

# **GURU NANAK COLLEGE (AUTONOMOUS)**

(Affiliated to University of Madras and Re-Accredited at 'A' Grade by NAAC)

Guru Nanak Salai, Velachery, Chennai – 600042.



## **M.Sc. Zoology**

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

## **Syllabus**

(For the candidates admitted in the Academic year 2019-20 and thereafter)

## **Vision**

- To instill the scientific dogmas of nature; to provoke the interest towards learning science and allied subjects; to equip the students with scientific skills to acquire competency needed for employment; to inculcate professional ethics and value-based education to improve socio-economic status; to impart interdisciplinary approach for identifying and solving real world scientific problems through research.

## **Mission**

1. To facilitate an encouraging and exciting environment to develop the scientific temper in students through a curriculum based on fundamental as well as advanced scientific knowledge.
2. To provide technical skills in the respective disciplines through conducting practical training including internship as well as project, this will hone the skills necessary to become a successful mathematician, physicist, chemist, biotechnologist and visual communication professional.
3. To inculcate interdisciplinary knowledge, elective subjects in various fields are offered, thereby providing an opportunity to the students to identify their interest towards a particular field and pursue the passion.

**GURU NANAK COLLEGE (Autonomous)**  
**M.Sc. DEGREE Course in ZOOLOGY**  
**PG & Research Department of Adv. Zoology & Biotechnology**  
**(2019 -2021)**  
**Programme Outcome**

**PO 1:** To acquire knowledge on classification and phylogeny of animals.

**PO 2:** To analyze complex interactions among the various animals of different phyla.

**PO 3:** To compare the physiological processes of animals and role of organ systems.

**PO 4:** To perform environmental conservation and protection of endangered species.

**PO 5:** To establish employment opportunities in Industries, Research and Education, Bioethics, Patenting, Environmental Protection, Conservation, Technical and Medical Profession.

**PROGRAMME SPECIFIC OUTCOME**

**PSO 1 :** To Prepare the Students to Compete and clear competitive exams like **CSIR – NET in Life Sciences, GATE, UGC-NET in Environmental Sciences, SET (Life Sciences), IFS** etc.; and to facilitate students in acquiring knowledge to become entrepreneurs in the field of Aquaculture related fields, Ornamental fishes and Entomology.

**PSO 2 :** To carry out research in the thrust areas of Life Sciences like Fishery biology, Animal diversity, Environmental Monitoring, Cell and Molecular Biology, Biotechnology, Bioinformatics and exposing them to research activities through Training on various Research Methodological tools, Organizing National and International Conferences and Workshops.

**M.Sc. ZOOLOGY**  
**Course Structure for 2019 – 2021 Batch**

Sem	Part	Subjects	Cdt	Hrs.	Exam Hrs	Total
I	Core-1	Functional Morphology and Phylogeny of Invertebrates	4	4	3	100
	Core-2	Cell and Molecular Biology	4	4	3	100
	Core-3	Genetics- A Molecular approach	4	4	3	100
	Elective Paper-1	Fish biology & Fisheries	3	4	3	100
	Core practical- 4	Invertebrates, Chordata, and Fishery Biology	*	6	*	*
	Core practical-5	Cell & Mol. Biol, Genetics, Microbiology and Animal Physiology	*	6	*	*
	Soft Skill-1	Personality Enrichment	2	2	3	100
		<b>Credit Total</b>	<b>17</b>	<b>30</b>		
II	Core Paper-6	Functional Morphology and Phylogeny of Chordates	4	4	3	100
	Core Paper-7	Comparative Animal Physiology	4	4	3	100
	Core Paper-8	Microbiology	4	4	3	100
	Elective Paper-2	Aquarium Fishes	3	4	3	100
	Core practical	Invertebrates, Chordata, and Fishery Biology	4	6	4	100
	Core practical	Cell & Mol. Biol, Genetics, Microbiology and Animal Physiology	4	6	4	100
	Soft skill-2	Computing Skills	2	2	3	100
		<b>Credit Total</b>	<b>25</b>	<b>30</b>		
III	Core Paper- 9	Developmental Biology	4	3	3	100
	Core Paper-10	Entomology	4	3	3	100
	Elective Paper-3	Environmental Biology	3	3	3	100
	Elective Paper- 4	Biophysics and Biostatistics	3	3	3	100
	Core practical - 11	Developmental Biology, Entomology and Environmental Biology	*	6	*	*
	Core practical - 12	Immunology and Biochemistry	*	6	*	*
	ED-1	Maternity and Child care	3	2	3	100
	ED-2	Research Methodology	3	2	3	100
	Soft Skill-3	Self and Time Management Skills	2	2	3	100
		Internship	2	*	-	100
		<b>Credit Total</b>	<b>24</b>	<b>30</b>		
IV	Core Paper -13	Biochemistry	4	4	3	100
	Core Paper - 14	Immunology	4	4	3	100
	Elective Paper- 5	Evolution of Life	3	3	3	100
	Core practical	Developmental Biology, Entomology and Environmental Biology	4	6	4	100
	Core practical	Immunology and Biochemistry	4	6	4	100
	Soft Skill-4	Spoken and Presentation Skills	2	2	3	100
	Core-15	Project	4	5	-	100
		<b>Credit Total</b>	<b>25</b>	<b>30</b>		
		<b>Total Credits</b>	<b>91</b>	<b>120</b>		

**SEMESTER- I**  
**FUNCTIONAL MORPHOLOGY AND PHYLOGENY OF INVERTEBRATES**

<b>Subject Code: 19PZOO301</b>	<b>Core Paper 1: Theory</b>	<b>Marks: 100</b>
<b>Semester: I</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To relate the morphological adaptations with phylogenetic study of Invertebrates.

**UNIT I** **(10 Hrs)**

**Levels of organization:** Unicellularity vs multicellularity Colonization and organization of germ layers Division of labour and organization of tissues (Brief fate of ectoderm, mesoderm and endoderm) - Development of coelom- Acoelomate- pseudocoelomate and coelomate organization - Radial and bilateral symmetry.

**UNIT II** **(20 Hrs)**

**Porifera and Coelenterata:** Porifera – Reproduction in sponges and Division of labour (Cell differentiation) - Phylum Coelenterata -Structural Peculiarities of Metridium. Polymorphism; Coral and Coral Reefs and their Theories. Origin of Bilateria; Origin of Metamerism.

**Platyhelminthes:** Parasitism in Platyhelminthes; Reproduction in Platyhelminthes.

**UNIT III** **(10 Hrs)**

**Annelida:** Nephridia and Coelomoducts – Adaptive Radiation in Polychaetes.

**Arthropoda:** Polymorphism; Crustacean larvae and their Significance; Pheromones in insects – Endocrine organs in Crustacea.

**UNIT IV** **(10 Hrs)**

**Mollusca:** Filter Feeding in Mollusca; Advanced features of Cephalopods; Gastropoda; Adaptive Radiation in Mollusca.

**Echinodermata:** Larval forms and their Evolutionary Significance.

**UNIT V** **(10Hrs)**

**Minor Phyla:** Rotifera, Acanthocephala, Ectoprocta, Entoprocta, Phoronida, Brachiopoda, Chaetognatha. Invertebrate fossils. Trilobites and cephalopods. Regeneration in invertebrates.

**TEXTBOOK:**

1. Barrington, E.J. W. 1969. Invertebrate Structure and Functions. English Language, Book Society.

**REFERENCE BOOKS**

1. Barnes: Invertebrate Zoology – Toppan International Co.,
2. Hyman L. H. The Invertebrata, Vol. I to IV.
3. Carter, G. S. A General Zoology of Invertebrates, (Sidewick and Jackson Ltd., (London)
4. Borradile, L. A. The Invertebrata. Cambridge University Press.
5. Gardinar, M. S. 1972 Biology of the Invertebrates, Mc Graw Hill Book Co., New York.
6. R. L. Kotpal: Protozoa, Porifera, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Minor Phyla. Rastogi Publications.
7. Moore, R. C. Lalilcker, C.G. and Fisher, A. G. Invertebrate Fossils, Mc. Graw Hill Book Co., New York.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	2	
	Unit – 2	3	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	

## CELL AND MOLECULAR BIOLOGY

<b>Subject Code: 19PZOO302</b>	<b>Core Paper 2: Theory</b>	<b>Marks: 100</b>
<b>Semester: I</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To impart knowledge of genome and signaling concepts in cell and Molecular Biology.

### UNIT I (10 Hrs)

**Molecular Techniques:** Microscopy (Conventional and Confocal), Cytological techniques, Ultracentrifugation, X-ray diffraction, Chromatography, Electrophoresis, Blotting techniques, and Animal cell/ tissue culture- Cell imaging.

### UNIT II (15 Hrs)

**Structural organization and function of intracellular organelles:** Structure of model membrane, Lipid bilayer and Membrane protein, Diffusion, Osmosis, Ion channels, Active transport, Ion pumps, Mechanism of sorting and Regulation of intracellular transport, Electrical properties of membranes. Structure and function of Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Cytoskeleton and its role in motility.

### UNIT III (15 Hrs)

**Informational macromolecules:** Chemistry of DNA, Polymorphism of DNA, Mechanism and Enzymology of DNA Replication- Role of Helicases, Primases, Nucleases, Ligases and Telomerases. Chemistry of RNA, Different types of RNA- mRNA, tRNA, rRNA and their functions- Mechanism and Enzymology of RNA Replication.

### UNIT IV (10 Hrs)

**Information transfer:** Genetic code and its characteristic features. Information transfer in prokaryotes and eukaryotes. Transcription – promoters, initiators, terminators. RNA processing – trimming of introns, splicing of exons, Ribozyme.

### UNIT V (10 Hrs)

**Cell Signaling:** Signaling molecules and their receptors – functions of cell surface receptors – Pathways of intracellular signal transduction.

**TEXT BOOK:**

1. Cooper: The Cell, A Molecular approach.

**REFERENCE BOOKS:**

1. David Frifielder: Molecular Biology.
2. Gerald Karp: Cell Biology- Mc GrawHill.
3. Lodish, Berk, Zipursky, Matsudaria and Baltimore, Molecular cell biology IV edition.
4. W.H.Freeman and Company.George M. Malacinski, 2010. Essential of molecular biology  
Watson: Molecular Biologyof the Gene, 4<sup>th</sup> edition, Narosa publication.

**Question paper pattern:**

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Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
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Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
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		Theory	Problems
<b>Section A</b>	Unit – 1	2	
	Unit – 2	3	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	



## GENETICS – A MOLECULAR APPROACH

<b>Subject Code: 19PZOO303</b>	<b>Core Paper 3: Theory</b>	<b>Marks: 100</b>
<b>Semester: I</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To understand the modern concepts of gene, genome, mutation at the molecular level and its functions.

### UNIT I (10Hrs)

**Gene Structure and Function:** Fine structure of the gene, The Cis-trans test, Phage T4, rII locus, linear set of nucleotide pairs – Colinearity of gene. One gene- One enzyme hypothesis (Neurospora, Eye pigmentation in *Drosophila*), one gene - One polypeptide concept. The Lactose Operon in *E.coli*. Induction and Repression – Activator and Repressor proteins and their control, Regulatory components of the lac system. Chemical modification of histones - DNA Methylation and Genomic Imprinting, X- Chromosome inactivation in mammals and Mendelian principles.

### UNIT II (10Hrs)

**Human Genetics:** Cytogenetic mapping Karyotype, Preparation, Banding techniques and importance, Idiogram. Variations in human karyotypes, polygenic inheritance, Genetic counseling. Principles and methods of pedigree analysis.

### UNIT III (15 Hrs)

**Molecular basis of Mutation:** Radiation induced mutation, chemically induced mutation, mutagens, mutable, mutator genes and mutation frequency - Transposons as mutational elements – Oligonucleotide directed Mutagenesis – PCR directed mutagenesis. Biological repair mechanisms – Direct reversal of damaged DNA, Alkyl transferases and Photolyase. Excision repair and Post replication repair.

### UNIT IV (15 Hrs)

**Gene Therapy:** Human diseases treated for gene therapy. Virus as vectors, non-viral DNA delivery systems. Embryo therapy, *Ex vivo* therapy, *In vivo* therapy, antisense gene therapy. Target tissue of choice for gene delivery systems. Somatic gene therapy for genetic and acquired diseases. Nanotechnology for drug targeting.

### UNIT V (10 Hrs)

**Genomes and Mapping:** Human genome project, Goals, Structure of eukaryotic nuclear genome – The repetitive DNA, Microsatellites, minisatellites, Interspersed repeats. Linkage map, Physical map, Restriction map, FISH map – Radiation maps. Tetrad analysis, mapping with molecular markers, mapping by using somatic hybrids. QTL mapping, heritability and its measurements.

**TEXT BOOK:**

1. Peter J. Russel W.W. Genetics. Benjamin Cummings.  
2002. Website: [www.geneticsplace.com](http://www.geneticsplace.com).

**REFERENCE BOOKS:**

1. Anna.C.Pai: Foundation Genetics, Mc Graw Hill BookCompany.
2. Burns, G.W. - The Sciences of Genetics, Mac millan publications.
3. Gardner: Principles of Genetics. 8<sup>th</sup> Edition, John Wiley and Sons.
4. Ursula Good enough: Genetics, Saunders College Publishing.
5. Benjamin Lewin Gene VII (2000). Oxford University press.
6. Griffiths, Gelbart, Lewontin and Miller. Modern Genetic Analysis. W.H. Freemanand Company.
7. P.K.Gupta. Biotechnology and Genomics. Rastogi publications.

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Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

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<b>Section A</b>	Unit – 1	2	
	Unit – 2	3	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	1	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	2	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	

## **ELECTIVE – I – FISH BIOLOGY & FISHERIES**

<b>Subject Code: 19PZOO304</b>	<b>Elective Paper 1: Theory</b>	<b>Marks: 100</b>
<b>Semester: I</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

**Course Objective:** This subject gives the in depth knowledge about fishes and fish farming.

**UNIT I - Introduction of Fish: (10 Hrs)**

Definition – salient features of the fishes - classification- Berg’s classification - evolution and phylogeny of fishes. Locomotion due to the Movement of appendages - General principles of locomotion - types of locomotion- special modes of locomotion-Migration in fishes - types of migration - factors influencing fish migration- advantages of fish migration.

**UNIT II – Digestion & Respiration: (10 Hrs)**

Food and feeding-food quality-alimentary canal-digestive glands- physiology of digestion- adaptive modifications in digestive tract of fishes-types of gills-structure of gills - specialized cells of gills - mechanism of gill respiration, air bladder and Weberian apparatus.

**UNIT III – Reproduction & Pathology: (10 Hrs)**

Role of hormones in reproduction and Induced breeding - maturity stages- morphological and histological observation of gonads - Age determination in fish. F i s h and shrimp (Viral and Bacterial) diseases.

**UNIT IV – Fish Genetics & Immunology: (5 Hrs)**

Sex determination in fish – monosex production - hormonal and chromosomal methods - hybridization techniques in aquaculture, androgenesis and gynogenesis- Fish immune system.

**UNIT V – Culture and Capture fisheries in India: (10 Hrs)**

Types of culture-Fresh water-Brackish water- Mariculture - Pond culture. Extensive- semi-intensive and intensive- Maintenance of fish hatchery – Live feed culture, larval rearing and nursery rearing-Integrated fish culture-Paddy cum fish - paddy cum prawn. Fresh water prawn culture.

## REFERENCE BOOKS:

1. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
2. Hanifa, M.A, 2011. Aquatic resources and aquaculture, Dominant, New Delhi.
3. Pandey, K and Shukla, J.P. 2010. Fish and fisheries, Rastogi Publications, Meerut.
4. Parihar, R.P. 1996. A text book of fish biology and Indian fisheries, central publishing house, Allahabad, India.
5. Khanna, S.S., and Singh H.R. 2012. A text book of fish biology & fisheries, Narendra publishing house.
6. Baluyut, E. A. (1989). Aquaculture systems and Practices. A selected review Publishing House, New Delhi.
7. Chondar. A (1970). Handbook of breeding of Indian major carps by pituitary hormone injection. Agra Satisdh Book Enterprise.
8. Day. F (1958). Fishes of India, Vol. I and Vol. II. William Sawson and Sons Ltd., London.
9. Jhingran, C. G. (1981). Fish and Fisheries of India. Hindustan Publishing Co., India.

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<b>Total Marks</b>				100

## Distribution of Questions:

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		Theory	Problems
Section A	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
Section B	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
Section C	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	

## **PRACTICAL – INVERTEBRATA, CHORDATA AND FISHERY BIOLOGY**

<b>Subject Code: 19PZOO305P</b>	<b>Core Practical - 4</b>	<b>Marks: 100</b>
<b>Semester: I &amp; II</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

### **INVERTEBRATA**

1. Identification and study of selected Protozoans and Helminthes of medical importance.
2. Identification and study of sections of certain animals from Coelenterata, Aschelminthes and Annelida to understand the evolution of different types of coelom.
3. Identification and study of Larval Forms from all Major Phyla of Invertebrates.
4. Identification and study of Invertebrate Fossils (specimens).
5. Commercially important invertebrates: Crab, Lobsters, Pearl oyster, Edible Oyster, Mytilus, Sepia and Loligo – their economic importance.
6. Dissection and mounting of Digestive & Nervous system in 1. Grylotalpa 2. Grasshopper and 3. Sepia (Digestive system)
7. Dissection of the Nervous system in Prawn.
8. Mounting of Pedicellariae and Aristotle lantern in Sea Urchin.

### **CHORDATA**

1. Identification of important Prochordates, South Indian Fishes, Amphibians, Reptiles, Birds and Mammals.
2. Dissection of aortic arches in Shark.
3. Dissection and Display of Arterial and Venous System, in Teleost fish

### **FISHERY BIOLOGY**

1. Fish Morphology – Morphometric characters: Head Structure, Types of scales in fishes.
2. Identification of: a) Marine, fresh water and estuarine fishes up to species level.  
b) Cultivable prawns.

3. Age determination – Scale method.
4. Observation of maturity stages of gonads and determination of Gonadosomatic index and fecundity.
5. Gut content analysis of some important fishes in relation to feeding habits.
6. Observation of Gears and Crafts.
7. Observation of fish parasites.
8. Observation of Larvivorous fishes and Aquarium fishes.
9. Observation of seaweed species – their economic importance.
10. Observation of Live feed organisms.

**STUDY TOUR** - Report on field visit for studying the adaptation of animals.

**PRACTICAL: CELL AND MOLECULAR BIOLOGY, GENETICS,  
MICROBIOLOGY AND ANIMAL PHYSIOLOGY**

<b>Subject Code: 19PZOO306P</b>	<b>Core Practical - 5</b>	<b>Marks: 100</b>
<b>Semester: I &amp; II</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**CELL AND MOLECULAR BIOLOGY**

**1. Cytological techniques**

Micrometry: Microscopic calibration and Measurements of cell size using ocular and stage micrometers.

**2. Study of different types of Blood cells - Differential count in Man and Fish.**

**3. Histochemical techniques**

Demonstration: Fixation, Dehydration, Embedding, staining (vital staining) and Mounting.

Histochemical localization of

- a. DNA
- b. Lipids
- c. Proteins

**GENETICS**

1. Preparation of culture medium and culture of *Drosophila*- methods of maintenance.
2. Identification of *Drosophila* species and mutants.
3. Identification of human blood groups and Rh- typing.
4. Preparation of Human karyotypes- Analysis of Normal and abnormal karyotypes (Down's syndrome, Turner's syndrome and Klinefelter's syndrome).

## MICROBIOLOGY

1. Microscopic observation for identification and characterization of microorganisms relevant to theory syllabus.

- a. *Staphylococcus aureus*
- b. *Escherichia coli*
- c. *Rhizopus*
- d. *Aspergillus niger*
- e. *Aspergillus flavus*
- f. *Penicillium*
- g. *Nostoc*
- h. *Oscillatoria*
- i. *Volvox*

2. Culture medium and preparation.

- i. Preparation of peptone water
- i.** Preparation of nutrient broth
- ii.** Preparation of solid media.
  1. Slant
  2. Stab
  3. Plate

3. Simple and Differential staining of bacteria.

## ANIMAL PHYSIOLOGY

1. Estimation of Respiratory Quotient in fish with reference to temperature.
2. Oxygen consumption in a terrestrial animal (Cockroach).
3. Salt loss and Salt gain in fish.
4. Estimation of carbohydrates in the tissues of meat.
5. Determination of amino acids in the tissues (Liver / Muscle) of fish/egg albumin (paper chromatography).
6. Principles and applications of the following instruments: Kymograph, Spectrophotometer, Sphygmomanometer and Electrophoretic Unit.



## SEMESTER-II

### FUNCTIONAL MORPHOLOGY AND PHYLOGENY OF CHORDATES

<b>Subject Code: 19PZOO307</b>	<b>Core Paper 6: Theory</b>	<b>Marks: 100</b>
<b>Semester: II</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** This subject gives the in depth knowledge about the chordates.

#### **UNIT I (10 Hrs)**

Origin of Chordates- Theories. Broad classification of Chordates – Phylogenetic Affinities of Cephalo chordata and Urochordata. Brief account of physiology of digestion in vertebrates and symbiotic digestion in Ruminants.

#### **Unit II (20 Hrs)**

Evolutionary and structural peculiarities of Cyclostomata and affinities – Petromyzon - Myxine. Elasmobranch evolution – Dipnoi structural peculiarities, Discontinuous distribution and their affinities. Coelocanth fishes. Economic importance of fishes. Parental care in fishes.

#### **Unit III (10 Hrs)**

Aves - Origin and evolution of Mammals critical account of Prototheria, Metatheria and Eutheria. Adaptive radiation in mammals.

#### **Unit IV (10 Hrs)**

Comparative anatomy- Comparative study of Integumental derivatives, Jaw suspension – Fate of visceral arches. Respiratory organs, External respiration and cellular respiration with reference to human.

#### **Unit V (10 Hrs)**

Vertebrate kidney, Urinogenital organs, Brain, Heart and Aortic arches. Circulation- Types of circulating fluids; Water, coelomic fluid, lymph and blood.

**TEXT BOOK:**

Newman, The Phylum Chordata, Mac Millan and Co.

**REFERENCE BOOKS:**

1. Colbert, E.H. Evolution of Vertebrates. Wiley Eastern Limited.
2. Hyman, L.H – Comparative Vertebrate Zoology. University of Chicago Press.
3. Romer, A.S. Vertebrate body. Saunders Company.
4. Young, J.A- Life of Vertebrates. Oxford press.
5. Waterman, A.J – Chordate structure and Function. Mac Millan and co.

**Question Paper Pattern:**

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Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
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Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	3	
	Unit – 3	2	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	

## COMPARATIVE ANIMAL PHYSIOLOGY

<b>Subject Code: 19PZOO308</b>	<b>Core Paper 7: Theory</b>	<b>Marks: 100</b>
<b>Semester: II</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To enlighten the functional aspects of organ system in the body of animal and man.

### **UNIT I (15 Hrs)**

**Blood and circulation:** Blood Corpuscles, Haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity and Hemostasis.

### **UNIT II (10 Hrs)**

**Cardiovascular system:** Comparative anatomy of heart, myogenic heart - Specialized tissue, ECG- its principle and significance, cardiac cycle, heart as a pump and blood pressure.

### **UNIT III (10 Hrs)**

**Respiratory system:** Comparison of respiration in different species, Anatomical Considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

### **UNIT IV (15 Hrs)**

**Nervous system:** Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.

**Excretory system:** Comparative physiology of excretion, kidney, urine formation, urine concentration and waste elimination.

### **UNIT V (10 Hrs)**

**Endocrinology and reproduction:** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.

**TEXT BOOK:**

1. Hoar, W.S. General and Comparative Physiology.

**REFERENCE BOOKS:**

1. David Saunders: An Introduction to Biological Rhythms.
2. K. Nagabushanam, M.S.Kodarkar and R.Sarojini: An Introduction to Animal Physiology.
3. Prosser C.L. Comparative animal physiology.
4. Schmidt-Nielson: Animal physiology.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	

## MICROBIOLOGY

<b>Subject Code: 19PZOO309</b>	<b>Core Paper 8: Theory</b>	<b>Marks: 100</b>
<b>Semester: II</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

### Course Objectives:

- To understand the structural details of the microbes and correlate with microbial diseases.
- To understand the role of microbes in the environment and in the field of food production, biotechnology etc.

### UNIT-I

**(15 Hrs)**

**History and Scope:** Milestones in Microbiology- Microbial Taxonomy- Classification system- Phenetic- Numerical- phylogenetic. Major characteristics- Classical and molecular, phylogenetic tree, Domain kingdom- DNA and ribosomal RNA analysis. Characterization and identification – Serological and Gene probe method. Morphology-Ultra structure of Bacteria, Fungi and Viruses- Bacterial physiology- Growth and Nutrition-Nutritional requirements - Kinetics of growth. Enumeration of bacteria – Viable plate count-MPN procedure.

### UNIT-II

**(10Hrs)**

**Medical microbiology-** Pathogenic Microbes in Bacterial- Tuberculosis, Whooping cough and Tetanus. Viral- Measles, Hepatitis and HIV. Fungal- Candidiasis. Protozoan- Amoebiasis and Malaria. Cure, Control and Prevention.

### UNIT-III

**(10Hrs)**

**Microbial Ecology and Environmental Microbiology-** Role of microorganisms in Carbon, Nitrogen and Sulphur cycle. Population interaction – Commensalism, Co-metabolism, Epiphyte, Synergism, Mutualism, Competition, Predation and Parasitism.

### UNIT-IV

**(10Hrs)**

**Food and Dairy Microbiology-** Microbes in food, Role of microorganisms in food production, Dairy and Non-dairy-Fermented food and Alcoholic beverages. Microorganisms and Food spoilage.

### UNIT-V

**(15 Hrs)**

**Industrial Microbiology-** Industrial uses of microbes- Fermentation products. Production of Penicillin, Ethanol, Vinegar, Vitamin B<sub>12</sub>, Citric acid and Protease. Methods of Immobilization: Types of Reactors: Animal and Plant Cell Bioreactors.

**TEXT BOOK:**

1. Michael. J. Pelczar Jr, Chan. E.C.S, Kriej, Noel.R. Microbiology. Tata Mac Grawhill.

**REFERENCE BOOKS:**

1. Dubey, R.C. and Maheswari, D.K, A text book of Microbiology.
2. Lansing, M. Prescott, John P.Harley and Donald A. Klein. Microbiology Mc Graw Hill(1999):
3. Patel, A.H. - Industrial Microbiology (2001). MacMillan India Limited.
4. Powar and Daginwala: General Microbiology - Vol II Microbiology-fourth edition.
5. Ronald, M. Atlas, Principles of Microbiology (1997)
6. Sharma. P.D, Microbiology- A text book for university students.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition/ Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit - 5	1	

## ELECTIVE – II AQUARIUM FISHES

<b>Subject Code: 19PZOO310</b>	<b>Elective Paper I: Theory</b>	<b>Marks: 100</b>
<b>Semester: II</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

**Course Objective:** To provide basic information on common aquarium fishes of India and its export potential.

### **UNIT I** **(10Hrs)**

Introduction: Taxonomy and biology of some common Fresh water and Marine Ornamental Fishes.

### **UNIT II** **(5 Hrs)**

Food and Feeding Management: Live feed organisms (Daphnia, Tubifex, Cyclops, Brachionus and Chlorella.) - Formulated feed (Freeze dried tubifex, liver and vegetable food.) – Preparation of commercial feed and quality assessment.

### **UNIT III** **(10 Hrs)**

Aquarium Keeping and Management: Setting up of an aquarium tank – Selection of stone and gravel – Decors - Aquarium plants – Water quality management – Aeration – Illumination devices - Salinity – pH - Temperature maintenance – Filtration (Mechanical and Biological filters). Safety measures and devices for maintenances.

### **UNIT IV** **(10 Hrs)**

Breeding techniques and Health assessment: Development of brood stocks – Selection of brood fishes - Breeding of Egg layers and Live bearers – Common diseases of aquarium fishes and their control – Microbial: Bacterial, Viral and Fungal diseases; Non – microbial – Protozoans, Trematodes, Cestodes, Nematodes and Crustaceans.

### **UNIT V** **(10Hrs)**

Prospects of ornamental fishes: Export and industrial importance - Hobby and household industry – List of fresh water and marine ornamental fishes available in India for export with its indicative prices - Role of women in ornamental fish culture.

**TEXT BOOK:**

1. Donald Wilkie, Aquarium fish (1985). Pelhem Book, Ltd.

**REFERENCE BOOKS:**

1. Boulenger, E.G., Keep an Aquarium (1939).
2. Dey V.K., Ornamental fishes-MPEDA Hand book of Aqua farming
3. Harvey Jack Hims. Georg, F., A guide to fresh water Aquarium fishes. Hamylnn publications, 1973.
4. Gregory C. Bateman, Fresh water Aquaria - 7<sup>th</sup> edition. Revised Jack Hen.
5. Hornell, J. Guide to Madras aquaria (1921).
6. John G. Shedd, Aquarium (1933).
7. Stephen Spotte, Marine Aquarium keeping. The Science, Animals and Art. (1973).John Wiley & Sons.
8. William T. Innes, The aquarium (1932).
9. Robert Goldstein, Diseases of aquarium fishes (1971). T.F.H.Publication.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	



**SEMESTER-III**  
**DEVELOPMENTAL BIOLOGY**

<b>Subject Code: 19PZOO311</b>	<b>Core Paper 9 : Theory</b>	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** Developmental biology helps to understand the ontogeny of animals.

**UNIT-I** **(15Hrs)**

**Basic concepts of development:** Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

**UNIT-II** **(15Hrs)**

**Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals.

**UNIT-III** **(10Hrs)**

**Human Embryonic Development:** Hormonal control of ovulation and pregnancy-development of germinal layers, foetal and maternal relationships- embryonic mutation – partition- embryonic adaptation and the development of mammals. Spermatozoa- Human embryo- Prenatal diagnosis- Medical implication of developmental Biology.

**Unit-IV** **(10Hrs)**

**Gene activity:** Gene activity during Gastrulation- Involvement of paternal the core genes in the development.

**Unit-V** **(10Hrs)**

**Application of modern techniques in Developmental Biology:** IVF in Human cryopreservation, human cloning and its ethical implications, embryo transfer and developmental potential.

**TEXT BOOK:**

1. Balinsky B.I., An introduction to Embryology. (1981) Saunders, Philadelphia.

**REFERENCE BOOKS:**

1. M.J. Berrill–Developmental Biology. (1986) Tata Mc Graw Hill, publications Ltd.
2. Raven: An outline of developmental physiology. Porgamanpress.
3. Robert S.Rugh: The frog Reproduction. (1951) Tata Mc Graw Hill publications Ltd.
4. P.K.Gupa, Biotechnology and genomics.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
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<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	3	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit - 5	1	

## ENTOMOLOGY

<b>Subject Code: 19PZOO312</b>	<b>Core Paper 10: Theory</b>	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

### **Course Objective:**

To study about the insects and their habitats and physiology.  
To study about the economic importance of insects.

### **UNIT I (10 Hrs)**

Biology of an insect with special reference to the following: Nutrition, Development, Reproduction and Endocrinology. Insects and their interrelationships with environments (Interspecific and Intraspecific).

### **UNIT II (10 Hrs)**

Insects as pollinators, predators, parasitoids, scavengers and weed killers. Biology of Honeybees, Lac insects and their management. Prospects of Sericulture, Biology of Silkworm (Nutrition, Genetics, Endocrinology, Reproduction, Pest and Diseases).

### **UNIT III (15 Hrs)**

Insects as crop pests: Types of injuries and loss caused to plants in general factors governing the outbreak of pests. Pests of rice, sugarcane, coconut, vegetables and stored products.

### **UNIT IV (15 Hrs)**

Methods of pest control- Natural control-Applied or Artificial control- Prophylactic methods- Curative or Direct method- Cultural methods- Mechanical method, Physical method- Biological methods-Chemical methods- Attractants, Repellents, and Antifeedants.

### **UNIT V (10 Hrs)**

Pesticide – Classification of Insecticides- Inorganic Compounds- Organic compounds, Synthetic organic compounds. Plant protection appliances- Dusters and Sprayers, Aircraft and Other equipments. Integrated Pest Management. Synthetic organic compounds. Plant protection appliances- Dusters and Sprayers, Aircraft and Other equipments. Integrated Pest Management.

**REFERENCES:**

1. The Science of Entomology. William S. Romoser and John G. Stoffolano. Wm. C. Brown Publishers, England.1994.
2. The Silkwoonn. An important laboratory tool. By Yataro Tazima, Kodarsha, Scientific Book Ltd., Japan.1978.
3. Sericulture Manual: FAD, Agril, Service Bulletin,Rome.
4. Applied Entomology: P. G. Fenemore, Allaprakash, Wiley Eastern Ltd., Delhi.1992.
5. Park, J. E and K. Park. Textbook of social and preventive medicine. Publ. Mis. Banarasides Bharol.Jabalpur.
6. Nayar, K. K, Ananthakrishnan, T. Nand B. V. David. General and Applied Entomology. Tata McGraw Hill Publ., New Delhi.1989.
7. Entomology and Pest Management. Larry, P. Pedigo Prentice Hall, New Jersey.1989.

**Question Paper Pattern:**

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Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
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<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	2	
	Unit - 5	1	

### ELECTIVE – III ENVIRONMENTAL BIOLOGY

<b>Subject Code: 19PZOO313</b>	<b>Elective Paper - III</b>	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

**Course Objective:** To study the interaction between living organism and the environment.

#### UNIT I (10Hrs)

**The Environment:** Physical environment; biotic environment; biotic and abiotic interactions. Major Biomes with special reference to rain forest, high altitudes, Deserts and Mangroves.

#### UNIT II (10 Hrs)

**Marine habitat:** Zonation of Sea Nekton and Benthos. Population ecology: Characteristic of a population, population growth curve, Concept of metapopulation, age structured Populations.

#### UNIT III (10Hrs)

**Biodiversity:** Status, major drivers of biodiversity change; biodiversity management, approaches and conservation, Types of Environmental pollution - Air , Water, Industrial and Noise, their Biological effects and Control measures.

#### UNIT IV (10 Hrs)

**Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity, Edges and Ecotones. Ecosystem structure and function; energy flow and mineral cycling.

#### UNIT V (5Hrs)

**Radiation Ecology:** Radiation Ecology and its effects on biosphere.

**TEXT BOOKS:**

1. Anantha krishnan, T.N., Bioresources Ecology. (1982) Oxford- IBH Publishing Co, NewDelhi.
2. Theodosius Dobzhansky, Francisco J .Ayala, G. Ledyard Stebbins, James W. Valentine, Evolution (1977) W.H.Freeman andCo.

**REFERENCE BOOKS:**

1. Began M.J.L.Harper and C.R.Town Send (1990), Ecology, individuals, populations and communities. Blackwell Scientific Publication,London.
2. Clarke, G. L., Elements of Ecology (1954), John Wiley, NewYork.
3. Odum .E.P. Fundamentals of Ecology (1971) 3<sup>rd</sup> Edition, W.B.Saunders Co, Philadelphia.
4. Elton,C. Animal Ecology, (1971), Methuen company.
5. Rastogi, V.B. and Jayaraj, M. S., Animal ecology and distribution of animals.

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer any 5 out of 8 questions	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
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**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
Section A	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
Section B	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	2	
Section C	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit - 5	1	

### **ELECTIVE - IV BIOPHYSICS AND BIOSTATISTICS**

<b>Subject Code: 1PPZOO314</b>	Elective IV – Theory & Problems	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

**Course Objective:** To highlight the statistical applications in biological sciences and to enhance the principles of physics in biology.

**UNIT-I** **(5 Hrs)**

Principles of Light Microscopy, Electron Microscopy and their applications; Principles and methods of Histology and Histochemistry, Freeze-drying, Freezing Microtome and Cryostat.

**UNIT-II** **(10Hrs)**

Electronic configuration of an atom: Vander Waal's forces – Hydrophobic and hydrophilic interactions; Principles and different types of Chromatography and Electrophoresis; Principles and applications of Colorimetry, Spectroscopy, Ultra violet and Infrared Spectroscopy in Biological investigations.

**UNIT-III** **(10Hrs)**

Phenomenon of Radioactivity: Isotopes and their use in biological investigations. Biological effects of radiation- Determination and measurement of radio activity-Geiger Muller and scintillation counter- Biological applications of radio isotopes and autoradiography.

**UNIT-IV** **(10 Hrs)**

Sampling and Sampling Designs: Definitions – Theoretical basis Laws – Methods. Sampling and Non-sampling errors. Variables-Qualitative and Quantitative, Discrete and Continuous. Types of classification-Qualitative and Quantitative. Qualitative - Chronological, Geographical etc, Quantitative –Frequency distribution, Discrete and Continuous frequency distribution. Diagrammatic and Graphical representation of Data - Bar diagrams-Pie diagrams- Cartograms. Frequency distribution-Histograms, Frequency Polygon and Frequency Curve.

**UNIT- V** **(10Hrs)**

Measures of Central tendency: Arithmetic Mean, Median and Mode. Definition and computation for different types of data (ungrouped, discrete and continuous frequency distribution). Measures of Dispersion: Standard deviation- ungrouped data, discrete and

continuous frequency distribution. Correlation- Definition and Types, Scatter diagram, Computations of Karl Pearson's coefficient of correlation, Students " t " test and Chi square analysis.

**TEXT BOOKS:**

1. Dr.S.P.Gupta, Statistical Methods. (1984) Sultan Chand and Sons, New Delhi.
2. M.A Subramanian, Biophysics Principles and Techniques (2005), MJP Publishers.

**REFERENCE BOOKS:**

1. Pillai, R.S.N.and Bagawathi.V Statistical Theory and practice (1989).
2. Sokal, R.R and Roulf, F.J - Biometry. The Principles and Practice of Statistics in Biological Research. (1969).

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition/ Principles Answer any 10 out of 12 questions	1 – 12	3	30
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	<b>Total Marks</b>			100

**Distribution of Questions:**

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		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	1	1
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	2	
	Unit - 5		1



**PRACTICAL - DEVELOPMENTAL BIOLOGY, ENTOMOLOGY AND ENVIRONMENTAL BIOLOGY**

<b>Subject Code: 19PZOO15P</b>	<b>Core Practical - 11</b>	<b>Marks: 100</b>
<b>Semester: III&amp; IV</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**DEVELOPMENTAL BIOLOGY**

1. Oogenesis and Spermatogenesis– Histological studies in mammals.
2. Study of life cycle of *Drosophila melanogaster* and record its developmental stages (Egg, larvae, pupal and adult stages).
3. Study of life cycle of frog and record its developmental stages (Egg, tadpole, young adult with tail and adult stages).
4. Demonstration: Induced ovulation and fertilization in frog or fish.
5. Egg density in frog/fish.
6. Mounting of Chick embryo (24 Hrs, 48 Hrs, 72 Hrs, and 96 Hrs).

**ENTOMOLOGY**

1. **Taxonomy:** Identification of insects of orders Odonata, Orthoptera, Blattodea, Mantodea, Isoptera, Hemiptera, Thysanoptera, Neuroptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.
2. **Control:** Insecticide formulations and mixtures, common natural enemies of crop pests (parasitoids, predators and microbes)
3. **Storage Entomology:** Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them.
4. **Plant protection appliances:** Dusters and sprayers.

**ENVIRONMENTAL BIOLOGY**

1. Identification of freshwater and marine planktons.
2. Study of rocky, sandy, muddy shore fauna, Marine and Fresh water fauna and their adaptations.
3. Determination of hydrobiological features of different samples – (freshwater, brackish water, seawater and polluted water)-pH, salinity, free-carbon dioxide dissolved oxygen and calcium.
4. Analysis of macro and microorganisms in soil, soil litter of the Guru Nanak College campus.
5. Animal associations- parasitism, mutualism and commensalism
6. Study of termitarium (demonstration).
7. Earthworm population estimation.
8. Analysis of industrial effluent for TDS, TSS, BOD and COD. (Demonstration)
9. Study of fauna in their natural habitats by visiting places of zoological interest.

**PRACTICAL**  
**IMMUNOLOGY AND BIOCHEMISTRY**

<b>Subject Code: 19PZOO16P</b>	<b>Core Practical - 12</b>	<b>Marks: 100</b>
<b>Semester: III &amp; IV</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**IMMUNOLOGY**

1. Haemagglutination - Quantitative analysis – haemagglutination titration.
2. Preparation of Antigen; RBC-Demonstration.
3. Immuno-Electrophoresis - Demonstration.

**BIOCHEMISTRY**

1. Estimation of protein by Lowry's method from fish tissues.
2. Estimation of carbohydrates by Anthrone method from fish tissues.
3. Estimation of lipids by Zak's method from fish tissues.
4. Amino acid detection by TLC method.
5. Blood: Clotting time and bleeding time.
6. Estimation of hemoglobin.
7. Erythrocyte Sedimentation Rate (ESR) – Chick.

**STUDY TOUR**

Report on the physiological and ecological adaptations of animals through field visit

## **ED-1: MATERNITY AND CHILD CARE**

<b>Subject Code: 19PZOO317</b>	<b>ED-1</b>	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

### **Course Objective:**

- To orient the students regarding the care during pregnancy.
- To orient the students about the care given to the new born.
- To discuss the morphological and hormonal changes during menstrual cycle.
- To describe the mechanism of fertilization, implantation and about twins.
- To highlight the importance of birth control, its types and the causes of infertility.
- To discuss the treatments for infertility and various testing methods of pregnancy.
- To learn the nutrition, vaccination schedules and theories of child behavior.

### **Unit I (10 Hrs)**

Structure and functions of Reproductive organs in male and female – Structure of a mammalian sperm – longevity – Morphology and cyclic changes of ovary – uterus – vagina and mammary glands during menstrual cycle – hormonal changes – puberty– menarche – menopause.

### **Unit II (5 Hrs)**

Formation of gametes – spermatogenesis – spermiogenesis – oogenesis – structure of human ovum – Ovulation – Role of hormones.

### **Unit III (10 Hrs)**

Fertilization – types – mechanism – chemotaxis – capacitation – Acrosomal reaction – activation of ovum – cortical reaction – amphimixis – monospermy, polyspermy – implantation – development of foetus – Birth of identical and non- identical twins – Siamese twins.

### **Unit IV (10 Hrs)**

Pregnancy – maternal body changes – Test for pregnancy – parturition – Role of hormones – Birth control– necessity for birth control– contraceptive devices – Infertility – causes

### **Unit V (10 Hrs)**

Medical diagnosis for healthy new born child, Vaccination schedule, Nutrition for 0 months to 1 year of baby, Theories of Child Behavior – Language Theories – Emotional Theories – Learning Theories – Intellectual Theories – Psycho-Social Theories – Personality Theories – Moral Theories - Implications of Theories.

**TEXT BOOK:**

1. Inderbir Singh and Pal, G.P. 2005. Human Embryology, 7<sup>th</sup>
2. Berk, L.E., (2000), Childhood to Adolescence, Mc.Graw Hill Company, London
3. Berk, L.E., (2007), Development through the life span, Pearson Educational, New Delhi
4. Briyastava, K.K, (2003), Principles of Guidance and Counseling, Kanishka Publishers and distributors, New Delhi
5. Dash, D.N., (2003), Guidance and Services in Schools, Dominant Publishers and distributors, New Delhi

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
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<b>Total Marks</b>				100

**Distribution of Questions:**

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		Theory	Problems
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	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	1	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	

## **ED-2: RESEARCH METHODOLOGY**

<b>Subject Code: 19PZOO318</b>	<b>ED-2</b>	<b>Marks: 100</b>
<b>Semester: III</b>	<b>Credits: 3</b>	<b>Total Hours: 45</b>

**Course Objective:** To acquire the knowledge on research and use of various tools and techniques in research.

### **Unit-I** **(5 Hrs)**

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition and Variable.

### **Unit-II** **(10 Hrs)**

Problem Identification and Formulation – Research Question – Investigation Question – Research Design: Concept and Importance in Research – Features of a good research design – Exploratory research Design – concept, Types and Uses, Descriptive research design – Concept, Types and Uses. Experimental design: Concept of Independent and Dependent variables.

### **Unit-III** **(10 Hrs)**

Data Analysis: Data Preparation- Univariate analysis (frequency tables, bar charts, pie charts, percentages). Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of association.

### **Unit-IV** **(10 Hrs)**

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish and Research ethics: Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook. Academic Databases for Computer Science Discipline.

**Unit-V****(10 Hrs)**

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism Biopiracy.

**Books Recommended:-**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet

**Question Paper Pattern:**

Section	Question Component	Numbers	Marks	Total
Section A	Definition / Principles Answer any 10 out of 12 questions	1 – 12	3	30
Section B	Short Answer ( Answer any 5 out of 8 questions)	13 - 20	6	30
Section C	Essay Answer any 4 out of 6 question	21 - 26	10	40
<b>Total Marks</b>				100

**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	2	
	Unit – 2	3	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	2	

## SEMESTER-IV

### BIOCHEMISTRY

<b>Subject Code: 19PZOO319</b>	<b>Core Paper 13: Theory</b>	<b>Marks: 100</b>
<b>Semester: IV</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To train the students to apply the principles for a better understanding of biological phenomena and to impart knowledge.

#### **UNIT I (10 Hrs)**

Nature of living matter- Biomolecules, pH, Buffers. Enzymes –Mechanism of enzyme action, coenzymes, classification and functions. Isoenzymes, Apoenzymes, Holoenzymes –Enzyme kinetics.

#### **UNIT II (10 Hrs)**

Clinical Biochemistry - Test for Liver function, Serum bilirubin, Classification of Jaundice, Bile acids and Bile salts, Tests based on the metabolic capacity of liver, Tests based on synthetic function of liver. Gastric function – Mechanism of HCl secretion.

#### **UNIT III (15 Hrs)**

Proteins-Classification based on structure and solubility- Protein metabolism- Amino acid metabolism- Oxidative Deamination, Transamination, Decarboxylation, Demethylation Reaction, Structure of Haemoglobin, Haemoglobinopathies.

#### **UNIT IV (10 Hrs)**

Lipids- Classification –Structure and Properties, Steroids-Cholesterol and Sex hormones. Lipid metabolism-Metabolism of fatty acids and glycerol, Coronary Artery Disease.

#### **UNIT V (15 Hrs)**

Bioenergetics- Electron Transport Chain, Laws of Thermodynamics. Metabolism of Xenobiotics –Detoxification – Definition – Mechanism – Phase I Oxidation, Reduction, Hydrolysis –Phase II Conjugation Reaction - Glucuronic acid, Glutathione, Sulphate, Acetate and Methyl group.

**TEXT BOOK:**

1. Ambika Shanmugam: Fundamentals of Biochemistry for Medical Students.

**REFERENCE BOOKS:**

1. J.L.Jain:Fundamentals of biochemistry(1983).
2. Lehninger,A.L.(1970):Biochemistry, worth publishingco.,N. Y.
3. Lubert stryer: Biochemistry- (1975) Freeman andco.
4. D.W.Martin,P.A.Mayer and V.W.Redwell:Harper "s Review of biochemistry 19<sup>th</sup> edition(1983).Maruyen AsianEdition.

**Question Paper Pattern:**

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**Distribution of Questions:**

Sections	Units	No. of Questions	
		Theory	Problems
<b>Section A</b>	Unit – 1	3	
	Unit – 2	2	
	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	1	
<b>Section C</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	1	



## IMMUNOLOGY

<b>Subject Code: 19PZOO320</b>	<b>Core Paper 14: Theory</b>	<b>Marks: 100</b>
<b>Semester: IV</b>	<b>Credits: 4</b>	<b>Total Hours: 60</b>

**Course Objective:** To gain knowledge about the human immune system and Immune Deficiency Diseases.

### **UNIT I (10Hrs)**

Scope of Immunology – Types of Immunity - Innate and Acquired, Passive and Active. Primary and Secondary Lymphoid Organs – Structure and Function of Bone Marrow, Thymus, Spleen, Bursa of Fabricius, GALT, BALT, MALT and Lymph Nodes. Cells of Immune System – Origin and Differentiation of T & B Cells and Macrophage. Antigen – Class Determinants – Reactive Sites and Receptor Sites

### **UNIT II (10 Hrs)**

Major Histo-compatibility Complex (HLA) and its Products in Man. Transplantation Immunology, Tumour Immunology – Immune Deficiency Diseases – AIDS – Autoimmune Diseases – Examples – Concept and Mechanisms – Types of Hypersensitivity.

### **UNIT III (10Hrs)**

Antibody – Immunoglobulin – Primary Structure – Classes, Functions, Synthesis. Hybridoma technology Monoclonal Antibodies and their Applications. Genetic Mechanisms in Generation of Antibody Diversity – Regulation of antibody Diversity. Complement – Classical and Alternative Pathways and Immunological Significance – Antigen antibody reaction.

### **UNIT IV (15 Hrs)**

Cancer: Genetic rearrangements in progenitor cells - oncogenes - tumor suppressor genes - cancer and the Cell cycle. Virus-induced cancer – Metastasis - Interaction of cancer cells with normal cells. Apoptosis - Therapeutic interventions of uncontrolled cell growth.

### **UNIT V (15Hrs)**

Mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors - Cell-mediated effector functions - Inflammation - Hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, Vaccines.

### **TEXT BOOK:**

1. T.A. Brown – Gene cloning an Introduction (1995), Third edition Stanley Thornes Publishers.

**REFERENCE BOOKS:**

1. Benjamin Lewin Gene VII (2000) Oxford Universitypress.
2. Desmond S.T.Nicholl- An introduction to Genetic Engineering (1996) – Cambridge Universitypress.
3. Purohit-Biotechnology.
4. Schlegel- Genetic Engineering.
5. R.W.Old and S.B.Primrose Principles of Gene Manipulation. (1994).VEdition BlackwellScience.

**Question Paper Pattern:**

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	Unit – 3	3	
	Unit – 4	2	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	1	
	Unit – 2	2	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit - 5	1	

## ELECTIVE V- EVOLUTION OF LIFE

<b>Subject Code: 19PZOO321</b>	<b>Elective – 5 - Theory</b>	<b>Marks: 100</b>
<b>Semester: IV</b>	<b>Credits: 3</b>	<b>Total Hours:45</b>

**Course Objective:** To explore the process and product of evolution since nothing in biology makes sense except in the light of evolution.

### UNIT-I (5 Hrs)

**Evolutionary Thought and Causal Factors:** Neo- Lamarckism- Neo- Darwinism; Adaption, struggle, fitness and natural selection.

### UNIT-II (10 Hrs)

**Cosmic Evolution and Origin of Life:** Origin of life- Pre-biotic, Organic compounds- Nature of proto-cells- Evolution of prokaryotes- Origin of eukaryotes- Origin of mitosis and sex. Origin of unicellular and multicellular organism.

### UNIT-III (10 Hrs)

**Paleontology:** Geological time scale- Fossil records (nature; conditions and dating) - Man in the fossil records- mass extinction.

### UNIT-IV (10 Hrs)

**Selection in Action natural selection:** (Normalising; Diversifying; Disruptive) and Genetic Polymorphism- Gene Pool and Hardy- Weinberg equilibrium- genetic drift- Animal colouration and mimicry- Micro and Macro evolution. Adaptation, Pre - adaptation and Post-adaptation.

### UNIT-V (10 Hrs)

**Adaptation, Speciation, Man and Natural Selection:** Adaptive radiation in reptiles and mammals- Convergence- Parallelism -Co-evolution- evolutionary constancy- speciation and Isolating mechanisms- Hybridization as an evolutionary catalyst- Evolutionary genomics- Human races- Sociobiology (Scope, selfish gene, altruism, kin selection) - Man and Natural selection- Evolutionary future of mankind.

**TEXT BOOKS:**

1. Darwin, C.R. 2000. On the Origin of species by means of natural selection (Revised edition) Collier Books, New York.

**REFERENCE BOOKS:**

1. Dodson, E.O. 1990. A Text Book of Evolution, W.B. Saunders, Philadelphia.
2. Lull.R.S.1984.Organicevolution, Seema publication.

**Question Paper Pattern:**

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	Unit – 4	3	
	Unit – 5	2	
<b>Section B</b>	Unit – 1	2	
	Unit – 2	1	
	Unit – 3	2	
	Unit – 4	1	
	Unit – 5	2	
<b>Section C</b>	Unit – 1	1	
	Unit – 2	1	
	Unit – 3	1	
	Unit – 4	1	
	Unit - 5	2	