

SCHEME & SYLLABUS

M.Sc. (Hons.) Zoology



**Department of Life Sciences
University Institute of Science & Humanities
Sant Baba Bhag Singh University
2018**

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FIRST SEMESTER



SECOND SEMESTER



THIRD SEMESTER



FOURTH SEMESTER

Course Scheme, M. Sc. (Hons.) Zoology (Semester-I-IV)

SEMESTER I

I. Theory Subjects

S.No	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	ZOO501-18	Structure & Function of Invertebrates	4:0:0	4:0:0	4	4
2	ZOO503-18	Structure & Function of Chordates	4:0:0	4:0:0	4	4
3	ZOO505-18	Cell and Molecular Biology	4:0:0	4:0:0	4	4
4	ZOO507-18	Tools & Techniques for Biology	4:0:0	4:0:0	4	4
5	MAT515-18	Biostatistical Methods (SEC-1)	4:0:0	4:0:0	4	4

II. Practical Subjects

1	ZOO509-18	Seminars-I/Assignment-I	0:0:2	0:0:1	2	1
2	ZOO511-18	Structure and Functions of Animals Practical	0:0:4	0:0:2	4	2
3	ZOO513-18	Molecular Cell Biology and Tools & Techniques Practical	0:0:4	0:0:2	4	2
Total					30	25

Total Contact hrs: 30
Total Credit Hours: 25

SEMESTER-II

I. Theory Subjects

S. No	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	ZOO502-18	General & Comparative Animal Physiology	4:0:0	4:0:0	4	4
2	ZOO504-18	Biosystematics, Taxonomy & Evolution	4:0:0	4:0:0	4	4
3	ZOO506-18	Biomolecules & Structural Biology	4:0:0	4:0:0	4	4
4	ZOO508-18	Population Ecology & Environmental Physiology	4:0:0	4:0:0	4	4
5	CSE554-18	Introductory Concepts of Computer Technology	4:0:0	4:0:0	4	4

II. Practical Subjects

1	ZOO510-18	Seminars-II/Assignment-II	0:0:2	0:0:1	2	1
2	ZOO512-18	Physiology and Biochemistry Practical	0:0:4	0:0:2	4	2
3	ZOO514-18	Ecology, Environmental Physiology, Systematics, Taxonomy and Evolution Practical	0:0:4	0:0:2	4	2
Total					30	25

Total Contact hrs: 30
Total Credit Hours: 25

SEMESTER III

I. Theory Subjects

S.No	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	ZOO601-18	Genetics and Cytogenetics	4:0:0	4:0:0	4	4
2	ZOO603-18	Developmental Biology and Embryology	4:0:0	4:0:0	4	4
3	ZOO605-18	Elective course (any one of the following) A. General Entomology & Insect Morphology B. Comparative Endocrinology C. Fish Structure & Function	4:0:0	4:0:0	4	4
4	ZOO607-18	Elective course (any one of the following) A. Insect Anatomy & Physiology B. Endocrine Physiology C. Fish Morphology & Anatomy	4:0:0	4:0:0	4	4

II. Practical Subjects

1	ZOO609-18	Project work-I	0:0:10	0:0:5	10	5
2	ZOO611-18	Genetics, Cytogenetic Development and Differentiation Practical	0:0:4	0:0:2	4	2
3	ZOO613-18	A: General Entomology Practical B: Comparative Endocrinology and Endocrine Physiology Practical C. Fish Biology (Practical)	0:0:4	0:0:2	4	2
Total					34	25

Total Contact hrs: 34
Total Credit Hours: 25

SEMESTER-IV

I. Theory Subjects

S. No	Sub Code	Subject Name	Contact Hours (L:T:P)	Credits (L:T:P)	Total Contact Hours	Total Credits Hours
1	ZOO602-18	Animal Behavior	4:0:0	4:0:0	4	4
2	ZOO604-18	Introduction to Immunology	4:0:0	4:0:0	4	4
3	ZOO606-18	Elective course (any one of the following) A. Insect Taxonomy, Ecology & Development B. Male Reproductive Endocrinology C. Taxonomy, Systematics & Ecology of Fishes	4:0:0	4:0:0	4	4
4	ZOO608-18	Elective course (any one of the following) A. Applied Entomology B. Female Reproductive Endocrinology C. Pisciculture & Economic Importance of Fishes	4:0:0	4:0:0	4	4

II. Practical Subjects

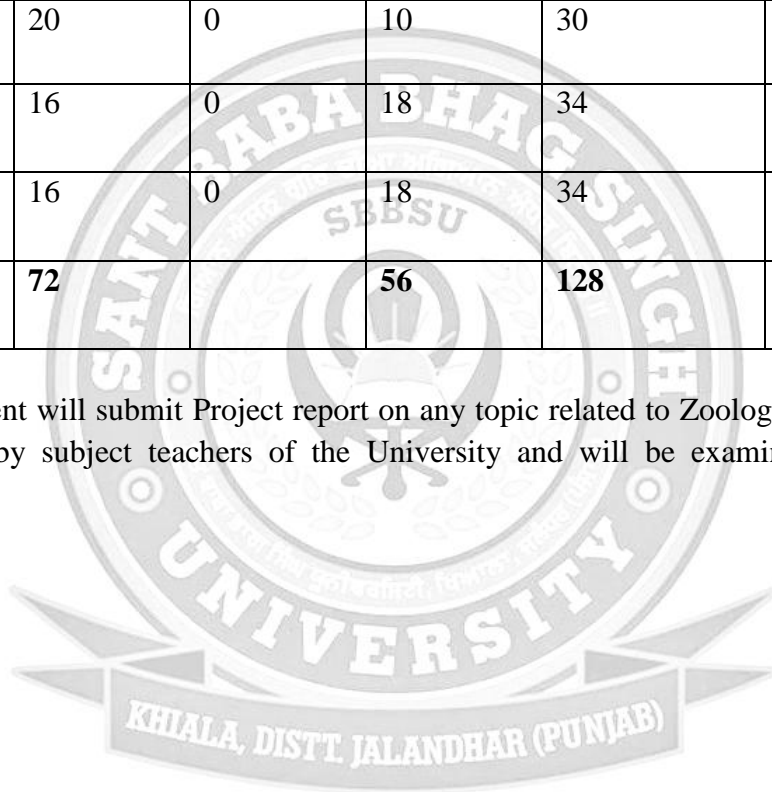
1	ZOO610-18	Project Work-II	0:0:10	0:0:5	10	5
2	ZOO612-18	Animal Behavior and Vertebrate Immunology Practical	0:0:4	0:0:2	4	2
3	ZOO614-18	A: Insect Taxonomy, Ecology, Development & Applied Entomology Practical B: Reproductive Endocrinology Practical C. Fish Biology & Fisheries (Practical)	0:0:4	0:0:2	4	2
Total					34	25

Total Contact hrs: 34
Total Credit Hours: 25

COURSE SCHEME SUMMARY

Semester	L	T	P	Contact hrs/wk	Credits
1	20	0	10	30	25
2	20	0	10	30	25
3	16	0	18	34	25
4	16	0	18	34	25
Total	72		56	128	100

Note: Each student will submit Project report on any topic related to Zoology. Project report will be guided by subject teachers of the University and will be examined by external Examiner.



Course Code	ZOO501-18
Course Title	Structure and Function of Invertebrates
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To make students aware about the functions of different body parts lower animals and their way of living.

Syllabus

UNIT-I

Locomotion: Flagellar and ciliary movement in Protozoa; **Theories of origin of Metazoa:** Colonial theory, Syncytial theory, Polyphyletic theory; **Porifera:** Canal system, skeleton and reproduction, **Coelenterata:** Nematocytes, Polymorphism in hydra

UNIT-II

Organization of coelom: Acoelomates, Pseudocoelomates and coelomates; **Polychaeta:** Filter feeding and Adaptive radiations; **Organs of respiration:** Gills, lungs and trachea; Respiratory pigments and their functions; Mechanism of respiration and transport of gases

UNIT-III

Organs of excretion: Coelom, coelomoducts, nephridia and Malpighian tubules; Mechanism of excretion in invertebrates; **Primitive Nervous system:** Coelenterates and Echinoderms; **Advanced Nervous system:** Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda)

UNIT-IV

Larval forms: Crustacean, Mollusca and Echinodermata; Larval forms of invertebrate parasites; Evolutionary significance of larval forms; **General characters and organization of minor phyla:** Rotifera, Acanthocephala, Ectoprocta, Endoprocta, Phoronida

Text and Reference Books:

S.No	Name/Title	Author	Publisher
1	Invertebrate Zoology	Barnes R.D	W.B. Saunders Co., Philadelphia
2	Life of Invertebrates	Hunter	Collier Macmillan
4	Modern Text Book of Invertebrates	R.L. Kotpal	Rastogi Publications (2015-2016)
5	The Invertebrates. Vol-I	Hyman, L.H.	McGraw Hill Co., New York.
6	The Invertebrates. Vol-II	Hyman, L.H.	McGraw Hill Co., New York.
7	The Invertebrates. Vol-III	Hyman, L.H.	McGraw Hill Co., New York.
8	Invertebrate Structure and Function	Barrington E.J.W	Thomas Nelson and Sons Ltd., London

Course Code	ZOO503-18
Course Title	Structure and Function of Chordates
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To enable the students to identify and differentiate different groups of chordates by providing them knowledge on characteristic features and their functions

Syllabus

UNIT-I

Protochordates and Cyclostomates: Characteristic feature and affinities; **Origin of the following:** Fishes, Amphibians, Reptiles, Birds and Mammals

UNIT-II

Adaptive radiations: In vertebrates, aquatic, terrestrial, Aerial, Arboreal, Fossorial; Parental care in fishes; **Skull:** In reptiles; **Migration:** Fishes and birds, **Aves:** Flightless birds

UNIT-III

Respiratory System: Characters of respiratory tissue; Internal and external respiratory organs; **Circulatory system:** Evolution of heart; Evolution of aortic arches; Comparative account of jaw suspensorium and vertebral column

UNIT-IV

Comparative account of limbs and girdles; **Urogenital system:** Evolution; **Sense organs:** Comparative account of Organs of olfaction and taste; **Nervous system:** Comparative account of brain and spinal cord; Comparative account of nervous system

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Text book of Zoology	Parker and Hashwell	Macmillan
2	Analysis of Vertebrate structure	Hildebrand	John Willey
3	Chordate Zoology	Verma J. & Agrawal	S. Chand Publications
4	Modern Text Book of Vertebrates	R.L. Kotpal	Rastogi Publications
5	Text Book of Zoology (Chordates)	Dhami and Dhami	Pradeep Publications

Course Code	ZOO505-18
Course Title	Cell and Molecular Biology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	Aware students about cell, its structure and interaction with one other.

Syllabus

UNIT-I

Cell: concept and general properties; **Cell types:** Prokaryotes and Eukaryotes and their organization; **Mitochondria:** Biogenesis and role in cellular energetics; **GERL:** concept and its functions; Structure and functions of lysosomes, peroxisomes and Glyoxisomes

UNIT-II

Structure of Membrane (Fluid mosaic model), Molecular composition of the membrane, functional significance; **Transport across cell membranes:** Simple diffusion and osmosis, facilitated diffusion (Uniports, Symports, Antiports, Ion channels), Active transport, Membrane pumps; **Trafficking Mechanisms** (Endocytosis and Exocytosis); **Cytoskeleton:** Microfilaments: structure dynamics and functions, Intermediate filaments: structure, dynamics and functions, Microtubules: structure, dynamics and functions

UNIT-III

Cell - cell adhesion and cell junctions: Ca^{++} dependent homophilic cell adhesion, Ca^{++} independent homophilic cell adhesion; Collagen and Non-collagen components of extracellular matrix of animal cells, Fibronectins and Integrins, Cell junctions (Gap junctions and Connexins); **Signal transduction mechanisms:** Cell surface receptors, Signal amplification, Secondary messengers, Signaling through G-protein coupled receptors (PKA, PKC), Enzyme linked receptor signaling (Growth factor receptor signaling, Jack state pathway)

UNIT-IV

Various cell cycle check points; Cyclins and cyclin dependent kinases; Regulation of CDK-cyclin activity; Apoptosis: Mechanism and significance; Biology of Cancer; Biology of aging

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	The cell: A molecular approach	Cooper G.M	ASM press, Washington
2	Molecular Biology of Cell	Alberts et al.	Garland Publishing, New York
3	Cell Biology	Chandra Roy and Kumar	New central book Agency, P. Ltd. Kolkata
4	Cell and Molecular Biology	Karp G.	John Wiley and Sons, Inc.
5	Cell and molecular biology	P.K. Gupta	Rastogi Publications

Course Code	ZOO507-18
Course Title	Tools and Techniques For Biology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non-Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give students knowledge about the different Instruments used in biological sciences and prepare them for research work.

Syllabus

UNIT-I

Microscopy, principle & applications of: Light microscope, phase contrast microscope and Fluorescence microscope; General principle and applications of Electron microscope (TEM & SEM); Principle and applications of confocal microscopy; **Cryotechniques:** Cryopreservation of cells, tissues, organs and organisms, Freeze fracture & freeze drying.

UNIT-II

Principles and applications of photometry: Beer & Lambert's law, Absorption spectrum & absorption maxima; Colorimeter & spectrophotometer; Flame photometer; Atomic absorption spectrophotometer

UNIT-III

Separation techniques: Chromatography, principle, types and applications; Electrophoresis, principle, types & applications; PAGE and agarose gel electrophoresis; **Radioisotopes in biology:** Units of radioactivity, Radioactive counters, Autoradiography

UNIT-IV

Histological techniques: Principles of tissue fixation, Microtomy, cryotomy; **Immunological techniques:** Immunodiffusion and Immunoelectrophoresis; **Molecular cytological techniques:** In situ hybridization (radiolabelled & non-radiolabelled methods), FISH, and Restriction banding; **Molecular biology techniques:** Southern hybridization and Northern hybridization; DNA sequencing; Polymerase chain reaction (PCR).

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Handbook of Microscopy	Locquin and Langeron	Butterworths
2	Modern Experimental Biochemistry	Boyer	Benjamin
3	Practical Biochemistry	Wilson and Walker	Cambridge
4	Introduction to Instrumental analysis	Robert Braun	McGraw Hill Int.
5	Experimental Biochemistry	Clark & Switzer	Freeman Publ.

Course Code	MAT515-18
Course Title	Biostatistical Methods
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give the knowledge of statistical techniques used in life sciences for simplification of complex things, so that they can be easily understood.

Syllabus

UNIT-I

Data collection, tabulation, Frequency distribution and its graphical representation; **Measures of Central tendency:** mean, mode, median; **Measures of Dispersion:** range, variance, Standard deviation and Standard error

UNIT-II

Probability: Mathematical definition of a probability event; Conditional probability; Additive and Multiple law of Probability; **Theoretical Distributions:** Binomial, Poisson and Normal

UNIT-III

Null Hypothesis and Level of Significance; Confidence limit and confidence interval; Skewness and Kurtosis moments; Student's t- test (Paired and Unpaired); Chi Square test

UNIT-IV

Correlation: Covariance, Karl pearson's correlation coefficient and Spearmans rank correlation coefficient; **Regression:** Least square technique for regression lines, regression coefficient; Relation between Correlation and Regression; **Analysis of variance** (one way and two way ANOVA)

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Introduction to Mathematics for Life Scientists	Batschelet, E	Springer-Verlag, Berlin
2	Mathematical Biology	Murray, J.D.	Springer-Verlag, Berlin
3	Statistical Methods	Snedecor&Cochran	Affiliated East-West Press
4	Biostatistics	P. Ramakrishnan	Saras Publications
5	Biostatistics: Basic Concepts and Methodology for the Health Sciences	Wayne W. Daniel	Wiley Publication

Course Code	ZOO511-18
Course Title	Structure and Functions of Animals Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To inculcate the knowledge of different organ systems of animals to students and also aware them about differences between non-chordates and chordates

Syllabus

List of Experiments

1. Preparation of permanent slides:

Protozoa: *Paramecium* (whole mount) and demonstration of food vacuoles, **Cnidaria:** *Bougainvillea*, *Sertularia* etc.; **Arthropoda:** Cyclops, Megalopa/Zoea, spiracles of cockroach, etc.; **Mollusca:** Glochidium larva, etc.; **Echinodermata:** Spheredium, pedicellaria, tubefeet

2. Dissections

Alimentary canal of cockroach/grasshopper; **Arthropoda:** Salivary gland of cockroach, Nervous system of Prawn; **Mollusca:** Nervous system of *Mytilus* and *Aplysia/Sepia*

3. Study of museum specimens:

Porifera, Cnidaria, Annelida, Arthropoda, Mollusca, Echinodermata, Amphibians, Reptiles and Pisces

4. Study of external morphology of honey bee and dissection of sting apparatus

5. Dissection and display of accessory respiratory organs of *Clarias batrachus*/*Channa* sp.

6. Study of important characters of poisonous & non-poisonous snakes and their biting apparatus.

7. Study of permanent slides of:

Protochordates: Whole mount of *Doliolum*, *Pyrosoma*, *Salpa* and *Oikopleura*;
Fishes: T.S. of gill, accessory respiratory organs, swim bladder

8. Study of Adaptive features of following:

Amphibians, Reptiles, Birds, Mammals

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
2	Practical Zoology Invertebrates	S.S. Lal	Rastogi Publications
3	A Manual of Practical Zoology Vertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO513-18
Course Title	Molecular Cell Biology and Tools & Techniques Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To indoctrinate the students with different modern techniques used in biological research and their applications.

Syllabus

List of Experiments

1. Microtomy of invertebrate or vertebrate materials
2. Preparation of buffer solutions of defined ionic concentration and determination of pH
3. Absorption spectrum of coloured and colourless solutions using spectrophotometer and colorimeter
4. Separation and detection of dyes/amino acids/sugars using paper chromatography and/or TLC
5. Study of permanent slides of cytology
6. Study of mitosis from onion root tips by making stained temporary squash preparation
7. Study of meiosis from testicular tissue of grasshopper
8. Salivary gland squash preparation for the study of polytene chromosomes of *Chironomus* / *Drosophila*
9. Mammalian blood smear preparation for the study of drumstick as sex chromatin test in rat / human
10. Study of Mendelian ratios from the seed coat colour pattern of seeds (monohybrid and dihybrid ratio)
11. Collection of *Drosophila* for the study of morphological characters of males and females
12. Study of cellular ultrastructure by means of electron micrographs
13. Working and applications of tools: B-Counter, ELISA reader and autoanalyser/ spectrophotometer and image analyzer

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
2	Practical Zoology Invertebrates	S.S. Lal	Rastogi Publications
3	Lab Manual of Blood Analysis and Medical Diagnostics	Prakash G	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO502-18
Course Title	General and Comparative Animal Physiology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To aware the students about the different types of systems and their functions in animals

Syllabus

UNIT-I

Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, haemostasis; **Respiratory system:** Comparison of respiration in different species, transport of gases, exchange of gases; Respiratory pigments through different phylogenic groups; Neural and chemical regulation of respiration.

UNIT-II

Excretory system: Comparative physiology of excretion, kidney, urine formation, waste elimination, micturition; Regulation of water balance, blood volume, blood pressure, electrolyte balance; **Digestive system:** Digestion, absorption, energy balance, BMR; **Thermoregulation:** Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.

UNIT-III

Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissues; **ECG** – its principle and significance, cardiac cycle, heart as a pump, blood pressure; **Nervous system:** Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture; Physiology of impulse transmission through nerves and synapse

UNIT-IV

Comparative study of mechanoreception, photoreception, hemoreception; **Sense organs:** Vision, hearing and tactile response; Stress and adaptation; **Endocrinology and reproduction:** Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes; Neuroendocrine regulation of Hormones, their classification and chemical nature

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Comparative animal physiology	Prosser, C.L	W.B. Saunders
2	Animal physiology	Eckert, R	Freeman & Co.
3	A Text book Animal Physiology	M.P. Arora	Rastogi Publ.
4	Text book Medical Physiology	Guyton and Hall	Harcourt Asia P. Lt
5	Animal Physiology	Arumugam and Mariakuttikan	Saras Publications
6.	Animal Physiology	Schiemdt-Neilsen	Cambridge

Course Code	ZOO504-18
Course Title	Biosystematics, Taxonomy & Evolution
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To provide students' knowledge of biosystematics and evolution.

Syllabus

UNIT-I

Definition and basic concepts of biosystematics and taxonomy; **Trends in biosystematics:** Chemotaxonomy, cytotaxonomy and molecular taxonomy; **Species concept:** Different species concepts; Theories of biological classification; Taxonomic categories & Hierarchy of categories

UNIT-II

Taxonomic characters: Different kinds, origin of reproductive isolation, biological mechanism of genetic incompatibility; Taxonomic procedures: Taxonomic collections, preservation, curation, process of identification; **Taxonomic keys:** Different kinds of keys, their merits and demerits; International code of Zoological nomenclature (ICZN); Concepts of evolution and theories of organic evolution

UNIT-III

Neo-Darwinism and population genetics: Hardy-Weinberg Law of genetic equilibrium; Destabilizing forces, natural selection, mutation, genetic drift, migration & meiotic drive; Ecological significance of molecular variations (genetic polymorphism); Patterns and mechanisms of reproductive isolation; **Modes of speciation** (allopatry & sympatry); Zoo-geological time scale

UNIT-IV

Trends in evolution; **Molecular evolution:** Gene evolution & Evolution of gene families; Molecular phylogenetics: Construction of phylogenetic trees, Amino acid sequences and phylogeny; DNA-DNA hybridization, restriction enzyme sites

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	The Biology of Biodiversity	Kato, M	Springer
2	Biodiversity	Wilson, E.O.	Academic Press
3	Principles of Animal Taxonomy	Simpson, G.G	Oxford IBH Pb Co.
4	Elements of Taxonomy	Mayor, E	
5	Threatened Animals of India	Tikadar, B.K	ZSI Publ. Calcutta
6.	Genes and Evolution	Jha, A.P.	John Publ., ND

Course Code	ZOO506-18
Course Title	Biomolecules & Structural Biology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To provide students' knowledge of structural units of life, their role and structural difference between them

Syllabus

UNIT-I

Primary, secondary, tertiary and quaternary structures of proteins; Protein folding and denaturation; **DNA:** Double helical structure of DNA; **RNA:** Structure of RNA, role of RNA in gene expression; DNA replication, recombination and repair.

UNIT-II

Glycolysis and Glyconeogenesis; Citric acid cycle; Oxidative phosphorylation; Pentose Phosphate Pathway.

UNIT-III

Functional importance of lipid storage & membrane lipids; **Fatty acid metabolism:** Synthesis and degradation of fatty acids; Protein Synthesis; Membrane channels and pumps

UNIT-IV

RNA synthesis and splicing; Biosynthesis of amino acids; Biosynthesis of nucleotides; Biosynthesis of membrane lipids and steroids

UNIT-V

Enzymes: Basic concepts and kinetics; Mechanism and Regulation of enzyme catalysis; Concept of free energy and thermodynamic principles in biology; Energy rich bonds, compounds and biological energy transducers.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Biochemistry	Voet, D. and J.G. Voet	Freeman & Co
2	Biochemistry	Lehninger	
3	Essentials of Molecular Biology	Freifelder, D	Freeman & Co
4	Biochemical Calculations	Segal, I.H	J. Wiley and Sons
5	Fundamentals of Biochemistry	J.L. Jain	S. Chand Publ.
6.	Biochemistry	Satyanarayan	Springer Publ.

Course Code	ZOO508-18
Course Title	Populations Ecology & Environmental Physiology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To aware the students about the role and need of conservation of our biodiversity. As each and every thing made by God has its role in the wellbeing of humans.

Syllabus

UNIT-I

Biodiversity Conservation and Status; Biodiversity laws, significance and management approaches; **Population ecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); **Concept of metapopulation**: demes and dispersal, interdemic extinctions, age structured populations.

UNIT-II

Adaptation: Levels of adaptation, mechanisms and significance of body size; **Biogeography**: Major terrestrial biomes; biogeographical zones of India; **Aquatic environments**: Freshwater, marine and estuarine environments; Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

UNIT-III

Eco-physiological adaptations to terrestrial, fresh water and marine water environments; **Ecological succession**: Types; mechanisms; changes involved in succession; concept of climax; Environmental limiting factors; Concept of homeostasis.

UNIT-IV

Inter and intra specific relationship competition; Predatory-prey relationship, predator dynamics, optimal foraging theory; Mutualism, evolution of plant-pollinator interaction; Environmental pollution; global Environmental change; Environmental impact assessment; Sustainable development

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Ecological Concepts	Cherrett, J.M.	Blackwell Science Publication
2	Ecology	Krebs, C.J	Harper & Row, New York
3	Fundamentals of Ecology	Eugene P. Odum	Cengage publications
4	Animal Physiology: Mechanisms and Adaptation	Eckert, R	W.H. Freeman and Co., New York.
5	Physiological Animal Ecology	Louw, G.N.	Longman Harloss, UK
6.	Ecology and Environment	P.D. Sharma	Rastogi Publications

Course Code	CSE554-18
Course Title	Introductory Concepts of Computer Technology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To aware students about the basic fundamentals of computer and its use in day today life.

Syllabus

UNIT-I

Evolution of computers; **Basics of computer and its operation:** Functional Components and their inter-connections, concept of Booting, Use of Operating System for directory listing, hierarchical directory structure, renaming, deleting files/folders, formatting floppy, copying files, concepts of path and pathname, switching between tasks, installation/removal of applications

UNIT-II

Computers and their applications in biology; **Operating systems:** Need for operating system, Functions of operating system (Processor Management, Memory Management, File Management and Device Management); **Types of operating system** - Interactive (GUI based), Timesharing, Real Time and Distributed; **Types of Software:** System Software, Utility Software and Application Software

UNIT-III

Computer fundamentals, Introduction to digital computers, Organization; Number system, I/O devices, Storage devices; Introduction to internet and its applications – www, email

UNIT-IV

MS-Windows basics; **MS-Word:** Meaning of Word–Processing, Creating, Saving, Printing documents, Formatting, Spell-Check, Adding page numbers, Header and Footer, Macros, Creating tables, Converting table to text and vice-versa, Mail Merge; **MS-Excel:** Spreadsheets, Using different types of formulae, Creating graphs and charts, Exporting charts to MS-Word, **MS-PowerPoint:** Creating presentations, Formatting, Adding effects and timings.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Computer Fundamentals	Sinha, P.K.	
2	Windows Based Computer Courses	Sumit Kumar,	JBD Publishers
3	Fundamentals of Computers	Rajaraman	Prentice Hall of India
4	Introduction to Computers, 6th Ed	Peter Norton's	

Course Code	ZOO512-18
Course Title	Physiology and Biochemistry Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give students about

Syllabus

List of Experiments

1. Detection of carbohydrates, proteins and lipids in the given sample
2. Detection of urea, uric acid, ammonia in the given sample
3. Counting of red blood corpuscles in the blood of rat or man
4. Counting of white blood corpuscles in the blood of rat or man
5. Determination of haemoglobin percentage in the blood of rat or man
6. Detection of blood groups and Rh factor in rat or man
7. Estimation of ascorbic acid content in lemon extract using titration method
8. Determination of blood clotting time
9. Preparation of haemin crystals
10. Determination of Erythrocyte sedimentation rate (ESR)
11. Separation of Serum and tissue protein with the help of electrophoresis
12. Quantitative determination of biological parameters (protein, cholesterol and blood sugar, RNA and DNA etc.) with the help of colorimeter

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Anatomy and Physiology A Lab Manual	Tortora and Amitrano	Cengage Learning India Pvt Ltd
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	Lab Manual of Blood Analysis and Medical Diagnostics	Prakash G	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO514-18
Course Title	Ecology, Environmental Physiology, Systematics, Taxonomy and Evolution Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give students knowledge about components of environment, naming of animals and some evolutionary processes so that they can well adopt themselves to changing environment

Syllabus

List of Experiments

1. Water analysis for
 - i. Dissolved oxygen
 - ii. Free carbon-dioxide
 - iii. Chloride
 - iv. Hardness and alkalinity
2. Composition and classification of soil, gravel, coarse and fine sands, clay, sand, loam, chalky and peaty
3. Ecological niche: A habitat study
4. Animal association and communities
5. Techniques of collection and preservation, mounting & display, indexing
6. Structural adaptations of ecological significance
7. Study of evolutionary trends through Photographs/models, Homology, Analogy, Parallel trends, Living fossils, polyphyletic origin, Anagenesis, Regressive trends.
8. Problem related to evolution, population genetics etc. (natural selection, adaptation, trends of evolution, genetic polymorphism etc.)
9. Preparation of phylogenetic tree using molecular data
10. Toxicity tests: LC₅₀/LD₅₀

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	Lab Manual of Blood Analysis and Medical Diagnostics	Prakash G	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO601-18
Course Title	Genetics and Cytogenetics
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To teach students about different genetic principles and also make them aware about the structure and functions performed by genes.

Syllabus

UNIT-I

Mendel's laws and their chromosomal basis; **Extensions of Mendalism:** Dominance relationships, Epistasis, Pleiotropy; Methods in gene mapping; Sex determination

UNIT-II

Types of gene mutation; DNA Damage and Repair; Fine structure of gene (*rll*locus); Regulation of gene activity in *lacoperon* of *E. coli*; Non-coding genes; **Mitochondrial DNA:** its organization and properties.

UNIT-III

Classes of DNA; **Chromosomal proteins:** histones, nonhistone proteins and scaffold/matrix proteins; Nuclear matrix and organization of interphase nucleus; Centromere, kinetochore and telomere; Polytene chromosome and Lambrush chromosome; Mitosis and Meiosis

UNIT-IV

Karyotype and nomenclature of metaphase chromosomes bands; Chromosomal anomalies and diseases; Types of chromosomal anomalies: Common syndromes caused by aneuploidy, mosaicism, deletion and duplication; Fragile site and X-linked mental retardation

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Molecular Biology of the Cell	Alberts et al	Garland Publ.
2	Eukaryotic Chromosome	Bostock and Summer	North-Holland
3	Principles of Genetics	Gardner et al	John Wiley
4	Cell and Molecular Biology	Karp	John Wiley and Sons
5	Genetics	B.D. Singh	Kalyani Publ.
6.	Cell and Molecular Biology	P.K. Gupta	Rastogi Publications

Course Code	ZOO603-18
Course Title	Developmental Biology and Embryology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To sentient students about the different stages in the development of humans and also the role played by different hormones during different stages of pregnancy

Syllabus

UNIT-I

Introduction to Development: Generation of new cells and organs; **Gametogenesis:** Origin and migration of primordial germ cells; Production of male gametes (Spermatogenesis); Production of female gametes (oogenesis) (Previtellogenesis, vitellogenesis and maturation phase in development of amphibian egg); Ovulation and ovum transport in mammals.

UNIT-II

Fertilization and early development: Pre fertilization events (sperm penetration of egg and acrosomal reaction, binding of sperm to the egg, Blocks to polyspermy); Biochemistry of fertilization (metabolic activation of egg, penetration of spermatozoa into the egg, union of gametes); Establishment of polarity in amphibians and birds; Gastrulation and formation of germ layers in animals

UNIT-III

Regeneration in nervous system; The somites and their derivatives; Development of Bones; Development of heart and formation of blood vessels; Development of Digestive tube and its derivatives.

UNIT-IV

Amphibian metamorphosis; Insect metamorphosis; Stem cell mediated regeneration of flatworms; Epimorphic regeneration of salamander limb; Morphallaxes in Hydra; Compensatory regeneration of mammalian liver

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Developmental Biology	Gilbert, S.F	Sinauer Associated Inc.
2	Introduction to Embryology	Balinsky, B.I	Saunders, Philadelphia
3	Development Biology	Berril, N.J. &Karp, G	McGraw Hill, New York
4	A text book of Zoology-II (BSc. III)	Dhami and Dhami	Pradeep Publications
5	Developmental Biology	Sastry and Shukla	Rastogi Publications

Course Code	ZOO605-18 A
Course Title	General Entomology & Insect Morphology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To help the students to understand the scope of entomology, aware them about structure of Insect and its body parts and give them the knowledge about significance of Insects.

Syllabus

UNIT-I

Entomology: Introduction, history and scope; **Insect collection:** Significance and insect nets and traps; General organization of a typical insect body; Structure of insect head, structure and functions of antennae; Head segmentation and its theories; Different types of mouth parts and relationship with feeding habits of insects

UNIT-II

Structure of typical wing bearing thoracic segment; **Insect legs:** Structure, their modifications and functions; Structure of insect wings, their modifications and wing coupling apparatus; Hypothetical wing venation

UNIT-III

Wing venation in grasshopper, housefly and honeybee; Structure of flight muscles and flight mechanisms in insects; General structure of insect abdomen and its appendages; Male and female genitalia in grasshopper

UNIT-IV

Coloration and mimicry in insects; Light production in insects; Sound production in insects; Sound reception in insects; Phase theory of locusts; Polymorphism in aphids; Methods of insect communication.

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	The Insects: An Outline of Entomology	Gullan and Cranston	Wiley-Blackwell
2	The Study of Insects	<u>Johnson, Triplehorn</u>	Brooks Cole
3	Laboratory Manual of Entomology	Alka Prakash	Newagepublishers
4	Basic Entomology	Sunil Kumar Yadav	New Vishal Publication
5	Imms' General Textbook of Entomology	Imms, Richards, Davies	Springer Netherlands

Course Code	ZOO605-18 B
Course Title	Comparative Endocrinology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non-Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To make students aware about the comparative structure of different endocrine systems in the body of animals.

Syllabus

UNIT-I

History and scope of endocrinology; General and comparative structure of anterior pituitary gland; General and comparative structure of neurohypophysis; General and comparative structure of thyroid; General and comparative structure of parathyroid

UNIT-II

General and comparative structure of pancreas; Structure of mammalian pineal body; General and comparative structure of adrenal medulla and chromaffin tissue; General and comparative structure of adrenal cortex and inter-renal tissue

UNIT-III

Neurosecretion and neuroendocrine mechanisms in non-arthropod invertebrates; Neuroendocrine system in Crustacean; Neuroendocrine system in Insecta; Neuroendocrine system in Mollusca

UNIT-IV

Caudal neurosecretory system in fish; General structure of thymus; Endocrine integration: migration of birds and fishes, bird plumage; **Hormone like substances:** Ectohormones, phytohormones, root growth hormones

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	General and Comparative Endocrinology	Power, Sheridan	Elsevier
2	A Textbook of Comparative Endocrinology	Gorbman and Bern	Wiley, New York
3	Endocrinology and Reproductive Biology	K.V. Sastry	Rastogi Publ.
4	Textbook of Endocrinology	Melmed et al.	Elsevier
5	A Textbook of Endocrinology	A.K. Berry	EMKAY Publ.

Course Code	ZOO605-18 C
Course Title	Fish structure and function
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non-Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To make students aware about the Fish Structure and Function.

Syllabus

UNIT I

1. Structure and function of skin
2. Structure and function of scales, determination of growth and age
3. Origin and evolution of paired fins
4. Different types of fins and their specific modifications
5. Skeleton of teleost fish

UNIT II

6. Locomotion in fish
7. Structure and function of swim bladder
8. Accessory respiratory organs with special reference to Indian fishes
9. Different types of feeding and feeding habits of fish

UNIT III

10. Structure, function and homologies of Weberian ossicles
11. Hill stream adaptation in fish
12. Deep sea fishes
13. Migration in fish
14. Chemical communication in fish

UNIT IV

15. Structure and functions of electric organs and electroreceptors
16. Structure and function of luminous organs
17. Structure and function of sound producing organs and sound reception
18. Poisonous and venomous fish.

UNIT V

19. Structure, working and functions of eye
20. Structure, working and functions of ear
21. Mendelian and non-Mendelian genetics in fish
22. Hybridization in fish
23. Sex determination in fish

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Fish Biology	P.S. Verma	Elsevier
2	Fish Anatomy and Physiology	P.S. Verma	Wiley, New York

Course Code	ZOO607-18 A
Course Title	Insect Anatomy and Physiology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To unfold structure and functions of different parts of insect body to students

Syllabus

UNIT-I

Insect Integument: Structure and functions; Mechanism of moulting and sclerotization of cuticle; Structure and types of spiracles; Structure of Malpighian tubules including cryptonephridia; Physiology of excretion and significance of cryptonephridia; Structure of brain and ganglia

UNIT-II

Mechanoreceptors: Structure and functions; **Chemoreceptors:** Structure and functions of chemoreceptors; **Photoreceptor organs:** Simple and compound eyes, formation of image; Structure and functions of fat body

UNIT-III

Haemolymph: Composition and functions; Insect circulatory system; **Digestive system:** Structure and modifications of alimentary canal and associated glands; Histology of alimentary canal, salivary glands and peritrophic membrane; Physiology and regulation of digestion

UNIT-IV

Neuroendocrine system and its variations in different insects; Chemistry and functions of hormones; **Reproductive system:** Structure of male and female reproductive systems; Types of insect reproduction; Insect pheromones

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1.	Imms' General Textbook of Entomology	Imms, Richards & Davis	Springer
2.	The Insects: An Outline of Entomology	J. Gullan and P. S. Cranston	Wiley Publishing house
3.	Introduction to the study of insects	Charles A. Triplehorn, Norman F. Johnson	
4.	Modern Entomology	B.D. Tembhare	Himalaya Publishing House, New Delhi

Course Code	ZOO607-18 B
Course Title	Endocrine Physiology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	Try to give the knowledge of different hormones produced by the different types of glands in humans and aware students about the role of each hormone in maintaining our body

Syllabus

UNIT-I

Role of hypothalamus and neuroendocrine integration in mammals; Hormones of anterior **pituitary** and their functional significance; Hormones of **neurohypophysis** and their functional significance in mammals; Hormones of **pars-intermedia** and control of pigmentary function in vertebrates

UNIT-II

Functional significance of pineal hormones; Biosynthesis and functions of thyroid hormones; Regulation of thyroxine secretion; Thyroxine and its influence on development and metamorphosis

UNIT-III

Parathyroid hormone and its physiological significance; Calcitonin, thyrocalcitonin and their functional significance; Biosynthesis of epinephrine and nor-epinephrine; Physiological significance of mineralocorticoids and glucocorticoids

UNIT-IV

Gastrointestinal hormones and their physiological significance; Insulin and insulin like peptides and their role in early mammalian development; Renin and angiotensins and their functional significance; Physiological significance of insulin in carbohydrate metabolism; Biochemistry and functional significance of sex steroids

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Textbook Of Endocrinology	Dharmalingam	Jaypee Brothers Medical Publishers
2	Text book of animal physiology	Mohan P. Arora	Himalaya Publ.
3	Mammalian Endocrinology	Ashoke Kumar Boral	New Central Book Agency
4	Introduction to Endocrinology	Negi, Chandra	Prentice Hall India Learning
5	Animal Physiology	Arumugam, Mariakuttikan	Saras Publication

Course Code	ZOO606-18 C
Course Title	Fish Morphology, Anatomy and Physiology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non-Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To make students aware about the Fish Structure and Function.

SYLLABUS

UNIT I

1. Chromatophores: Classification, ultrastructure, and functional significance
2. Color changes: Types, neural and endocrine control mechanisms
3. Respiratory organs: Kinds and physiology of aqueous breathing
4. Digestive system: Anatomy and physiology of alimentary canal

UNIT II

5. Nervous system: Brain its functional organization with ecological bearing
6. Nervous system: Nerves and their supply
7. Lateral line system: structure, modifications and significance
8. Circulatory system in fish, heart, venous and arterial system

UNIT III

9. Excretory system: kidney and physiology of excretion in teleost fish
10. Osmo-regulatory organs and mechanisms in fish
11. Neuroendocrine integration in fish
12. Hypothalamo hypophysial neurosecretory system in fish

UNIT IV

13. Anatomy and physiology of the pituitary gland
14. Anatomy and physiology of the thyroid gland
15. Pineal organ, interrenal tissue and caudal neurosecretory system
16. Seasonal cycles of male and female gonads

UNIT V

17. Hormonal control of reproduction
18. Environmental control of reproduction
19. Early development of a teleost
20. Parental care in fish

Suggested Readings:

S.No.	Name/Title	Author	Publisher
1.	Classification of fishes	Leo.S.Berg	fossilized & Recent
2.	Fish Biology	Francis day	Vol I & II Fishes of India.
3.	An aid to classification of Fishes	Gopalji Shrivastava	Indian of fishes of U.P.& Bihar
4.	Identification of fishes	B.Qurashi:. W.D.Rusell:.	Aquatic Productivity

Course Code	ZOO611-18
Course Title	Genetics, Cytogenetics, Development and Differentiation Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	In inculcate in students the knowledge of genes and chromosomes and also aware those to different stages of development in animals.

Syllabus

List of Experiments

1. Culturing of *E. coli* on solid and liquid media
2. Examination of wild type (male and females) and mutant of *Drosophila*
3. Monohybrid and Di-hybrid crosses in *Drosophila melanogaster*
4. Study of Meiosis in Grasshopper testes by squashing method
5. Temporary squash preparation of polytene chromosomes from salivary gland of *Drosophila/Chironomous* larva
6. Preparation of human karyotype
7. Study of permanent slides of following
 - 4.1. Inversions in polytene chromosomes of *Drosophila*
 - 4.2. G-Banded and C-banded metaphase chromosomes
8. Study of frog embryonic development through models
9. Study of electron micrographs of spermatogenesis and oogenesis
10. Study of permanent slides of chick and frog gonads and embryology
11. Whole mount preparation of chick embryo development

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO613-18A
Course Title	General Entomology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To demonstrate and perform dissection of insects to aware students about the various types of systems and their functions

Syllabus

List of Experiments

1. Dissection / demonstration of insect organ systems (nervous, digestive, reproductive, neuroendocrine) in insects like grasshopper, cricket, cockroach, wasp, honey bee, insect larvae.
2. Preparation of permanent stained mounts of insects, their body parts and dissected organs.
3. Study of permanent slides of insects, their body parts, organs and histological preparations
4. Study of insect specimens showing colouration, mimicry, light production, polymorphism, sound production and reception and other morphological modifications
5. Physiological experiments in insects like extirpation and implantation of endocrine organs, parabiosis, ligation of dipteran/lepidopteran larvae, preparation of isolated abdomen demonstration of digestive enzymes, excretory products etc.
6. Microtomy of insect material
7. Biochemical analyses like chitin test, demonstration of cuticular lipids
8. Estimation of total proteins, SDS PAGE of haemolymph proteins

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO613-18B
Course Title	Comparative Endocrinology and Endocrine Physiology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give practical demonstration to the students about the different endocrine glands in animals. Also make them aware about some techniques used for the study of endocrine cells.

Syllabus

List of Experiments

1. Dissection of endocrine glands in vertebrate and invertebrates (suitable insect such as cockroach, grasshopper, dipteran larvae)
2. Determination of proteins, /cholesterol/ sugar level using spectrophotometer
3. Separation of plasma proteins using electrophoresis
4. Microtomy of endocrine material (tissue fixation, processing, paraffin block preparation, sectioning, staining and mounting)
5. Study of slides of endocrine material from different animals
6. Identification of chemical structures of peptides and steroid hormones
7. Study of electron micrographs related to endocrinology
8. Estimation of hormones in blood
9. Study of Comparative structure of endocrine glands of selected vertebrates and invertebrates

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO613-18C
Course Title	Fish biology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To give practical demonstration to the students about the different Anatomy of various organ systems and mounting of fish material.

1. Anatomy of various organ systems and mounting of fish materials
2. Cranial nerves of teleost fishes: *Wallago*, *Mystus*, *Labeo* and other fishes
3. Osteology of fish: Scoliodon, carps, catfishes, murrels etc.
4. Accessory respiratory organs of air breathing fish
5. Study of histological (permanent) slides
6. Study of museum specimens of the concerned group

SCHEME OF PRACTICAL EXAMINATION

- | | |
|--|----|
| 1. Dissection with display and diagram | 20 |
| 2. Fish physiological exercise related to digestion respiration osmoregulation and colour change | 10 |
| 3. Minor dissection with display and diagram | 10 |
| 4. Mounting/skeletal preparation 02 | 10 |
| 5. Spotting (museum specimens-3, histological slides-3, bones-3) | 30 |
| 6. <i>Viva voce</i> | 10 |
| 7. Practical record | 10 |

TOTAL MARKS	100
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DURATION (HOURS)	06
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Course Code	ZOO602-18
Course Title	Animal Behavior
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To understand how animals behave and interact with their surrounding environment. What changes they made to adopt themselves in nature.

Syllabus

UNIT-I

Introduction: Ethology as a branch of biology; Analysis of behaviour (ethogram); Reflexes and complex behaviour; **Perception of the environment:** mechanical, electrical, chemical, olfactory, auditory and visual

UNIT-II

Communication: Chemical, visual, light and audio, evolution of language (Primates), **Ecological aspects of behaviour:** Habitat selection, food selection, optimal foraging theory, anti-predator defenses, aggression; Homing, Behaviour, dispersal, host-parasite relations; **Biological rhythms:** Circadian and circannual rhythms

UNIT-III

Orientation and Navigation; Migration of fishes, turtles and birds; **Learning and memory:** Conditioning, habituation, insight learning, association learning, Reasoning; Reproductive behaviour. Evolution of sex, mating and courtship behaviour, sexual selection and parental care

UNIT-IV

Social behaviour: aggregations, schooling in fishes, flocking in birds, herding in mammals, group selection, kin selection, altruism, reciprocal altruism, inclusive fitness; Social organization in insects; Social Organization in primates; Neural and hormonal control of behaviour; Bioluminescence

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Ethology: The biology of Behaviour	Eibl-Eibesfeldt, I	Holt, Rinehart & Winston
2	Behavioural Ecology	Krebs and Davies	Blackwell, Oxford
3	Principles of Animal Communication	Bradbury & Vehrencamp	Sinauer Assoc. Sunderland Massachusetts, USA
4	Animal Behaviour	Reena Mathur	Rastogi Publications
5	Animal Behaviour (Ethology)	Agrawal A.K.	S. Chand Publ.

Course Code	ZOO604-18
Course Title	Introduction to Immunology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To aware students about the internal defense mechanism of our body against different pathogens. Also aware them about the different types of cells which keep animals away from different diseases.

Syllabus

UNIT-I

Innate and acquired immunity; Cells of immune system and their differentiation; Antigenicity and immunogenicity, factors influencing immunogenicity, epitopes and haptens; Structure and functions of antibodies: Classes and subclasses, gross and fine structure, antibody mediated effector functions

UNIT-II

Antigen-antibody interactions: Antibody affinity and avidity, gross reactivity, agglutination; **Major histo-compatibility complex:** MHC haplotypes, class-I and class-II molecules, cellular distribution, peptide binding, expression and diversity; **T-cell receptors:** Isolation, molecular components and structure, T-cell maturation and thymus, T-cell activation mechanism, T-cell differentiation, cell death and T-cell population

UNIT-III

B-cell generation, activation and differentiation: B-cell receptors, selection of immature and self-reactive B-cells, B-cell activation and proliferation, T-B- cell interactions. **Cytokines:** Structures and functions, cytokine receptor, cytokines and immune response; **Complement system:** Complement activation & biological consequences; **Cell-mediated effector functions:** Cell adhesion molecules, effector cells and molecules; **CTL and NK cells-** mechanisms of action, delayed type hypersensitivity

UNIT-IV

Vaccines: Types of vaccines, active and passive immunization; Primary immunodeficiency, secondary or acquired immunodeficiency (AIDS); **Transplantation:** Immunological basis of graft rejection, general and specific immunosuppressive therapy

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Immunology	Kuby	W.H. Freeman, USA
2	Fundamentals of Immunology	Paul, W	L. Williams & Wilkins
3	Essentials Immunology	Roitt, I.M	ELBS edition
4	Immunology: Essential and Fundamental	Pathak & Palan	Anshan Ltd

Course Code	ZOO606-18A
Course Title	Insect Taxonomy, Ecology and Development
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To awake students about the diversity of insect and their taxonomic positions. Also help them to understand how different organs in insect develops.

Syllabus

UNIT-I

Insecta: Salient features, scheme of classification; Classification of **Apterygota** with distinctive feature, example of various orders and their sub divisions; Classification of **Exopterygota** upto orders with distinguishing characters and examples; Classification of the **Dictyoptera** upto families with distinguishing characters and examples; Classification of the **Orthoptera** upto families with distinguishing characters and examples

UNIT-II

Classification of the **Hemiptera** upto families with distinguishing characters and examples; Classification of the **Isoptera** upto families with distinguishing characters and example; Classification of the **Odonata** upto families with distinguishing characters and examples; Classification of the **Thysanoptera** upto families with distinguishing characters and examples

UNIT-III

Classification of **Endopterygota** upto orders with distinctive features and examples; Classification of the **Lepidoptera** upto families with distinguishing characters and examples; Classification of the **Diptera** upto families with distinguishing characters and examples; Classification of the **Hymenoptera** upto families with distinguishing characters and examples; Classification of the **Coleoptera** upto families with distinguishing characters and examples

UNIT-IV

Social organization in termites; Social organization in honey bees; Structure of insect eggs, development of upto formation of germ bands; Development and fate of embryonic membranes; Metamorphosis in insects; Insect diapause

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Imm's Text book of Entomology	Richards and Davies	Methuen and Co., London
2	Principles of Insect Morphology	Snodgrass, R.E	Tata MaGraw Hill's Bombay
4	The Insects – Structure and Function	Chapman, R.F.	ELBS, London
5	General and Applied Entomology	Nayar et al.	Tata MacGraw Hill
6.	A Text book of Entomology	Ross, H.H	John Wiley & Sons

Course Code	ZOO606-18 B
Course Title	Male Reproductive Endocrinology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To provide the knowledge of structure and functions of male sex organs

Syllabus

UNIT-I

Testes and Genital duct: Differentiation of the testes and male genital ducts; Histology of testes, epididymis, vasdeferens and seminal vesicles; Ultrastructure of testes; **Male gamete:** Structure and ultrastructure of mammalian sperm

UNIT-II

Blood – testis barrier; Hormonal regulation and Spermatogenic function of the testis **Sertoli cells:** Structure and functional significance of Sertoli cells; **Leydig cells:** Structure and functional role of Leydig cells

UNIT-III

Metabolism and biosynthesis of androgens; Biochemistry of semen; Maturation, transport and fate of spermatozoa in epididymis; Capacitation of spermatozoa

UNIT-IV

Endocrine physiology of epididymis and seminal vesicles; Structure and function of coagulating glands, prostatic complex and Couper's gland; Sperm motility; Contraception through male; Biological aspects of vasectomy; Male infertility

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	General Endocrinology	Turner & Bagnara	W.B. Saunders
2	Comparative Vertebrate Endocrinology	Bentley, P.J	Cambridge Univ.
3	Hand book of Physiology: Male Reproduction	Greep, R.O.	American Society
4	Hand book of Physiology: Female Reproduction	Greep, R.O.	American Society
5	Endocrinology	Hadley	

Course Code	ZOO606-18C
Course Title	Taxonomy, systematics and ecology of fishes
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To aware students about the internal defense mechanism of our body against different pathogens. Also aware them about the different types of cells which keep animals away from different diseases.

Syllabus

UNIT I

1. Outline classification of fishes as proposed by Berg
2. Classification of Elasmobranchii
3. Classification of Crossopterygii
4. Classification of Actinopterygii

UNIT II

5. Systematic survey of fish with particular reference to inland fishes of M.P.
6. Exotic fishes and their importance
7. Larvicidal fishes and their importance in public health
8. Predatory fishes and their significance in fish culture

UNIT III

9. Working and maintenance of fish aquarium
10. Fish nets and gears and methods of fishing
11. Fish diseases, symptoms and treatment
12. Common weeds of fish ponds and their control
13. Fish parasites and their control

UNIT IV

14. Physico-chemical characteristics of fish pond
15. Biological characteristics of fish pond
16. Culturable species of fishes of inland water and basis of their selection
17. Plankton and their significance in fish culture

UNIT V

18. Primary productivity of fish ponds and its significance
19. Aquatic macrophytes and culture of *Azolla*
20. Aquatic algae and culture of *Spirulina*
21. Sea weeds and their significance

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1.	Classification of fishes	Leo.S.Berg	fossiliged & Recent
2.	Fish Biology	Francis day	Vol I & II Fishes of India.
3.	An aid to classification of Fishes	Gopalji Shrivastava	Indian of fishes of U.P.& Bihar
4.	Identification of fishes	B.Qurashi:. W.D.Rusell:	Aquatic Productivity

Course Code	ZOO608-18 A
Course Title	Applied Entomology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To inculcate the knowledge of some important insects to the students and their role in economic development of humans. Also provide them with the knowledge of some pest in different crops so that we can make necessary preparations for their control.

Syllabus

UNIT-I

Apiculture and beekeeping: Classification of honey bees, life history of honey bee, social organization in honeybees; products of apiculture industry and its uses; **Lac Culture;** **Sericulture:** Definition, Types of sericulture; life cycle of silkworm (*Bombyx mori*), silkworm rearing technology; Role of insects in plant pollination; **Insects pests:** Classification and categories of pests, pest out breaks and pest resurgence

UNIT-II

Structure, life history, significance, nature of damage and control methods of following pests of **sugarcane:** (a) *Scirpophaga* (b) *Chilo tritaceae* (c) *Pyrilla* (d) *Aleurolobus*; Structure, life history, significance, nature of damage and control methods of following **cotton pests:** (a) *Sylepta* (b) *Erias* (c) *Pectinophara* (d) *Dysdercu*; Structure, life history, significance, nature of damage and control measures of following **general pests:** (a) grasshoppers & locusts (c) termites (d) aphids (e) hairy caterpillars; **Household pests** (cockroaches, crickets, ants, wasps, silverfish, cloth's moth, carpet beetle, furniture beetle, book lice, cigarettes beetles and their control

UNIT-IV

Role of insect as vectors of human diseases; Mosquitoes as pests of public health importance and their control; **Housefly:** A human health hazard and its control; **Live-stocks pests** and their control; Different measures of insect pest control.

UNIT-V

Detailed information and classification of insecticides and their mode of action Biological pest control; Integrated pest management; **Account of the following:** (a) Catalysts and synergists of insecticides (b) Systemic insecticides (c) Antifeedants (d) Attractants and repellents (e) Aerosols (f) Biopesticides (g) Microbiol insecticides (h) Male sterility techniques (i) IGRs, third & fourth generation pesticides (j) Chitin synthesis inhibitors

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Imm's Text book of Entomology	Richards and Davies	Methuen and Co., London
2	Principles of Insect Morphology	Snodgrass, R.E	Tata MaGraw Hill's Bombay
3	Introduction to Comparative Entomology	Fox and Fox	Reinhold Publishing Corporation
4	The Insects – Structure and Function	Chapman, R.F.	ELBS, London
5	General and Applied Entomology	Nayar et al.	Tata MacGraw Hill
6.	A Text book of Entomology	Ross, H.H	John Wiley & Sons

Course Code	ZOO608-18 B
Course Title	Female Reproductive Endocrinology
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To provide the students' knowledge of female reproductive organs and their role in development of fetus during pregnancy.

Syllabus

UNIT-I

Differentiation of the ovary and female genital ducts; Histology of ovary, uterus, cervix and vagina; Ultrastructure of ovum; Estrous cycle in mammals; Menstrual cycle in primates; Endocrine control of structure and function of mammalian oviduct

UNIT-II

Oviducal fluid: composition and physiology; **Puberty** and its hormonal control; **Implantation** and its hormonal regulation; **Pregnancy** and its hormonal regulation; Hormonal regulation of parturition

UNIT-III

Lactation and its regulation; **Placenta:** Fine structure and types; Placental hormones and their significance; **Corpus luteum** and its functional significance; **Prostaglandins** and their role in reproduction

UNIT-IV

Physiological role of ovarian steroidal hormones; Chemistry and functions of human chorionic gonadotropin; Delayed implantation and its mechanism; Control of fertility in females

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	General Endocrinology	Turner & Bagnara	W.B. Saunders
2	Comparative Vertebrate Endocrinology	Bentley, P.J	Cambridge Univ. Press
3	Hand book of Physiology (VOL. 6): Male Reproduction	Greep, R.O.	American Phy. Society
4	Hand book of Physiology (VOL. 7): Female Reproduction	Greep, R.O.	American Phy. Society
5	Endocrinology	Hadley, M.E	

Course Code	ZOO608-18 C
Course Title	Pisciculture and economic importance of fishes
Type of course	Theory
L T P	4 0 0
Credits	4
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To inculcate the knowledge of some important insects to the students and their role in economic development of humans. Also provide them with the knowledge of some pest in different crops so that we can make necessary preparations for their control.

Syllabus

UNIT I

1. Collection of fish seed from natural resources
2. Dry bundh breeding of carps
3. Wet bundh breeding of carps
4. Hypophysation and breeding of Indian major carps
5. Drugs useful in induced breeding of fish

UNIT II

6. Types of ponds required for fish culture farms
7. Management of hatcheries, nurseries and rearing ponds
8. Management of stocking ponds
9. Composite fish culture
10. Integrated fish culture in India

UNIT III

11. Fresh water and brackish water Prawn culture in India
12. Pearl Oysters and pearl culture in India
13. Edible Oysters and Oyster culture in India
14. Methods of fish preservation
15. Marketing of fish in India

UNIT IV

16. Economic importance and by-products of fishes
17. Shark liver oil industry in India
18. Transport of live fish and fish seed
19. Fisheries and prawn resources of M.P.

UNIT V

20. Riverine fisheries in India
21. Coastal fisheries in India
22. Offshore and deep sea fisheries in India
23. Role of fisheries in rural development
24. Fishery co-operative societies and their role in development of fisheries

Suggested Readings:

S.No.	Name/Title	Author	Publisher
1	The Physiology of Fishes. Vol. I & II.	Brown, M.E	Academic Press, New York.
2	Ichthyology	Lagler, K.F. Bardach, J.E., Miller, R.R. and Passino, D.R.M..	John Wiley & Sons, New York
3	Fish Physiology Vol.1-16	Hoar and Randall	Academic Press, New York
4	The Ecology of Fishes	Nikolsky, G.V..	Academic Press, New York

Course Code	ZOO612-18
Course Title	Animal Behavior and Vertebrate Immunology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To perform some experiment by which students may able to understand the Behaviour of animals. Also find-out the role played different types of body cell in defense mechanism of body.

Syllabus

List of Experiments

- Experiments on animals Behaviour:
Exploratory Behaviour in rats / mice; **Parental care** in rats / mice; **Burrowing Behaviour** of blowfly larvae; **Phototactic Behaviour** of blowfly larvae; **Burrowing & geonegative Behaviour** of earthworms
- Blood film preparation and identification of cells
- Lymphoid organs & their microscopic organization
- Study of antigen-antibody interaction
- Immunodiffusion
- Immunoelectrophoresis
- ELISA
- Immunocytochemistry
- Immunodiagnosis (demonstration using commercial kits)

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO614-18A
Course Title	Insect Taxonomy, Ecology, Development & Applied Entomology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	To help students in identification of different types of Insects and also help them in finding different types of methods for control of pests in crops

Syllabus

List of Experiments

1. Insect collection and preservation for systematic studies
2. Identification of different insects upto orders
3. Identification of insects upto families of economically important insect orders
4. Identification of insects upto species: Mosquitoes, honeybees, stored grain beetles, aquatic insects, important crop and household pests
5. Analysis of honey and its quality control
6. Field studies of insects to understand their habit, habitat environmental impact, beneficial and harmful activities etc.
7. Study of beneficial insects, benefits derived from them and useful products
8. Study of destructive insects, damage caused by them and damaged products
9. Study of insecticidal formulations and insect control appliances
10. Experiments on insect control like LC-50 /LD-50, knock down and recovery effect, repellency/antifeedance tests, percentage damage tests for leaf eating insects, and stored grain pests

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications

Course Code	ZOO614-18 B
Course Title	Reproductive Endocrinology Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	Practically demonstrate the internal structure of reproductive organs to students, so that they may be able to see the different types of cells.

Syllabus

List of Experiments

1. Dissection of various reproductive glands in vertebrates
2. Operations in male rats, castration, vasectomy
3. Operations in female rats, ovariectomy, hysterectomy, tubectomy; adrenalectomy, thyroidectomy, laparotomy
4. Preparation of vaginal smear, identification and staining with Papeniculaou stain
5. Preparation of sperm smear and classification of types of sperms with abnormalities
6. Confirmation of pregnancy in urine using antibody method
7. Separation of steroidal hormones; using thin layer chromatography
8. Identification of permanent slides of reproductive organs
9. Identification of chemical structures of steroidal hormones

Text and Reference Books:

S.No.	Name/Title	Author	Publisher
1	Practical Zoology Vertebrates	S.S. Lal	Rastogi Publications
2	Lab Manual of Blood Analysis and Medical Diagnostics	Prakash G	S. Chand Publications
3	A Manual of Practical Zoology Invertebrates	P.S. Verma	S. Chand Publications
4	Textbook of Medical Laboratory Technology	Godkar P.B. and Godkar D	Bhalani Publishing House

Course Code	ZOO614-18 C
Course Title	Fish biology and fisheries Practical
Type of course	Practical
L T P	0 0 4
Credits	2
Course prerequisite	B.Sc. Non Medical or B. Sc. Medical with Zoology as main subject
Course Objective	Practically demonstrate the internal structure of reproductive organs to students, so that they may be able to see the different types of cells.

- Systematic identification of freshwater fishes with particular reference to M.P.
- Age determination with the help of scales / otolith
- Pigmentary behaviour in fish
- Qualitative zooplankton analysis
- Nutrient analysis of water
- Analysis of gut contents
- Microtomy of fish materials

SCHEME OF PRACTICAL EXAMINATION

1. Systematic identification of fishes (5) up to species	20
2. Identification of zooplankton /age determination (scales & otolith)	15
3. Analysis of nutrients/maturity stage of fish	15
4. Microtomy of fish material (sectioning of wax blocks, stretching, & double or triple staining)	20
5. <i>Viva -voce</i>	10
6. Practical Record, project report, exertions report etc.	10
7. Seminar	10

TOTAL MARKS	100
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DURATION (HOURS)	06
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