course of Discipline 1 among the following along with corresponding practical			
ZOO7601T-E	Biostatistics & Bioinformatics	3	

ZOO7602T-E	Aquatic Biology		
ZOO7603T-E	Food Nutrition & Health		
ZOO7604T-E	Applied Zoology		
ZOO7601P-E	Practical - Biostatistics & Bioinformatics	2	
ZOO7602P-E	Practical - Aquatic Biology		
ZOO7603P-E	Practical - Food Nutrition & Health		
ZOO7604P-E	Practical - Applied Zoology		
Discipline Specific Elective Course of Discipline 2 / 3/ any other discipline		5	
One Skill Enhancement Course from the pool, including ZOO7605-S (Aquaculture) / ZOO7606-S (Computer Application in Biology) / ZOO7607-S (Intellectual Property Right)/ ZOO7708-S (Biosafety Measures)		2	
Core or elective course of any other discipline		5	
One Value Added Course from the pool, including ZOO7609-V (Traditional ways of water conservation in India) / ZOO7610-V (Bio- Ethics)		3	
Total Credits		20	

Note: 15 hours to be allotted per semester for 1 credit for theory classes; the hours will be double in case of Practical classes.

Core Course

ZOO5101T-C: Non-chordate Biology and Cell Biology

Course Description:

Non- chordate Biology part of the course enables students to study diversity of non-chordates. The course offers understanding to the animal architecture including bauplan, morphological concepts, various life support mechanisms and processes. The course also focus on classification and type study of some important non-chordate animals.

Cell Biology part of the course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

Course Learning Outcome: the learner will be able to

1. Understand fundamental principles and concepts of animal body plan
2. Understand life support processes in non-chordates
3. Understand diversity of non-chordates at both local and global level
4. Understand classification and phylogenetic significance of various non-chordate groups
5. Realize that very similar physiological mechanisms are used in very diverse organisms.
6. Understand the functioning of nucleus & cell organelles and understand the intricate cellular mechanisms involved.
7. Acquire the detailed knowledge of pathways related to cell division and apoptosis thus enabling them to understand the anomalies in cancer.
8. Develop an understanding how cells work
9. Get new avenues of joining research in areas such as genetic engineering of cells, cloning, vaccines development, human fertility programme, organ transplant, etc.
10. Understand how tissues are produced from cells in a normal course and about any malfunctioning, which may lead to benign or malignant tumor.

Course Content

Theory (Credits : 4)

UNIT – I

Non-chordate Biology

1. Taxonomy: Principal of Classification and Nomenclature, Binomial Nomenclature; Study of Kingdom Classification from two Kingdom to Six Kingdom. **Classification** of non-chordates with key characteristics and suitable examples (uptoechinodermata; uptoClass level with elementary Idea of Orders)
2. **Elementary idea of Morphological Concepts:**Basis of Classification: Symmetry, Cellularity,Germ Layers and Body Cavities, Segmentation, Affinities among major non-chordate groups.
3. **Habitat, habit, morphology, Salient features, lifecycle (excluding anatomy)and economic importance of** following:
 - i. *Amoeba, Paramecium, Sycon, Obelia,Aurelia, Fasciola hepatica, Taenia solium, Ascaris, Neanthes (Nereis), Paleomon, Pila, Asterias.*

UNIT – II

4. **Elementary Idea of**
 - i. Types of canal system in porifers
 - ii. Polymorphism in cnedarians,
 - iii. Types of corals and coral reefs.
 - iv. Parasitic adaptations in helminths
 - v. Social organization in honey bees
 - vi. Torsion in Gastropoda
 - vii. Water Vascular system of Starfish

Cell Biology

1. Cell biology, its scope in modern perspective.
2. Cell theory and its modern version and interpretation.
3. General structure of prokaryotic, bacterial and eukaryotic Cell.
4. Ultrastructure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes.
5. Mitochondria: Origin, structure, composition, genome organization and function.

6. Cytoskeleton: composition and functions; microtubules and microfilaments.
7. Nucleus: size, shape, structure and functions of interphase nucleus. Ultrastructure of nuclear membrane and pore complex. Nuclear sap/ nuclear matrix, nucleocytoplasmic interactions.
8. Nucleolus: general organization, chemical composition and functions,

UNIT – III

9. Cell membrane organization: cell membrane: origin, structure, composition, models and function. Fluid mosaic model. Lipid Composition, inner and outer leaflets. Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins
10. Transport across membrane: diffusion and osmosis. Active and passive transport, endocytosis and exocytosis
11. Cell cycle, cell division- mitosis and meiosis. Formation and fate of chiasmata and significance of crossing over, Programmed cell death (Apoptosis).
12. Chromosomes: Morphology, chromonema, chromomeres, telomeres, primary and secondary constrictions, chromatids, prokaryotic chromosome: Giant Chromosomes: Lamp-brush and Polytene chromosome
13. DNA Structure, polymorphism (A, B and Z type) and replication (semi-conservative mechanism),
14. RNA structure and types (mRNA, rRNA and tRNA);

Core Course

ZOO5102P-C:Practical

Practical (Credits : 2)

I. Microscopic Techniques:

- I. Organization and working of Optical Microscope: Dissecting and compound microscopes.
- II. General methods of microscopic slide preparations: Narcotization; fixing and preservation; washing; staining; destaining; dehydration; clearing and mounting.
- III. General idea of composition, preparation and use of:
 - a. Fixatives: Formalin, Bouin's fluid.
 - b. Stains: Aceto-carmin, Aceto-orcin, Haematoxylin, Eosin.
 - c. Common reagents: Normal saline, Acid water, Acid alcohol and Mayer's albumin.
- IV. Collection and Culture Methods:
 - a. Collection of animals from their natural habitat during field trips such as *Amoeba*, *Paramecium*, *Euglena*, *Daphnia*, *Cyclops*, etc.
 - b. Culture of *Paramecium* in the laboratory and study of its structure, life – processes and behavior in live state.

II. Study of Microscopic Slides and Museum Specimens:

Protozoa: *Amoeba*, *Euglena*, *Elphidium* (*Polystomella*), *Plasmodium*, *Paramecium*, *Leishmania*, *Paramecium* showing binary fission and conjugation, *Balantidium*, *Vorticella*.

Porifera: *Leucosolenia*, *Euplectella*, *Spongilla*, T. S. Sycon, L.S. Sycon, Gemmules.

Coelenterata: *Millepora*, *Physalia*, *Aurelia*, *Alcyonium*, *Gorgonia*, *Pennatula*, Sea anemone, *Obelia* colony and medusa.

Ctenophora: Any Ctenophore

Platyhelminthes: *Taenia*, *Planaria*, *Fasciola* (wm), T. S. body through various regions of *Fasciola*, *Fasciola – Larval Forms:* Miracidium, Sporocyst, Redia and Cercaria, *Taenia - Scolex*, *Cysticercus* larva.

Aschelminthes: *Ascaris*, *Wuchereria*, *Dracunculus*

Annelida: *Neries*, *Heteroneries*, *Arenicola*, *Aphrodite*, *Chaetopterus*, *Glossiphonia*, *Pontobdella*, *Polygordius*.

Onychophora: *Peripatus*

Arthropoda: *Limulus*, Spider, Scorpion, Centipede, Millipede, *Lepas*, *Balanus*, *Eupagurus*, Crab, *Mantis*, Honey-bee, (queen, king, worker) Locust, Silkworm Moth, Beetle, White grub. *Pediculus*, Bedbug, Termite and its castes, *Cyclops*, *Daphnia*, crustacean larvae (*Nauplius*, *Metanauplius*, *Zoea*, *Mysis*, *Megalopa*, *Phyllosoma*),

Mollusca: *Chiton*, *Aplysia*, *Cypraea*, *Mytilus*, Pearl Oyster, *Dentalium*, *Loligo*, *Nautilus*. Glochidium larva

Echinodermata: *Pentaceros*, *Echinus*, *Ophiothrix*, *Cucumaria*, *Antendon*.

Hemichordata: *Balanoglossus*.

III. Anatomy:

Earthworm: External features, general viscera, alimentary canal, reproductive system and nervous system.

Cockroach: External features, general viscera, alimentary canal, reproductive system and nervous system.

Prawn: External features, appendages, alimentary canal and nervous system; Hastate Plate

Pila: External features, pallial organs and nervous system; osphradium, radula.

Only culturable species / pest / vermin and animal that are not included in schedules of Wildlife Act, are to be dissected.

IV. Study of the following through permanent slide preparation: *Paramecium, Euglena*, Foraminiferous shells, Sponge spicules, Spongin fibres, Gemmule, *Hydra*, *Obelia* colony and Medusa; Parapodium of Nereis.

V. Study of wildlife of Rajasthan with the help of charts / models / photographs / digital alternatives / and visit of students to established museums / natural parks / natural reserves etc. (invertebrate only).

VI. Cell Biology:

1. Squash preparation of onion root tip for the study of mitosis.
2. Squash preparation for the study of meiosis in grasshopper or cockroach testes. (students can use Onion buds in case of non-availability of Grasshopper or Cockroach)
3. Study of giant chromosomes in salivary glands of Chironomous or Drosophila larva.
4. Study of DNA by separation using any detergent followed by staining.
5. Study of Cell permeability.

***Note:** UGC Notification No. F.14-6/2014(CPP-II), dated 1st Aug, 2014 regarding Dissection and Animal Experimentation in Zoology/ Life Sciences and allied disciplines in undergraduate, postgraduate and research programmes, will be followed

Scheme of Practical Examination and Distribution of Marks

(along with skeleton paper)

Time: 3 hrs. Min. Pass Marks: 18 Max. Marks: 50

Regular

1	Anatomy (Major Dissection)	06
2	Microscopic Techniques (Microscope / General Methods & chemicals / Culture)	03
3	Permanent Preparation (Preparation, identification and diagram of the material)	04
4	Exercise in Cell Biology	05
5	Identification and Comments on Spots (1 to 6)	12
6	Study of wild animal of Rajasthan (report)	03
7	Viva voce	04
8	Class Record	03
9	Internal Assessment	10

Total 50

Reference Books

1. **R.C. Brusca and G.J. Brusca.** Invertebrates. *Sinauer Associates Inc. Publishers*
2. **D.T. Anderson (Editor).** Invertebrate Zoology. *Oxford University Press.*
3. **E.N.K. Clarkson.** Invertebrate Palaeontology and Evolution. *Blackwell Science.*
4. **Karp, G.** Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.
5. **Cooper, G.M. and Hausman, R.E.** The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. **Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P.** The World of the Cell. Pearson Benjamin Cummings Publishing, San Francisco.

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|---|
| <p>7. P.S. Verma Cell Biology S.ChandPublishing
8. C.B. Power Cell Biology Himalaya Publishing House
9. RL KotpalInvertebrates Rastogi Publications</p> |
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B.Sc. (Multidisciplinary) Programme

(ZOOLOGY DISCIPLINE)

SEMESTER –II

Core Course

ZOO5201T-C :Chordate Biology and Developmental Biology

Course Description:

Chordate Biology part of the course provide foundation for students interested in natural history of chordates, particularly vertebrates. The course focus on general characters and classification of main chordate groups. Anatomical and developmental Study of representative fauna of various groups of vertebrate is also emphasized to understand evolutionary development. Additionally some important topics related to structure and function of vertebrates are also included.

Developmental Biology part of the course explains the sequence of events starting with a single cell to the production of very complex organs. The course not only describes how embryos develop (embryology), but also highlights how the processes of development are brought about by changing individual cells into specialized cells with specific functions (the cellular level), and how genes within the genome of the organism drive and guide these changes (the molecular level). It also deals with a comparative account of development in some select groups of animals.

Course Learning Outcome: the learner will be able to

1. Understand chordate characteristics and body plan
2. Understand diversity of chordates at both local and global level
3. Understand classification and phylogenetic significance of various chordate groups
4. Understand significant structure and functional aspects of vertebrate life.
5. Realize that very similar physiological mechanisms are used in very diverse organisms.
6. Develop critical understanding how development of an embryo take place through the processes of cell division, cell differentiation and morphogenesis.
7. Understand how developmental processes and gene functions within a particular tissue or organism
8. Understand how variation in the gene expression and function of gene governs development.

Course Content

Theory (Credits : 4)

UNIT – I

Chordate Biology

1. Chordate Characteristics (Notochord, Pharyngeal slits, Endostyle or Thyroid Gland, Dorsal and Tubular Nerve Cord, Postanal Tail), Chordate Body Plan. Chordate Innovations (Vertebral Column, Cranium)
2. General Characteristics, Classification and suitable examples of Protochordates: Cephalochordata, Urochordata, Cyclostomata; Chondrichthyes (Elasmobranchs, holocephalans); Teleostomi: Osteichthyes (Actinopterygii, Sarcopterygii), Dipnoi; Modern amphibian; Reptilia; Dinosaur; Aves and Mammals
3. Habitat, Habit, Salient Features and anatomy of *Herdmania*, *Branchiostoma*.
4. Ascidian Tadpole Larva and retrogressive metamorphosis.
5. Habitat, Habit and salient features of *Petromyzon* and *Myxine*, Ammocoete Larva
6. Habitat, Habit, Salient Features and anatomy of *Scoliodon* and *Labeo*
7. Types of vertebrae among vertebrates,
8. Tooth replacement in Elasmobranchs, Electric Organs,
9. Swim Bladders and its distribution within fishes,
10. Scale types in fishes,
11. Fin types in Fishes, Fish tail Types
12. Parental Care and Migration in Fishes.
13. Origin of tetrapoda
14. Habitat, Habit, anatomy and development of *Rana*
15. Tadpole larva and metamorphosis,
16. Neoteny and Parental care in Amphibians.

UNIT – II

17. Amniotes, Cleidoic egg, Skull Fenestration in Reptilia,
18. Poisonous and non-poisonous snakes, poison apparatus.
19. Habitat, Habit, anatomy and development of *Varanus*.
20. Habitat, Habit, anatomy and development of Fowl,
21. Feather types, their development and function in birds,
22. Flight Adaptations, Bird Migration
23. Mammalian adaptive radiation,
24. Habitat, Habit, anatomy and development of *Rabbit*.

Developmental Biology

1. Gametogenesis - spermatogenesis and oogenesis, vitellogenesis, egg membranes
2. Fertilization - sperm-egg interactions - biochemical events,
3. Post fertilization events
4. Parthenogenesis
5. Types of animal eggs; patterns of cleavage;
6. Germ layers, gastrulation, fate maps and cell lineage

UNIT- III

1. Organizer - concept, induction process
2. Extra embryonic membranes,
3. Types and physiology of placenta
4. Organogenesis of heart,
5. Organogenesis of kidney
6. Organogenesis of nervous system & sense organs
7. Post-embryonic developments - insects & amphibians
8. Regeneration in invertebrates and vertebrates
9. Development of immune system in vertebrates
10. Ageing concepts and models.

Core Course

ZOO5202P-C:Practical

Practical

(Credits : 2)

- I. Study of Microscopic Slides:** Whole mounts of oral hood, velum and pharyngeal wall of *Amphioxus*; T. S. of *Amphioxus* through various regions; tadpole larva of *Ascidia*; whole mounts of *Salpa*, *Doliolum* and *Oikopleura*.
- II. Study of Museum Specimens:** *Ascidia*, *Ciona*, *Botryllus*, Ammocoete larva, *Petromyzon*, *Myxine* or *Bdellostoma*, *Zygaena* (*Sphyrna*), *Torpedo*, *Chimaera*; *Acipenser*, *Amia* or *Lepidosteus*, *Labeo*, *Clarias*, *Anguilla*, *Hippocampus*, *Exocoetus*, *Echeneis*, any flat-fish, Protopterus, *Icthyophis* or any blind-worm, *Proteus*, *Ambystoma*, Axolotl, Siren, *Alytes*, *Hyla*, *Testudo*, *Chelone*, and Fresh Water Tortoise, *Sphenodon*, *Hemidactylus*, *Phrynosoma*, *Draco*, *Chameleon*; *Eryx*, *Hydrophis*, *Naja*, *Viper*, *Crocodilus*, *Alligator*, *Archaeopteryx*, any Running Bird, *Pavo cristatus*, *Choriotisnigriceps*, *Ornithorhynchus*, *Tachyglossus*, *Didelphys*, *Macropus*, Bat, *Loris*, Scaly anteater.
- III. Study of the following through Permanent Slide preparations:** Striped muscle fibers; Smooth muscle fibers, scales of edible fish, feather of birds, hair of different animals, blood film of any vertebrate.
- IV. Anatomy: Any edible fish (*Wallago* / *Labeo*):** External features, general viscera, afferent and efferent branchial blood vessels, eye muscles and their innervations, brain, cranial nerves and internal ear.
- V. Developmental Biology:**
- I. Study of development of frog/toad with the help of Observation in Nature/ charts/ models/ digital techniques:** Eggs, cleavage, blastula, gastrula, neurula, tail-bud, hatching, mature tadpole larvae, metamorphic stages, toadlet /froglet; **Histological slides:** Cleavage, blastula, gastrula, neurula and tail bud stage; **Study of limb/tail regeneration** with the help of histological slides.
- II.** Study of development of chick with the help of **Whole mounts:** 18 hrs, 21 hrs, 24 hrs. 33 hrs, 72 hrs and 96 hrs. of incubation period embryos; **Study of primitive streak** stage in living embryo after removal of the blastoderm from the egg, may be demonstrated; **Study of the embryo at various stages** of incubation in vivo by making a window in the egg shell; **Study of various foetal envelopes** in a 10-12 day old chick embryo (amnion, chorion, allantois and yolk sac).
- III. Study of development of human with the help of charts/ models/ digital techniques**
- IV. Field Visit:** Visit to a Zoo/ Museum of Natural History /Wild life Sanctuary and/or Study of local vertebrate faunal diversity (Candidates are expected to submit a detailed report of such visit).

***Note:** UGC Notification No. F.14-6/2014(CPP-II), dated 1st Aug, 2014 regarding Dissection and Animal Experimentation in Zoology/ Life Sciences and allied disciplines in undergraduate, postgraduate and research programmes, will be followed

Scheme of Practical Examination and Distribution of Marks

(along with skeleton paper)

Time: 3 hrs.	Min. Pass Marks: 18	Max. Marks: 50
		Regular
1	Anatomy (Major Dissection)	07
2	Permanent Preparation (Preparation, identification and diagram of the material)	04
3	Exercise in Developmental Biology	06
4	Identification and Comments on Spots (1 to 6)	12
5	Field Visit (report)	04
6	Viva voce	04
7	Class Record	03
9	Internal Assessment	10
Total	50	

Reference Books

1. **K.V. Kardong.** Vertebrates: Comparative Anatomy, Function, Evolution. *The McGraw-Hill Companies.*
2. **D.W. Linzey.** Vertebrate Biology. *The McGraw-Hill Companies.*
3. **J.Z. Young.** The life of vertebrates. *The Oxford University Press.*
4. **E.L. Jordan and P.S. Verma.** Chordate Zoology. *S. Chand and Co.*
5. **S.F. Gilbert.** Developmental Biology, *Sinauer Associates Inc.*