

Sardar Patel University Mandi

District Mandi -175001 (HP) India

www.spumandi.ac.in

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Syllabus for M.Sc. Zoology

2 Years (CBCS)

Session 2022-23 Onwards

Faculty of Life Sciences

Sardar Patel University Mandi (HP)

M.Sc. ZOOLOGY
TWO-YEARFULL-TIMEPROGRAMME

PROGRAMMESTRUCTURE

The M.Sc. Programme is divided into two Parts as under. Each part will consist of two Semesters as given below:

		Semester-Odd	Semester-Even
Part I	First Year	Semester –1	Semester –2
Part II	Second Year	Semester –3	Semester –4

Semesters I and II (Part I) shall have Core Papers to be studied by all students of the M.Sc. Zoology programme. Semesters III and IV (Part II) would comprise Optional Papers from which each student would have to select the papers from pool. In Semester IV there shall be specialization in which students has to opt one specialization out of total offered by the department and study two courses of that. Allotment of specialization shall be on the basis of merit/choice It is mandatory for each student to complete a project, assigned in beginning of 3rd semester and goes on until 4th semester.

SCHEME OF EXAMINATIONS

- Examination shall be conducted at the end of each semester as per the Academic Calendar/Date Sheet notified by the University.
- The program description is as under:

(i)	Internal Assessment	40 marks
(a)	Mid Term Exam I + Attendance	15+5= 20marks
(b)	Mid Term Exam II + Attendance	15+5 = 20 marks
(ii)	End-Semester Examination	40 marks
(a)	Theory Examination	40 marks
(b)	Practical Examination (Execution-12, Viva-05, Record-03)	20 marks
	Grand Total	100 Marks

- The system of evaluation shall be as follows:
 - Internal assessment will be broadly based on attendance in Theory and Practical's (5marks), assignments, seminars and tests in the theory component. These criteria are tentative and could be modified based on guidelines approved by the board of studies.
 - As regards project, the scheme of evaluation shall be as follows:
 - Project work would be assigned in the beginning of 3rd Semester to enable students to initiate work on the same.
 - It would formally begin from Semester III and shall be theoretical/filed based in nature.
 - There shall be a viva-voce examination (conducted by a board of faculty

members) at the end of Semester IV on the project work that shall be evaluated for 02 credits/50marks.

4. Examinations for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examinations.
5. The students have to attain 100% credits (100 credits) as mentioned in scheme to get master degree in Zoology (MSC Zoology).
6. Code MZOO stands for M – Masters, ZOO - Zoology

COURSE EVALUATION (EVALUATION OF THE STUDENTS)

All courses (Core and Elective) involve an evaluation system of students that has the following two components:

- (i) Continuous Comprehensive Assessment (CCA) accounting for 50% of the final grade that a student gets in a course; and
- (ii) End-Semester Examination (ESE) accounting for the remaining 50% of the final grade that the student gets in a course.
- (i) Continuous Comprehensive Assessment (CCA): This would have the following components:
 - (a) Classroom Attendance – Each student will have to attend a minimum of 75% Lectures / Tutorials / Practical's. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE).
 - Provided that those having between 74% and 65% attendance will apply for exemption in a prescribed form accompanied by clear reason(s) for absence to the authorized functionaries.
 - Provided that those having between 64% and 50% attendance will apply for exemption in a prescribed form accompanied by a Medical Certificate from a Government Hospital.
 - Provided that exemption from 75% attendance will be given to those participating in prescribed co-curricular activities (e.g. NCC, NSS, Youth Festivals, Sports etc.) to the extent of 25% (making the necessary attendance as 50% in these cases). However, the claim for this exemption should be supported by authenticated certificate from the concerned college / University authorities.
 - Provided further that those getting the exemptions, except for those getting exemptions for co-curricular activities, will not be entitled for getting the CCA marks for classroom attendance as given below.

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:

> 75% but < 80%	1 marks
80% to 85%	2 marks
> 85 but < 90%	3 marks
90% to 95%	4 marks
> 95%	5 marks

- (b) **Mid-Term (Minor) Tests:** There will be two mid-term tests, first after 40 teaching days (8 weeks) covering the syllabus covered so far, and second after 80 teaching days (16 weeks) covering the syllabus after the first minor test. Each of these mid-term tests will be for 15 marks.
- (c) **Seminar / Assignment / Term Paper:** The remaining 15 marks of the CCA will be awarded on the basis of seminar / assignment / term paper etc. that the course teacher might give to

the students. At least one such seminar / assignment / term paper will have to be done in a semester course.

- (d) **End-Semester Examination (ESE)**: The remaining 50% of the final grade of the student in a course will be on the basis of an end-semester examination (ESE) that will be for three hours' duration and will be covering the whole syllabus of the course.

PROMOTIONCRITERIA

SEMESTER TO SEMESTER: Students shall be required to fulfill the Part to Part Promotion Criteria. Within the same Part, students shall be allowed to be promoted from a Semester to the next Semester, provided she/he has passed at least half of the courses of the current semester.

PART I TO PART II: Admission to Part II of the programme shall be open to only those students who have successfully passed at least 75% papers out of papers offered for the Part I courses comprising of Semester-1 and Semester-2 taken together. However, she/he will have to clear the remaining papers while studying in Part-II of the programme.

M. Sc. Zoology (2022-23 onwards)
COURSE SCHEME - CHOICE BASED CREDIT SYSTEM (CBCS)

COURSE CODE	COURSE NAME	L+T+P	CREDITS
SEMESTER I			
MZOO-101	Biosystematics and Taxonomy	3+1+0	4
MZOO-102	Cell and Molecular Biology (Common course with MBOT-102)	3+1+0	4
MZOO-103	Biochemistry and Metabolism (Common course with MBOT- 103)	3+1+0	4
MZOO-104	Tools and Techniques in Biological Sciences (Common course with MBOT- 104)	3+1+0	4
MZOO-101 (P)	Biosystematics and Taxonomy-Practical	0+0+2	2
MZOO-102 (P)	Cell and Molecular Biology-Practical	0+0+2	2
MZOO-103 (P)	Biochemistry and Metabolism-Practical	0+0+2	2
MZOO-104 (P)	Tools and Techniques in Biological Sciences-Practical	0+0+2	2
TOTAL CREDITS			24
SEMESTER II			
MZOO-201	Structure and Functions of Invertebrates& Vertebrates	3+1+0	4
MZOO-202	Ecology & Environment (Common course with MBOT-202)	3+1+0	4
MZOO-203	Cytogenetics and Evolution (Common course with MBOT-203)	3+1+0	4
MZOO-204	Biostatistics and Bioinformatics (Common course with MBOT-204)	3+1+0	4
MZOO-201 (P)	Structure and Functions of Invertebrates& Vertebrates-Practical	0+0+2	2
MZOO-202 (P)	Ecology & Environment-Practical	0+0+2	2
MZOO-203 (P)	Cytogenetics and Evolution-Practical	0+0+2	2
MZOO-204 (P)	Biostatistics and Bioinformatics-Practical	0+0+2	2
TOTAL CREDITS			24
SEMESTER III			
MZOO-301	Insect Diversity and Physiology	3+1+0	4
MZOO-302	Animal Physiology	3+1+0	4
MZOO-303	Protein Structure, Function and Evolution	3+1+0	4
MZOO-304	Mammalian Neurobiology	3+1+0	4
MZOO-305	Biology of Parasites	3+1+0	4
MZOO-306	Disease Biology	3+1+0	4
MZOO-307	Limnology	3+1+0	4
MZOO-308	Animal Behaviour	3+1+0	4
MZOO-301(P)	Insect Diversity and Physiology-Practical	0+0+2	2
MZOO-302(P)	Animal Physiology-Practical	0+0+2	2
MZOO-303(P)	Protein Structure, Function and Evolution - Practical	0+0+2	2
MZOO-304(P)	Mammalian Neurobiology	0+0+2	2
MZOO-305(P)	Biology of Parasites-Practical	0+0+2	2
MZOO-306(P)	Disease Biology-Practical	0+0+2	2
MZOO-307(P)	Limnology-Practical	0+0+2	2
MZOO-308(P)	Animal Behaviour-Practical	0+0+2	2
TOTAL CREDITS			24
NOTE: SELECT TWO COURSES OF THEORY AND TWO COURSES OF PRACTICAL OUT OF MZOO- 303 TO MZOO- 308			

SEMESTER IV			
MZOO-401	Developmental Biology	3+1+0	4
MZOO-402	Applied Zoology	3+1+0	4
MZOO-401(P)	Developmental Biology-Practical	0+0+2	2
MZOO-402(P)	Applied Zoology-Practical	0+0+2	2
SPECILIZATIONS			
MZOO-403	ENTOMOLOGY		
MZOO-403(i)	Advance Topics in Entomology	3+1+0	4
MZOO-403(ii)	Medical Entomology and Vector Biology	3+1+0	4
MZOO-403(i)(P)	Advance Topics in Entomology -Practical	0+0+2	2
MZOO-403(ii)(P)	Medical Entomology and Vector Biology-Practical	0+0+2	2
MZOO-404	FISH AND FISHERIES		
MZOO-404(i)	Fish and Fisheries-I	3+1+0	4
MZOO-404(ii)	Fish and Fisheries-II	3+1+0	4
MZOO-404(i)(P)	Fish and Fisheries-I- Practical	0+0+2	2
MZOO-404(ii)(P)	Fish and Fisheries-II- Practical	0+0+2	2
MZOO-405	CYTOGENETICS		
MZOO-405(i)	Cytogenetics-I	3+1+0	4
MZOO-405(ii)	Cytogenetics-II	3+1+0	4
MZOO-405(i)(P)	Cytogenetics-I- Practical	0+0+2	2
MZOO-405(ii)(P)	Cytogenetics-II- Practical	0+0+2	2
MZOO-406	BIODIVERSITY AND WILDLIFE		
MZOO-406(i)	Biodiversity and Wildlife-I	3+1+0	4
MZOO-406(ii)	Biodiversity and Wildlife-II	3+1+0	4
MZOO-406(i)(P)	Biodiversity and Wildlife-I- Practical	0+0+2	2
MZOO-406(ii)(P)	Biodiversity and Wildlife-II- Practical	0+0+2	2
MZOO-407	ANIMAL PHYSIOLOGY		
MZOO-407(i)	Molecular Physiology	3+1+0	4
MZOO-407(ii)	Comparative Endocrinology	3+1+0	4
MZOO-407(i)(P)	Molecular Physiology-Practical	0+0+2	2
MZOO-407(ii)(P)	Comparative Endocrinology-Practical	0+0+2	2
MZOO-408	PARASITOLOGY		
MZOO-408(i)	Parasitology	3+1+0	4
MZOO-408(ii)	Medical Parasitology	3+1+0	4
MZOO-408(i)(P)	Parasitology- Practical	0+0+2	2
MZOO-408(ii)(P)	Medical Parasitology- Practical	0+0+2	2
MZOO-409	Project Report**	4	4
TOTAL CREDITS			28
NOTE: SELECT ONE SPECIALIZATION WITH TWO COURSES OF THEORY ALONG WITH THEIR PRACTICAL OUT OF MZOO-403 TO MZOO- 408			
GRAND TOTAL (I+ II + III + IV)			100

M.Sc. Zoology
SEMESTER-I
BIOSYSTEMATICS AND TAXONOMY
COURSE CODE: MZOO-101

Definition and basic concepts of Biosystematics and taxonomy

Historical resume of systematic
Stages in taxonomy
Importance of taxonomy
Aims and tasks of a taxonomist

**Trends in Biosystematics-
concepts of different conventional and newer aspects**

Ecotaxonomy
Behavioural taxonomy
Cytotaxonomy
Biochemical taxonomy
Numerical taxonomy

Species concept and modes of speciation

Typological species concept
Biological species concept
Evolutionary species concept
Polytypic & monotypic species, subspecies, intraspecific groups, super
species and other kind of species.

Concept of zoological classification

Theories of biological classification
Components of classification
Phyletic Lineages
Linnaean hierarchy

Taxonomic collections, methods & data recording

Collection methods and data collection
Preservation and curation
Methods of identification and problems in identification
Taxonomic characters and taxonomic keys
Preparation of taxonomic publication and kinds of publication
Ethics in publication

1. Zoological Nomenclature

International code of Zoological Nomenclature (ICZN)
Operative principles and important rules of nomenclature
Important Latin words & abbreviations and Linnaean Signs

Suggested Readings:

- Kato, M. The Biology of Biodiversity. Springer.
- Wilson, E. O. Biodiversity. Academic Press, Washington.
- Simpson, G. G. Principle of animal taxonomy. Oxford IBH Publishing company.
- Mayer, E. Elements of Taxonomy. Oxford & IBH Publishing company.
- Wilson, E. O. The diversity of Life (The College edition W.W. Norton)

&Co.

- Tikadar, B. K. Threatened Animal of India, ZSI publication, Calcutta
- Kapoor, V. C. The Theory and Practice of Animal Taxonomy. Oxford & IBH Publishing Co.
- Avise, J.C. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
- Narendran, T. C. An Introduction to Taxonomy. Zoological Survey of India

Practical Exercises

Biosystematics and Taxonomy

- Techniques of collection and preservation with respect to insects and fishes.
- To prepare identification keys of various animal groups.
- To study external morphological features of various animal groups (beaks & claws, scales of fishes, wing venation and external genitalia of insects).
- Identification methods for insects, fishes, birds etc.
- Methods of describing common insects representing different orders, with particular reference to the recording of taxonomic characters.
- To prepare insect box.

M.Sc. Zoology
SEMESTER-I
CELL AND MOLECULAR BIOLOGY
COURSE CODE: MZOO-102

Structural Organization of Plant and Animal Cell

Cell wall: structure, function and biogenesis. Plasma membrane; structure, models, functions, principles of membrane transport; types of carrier proteins and active membrane transport (Na^+ and K^+ pump, Ca^{++} pump, H^+ pump); Ion channels. Plasmodesmata: structure, role in movement of molecules, comparison with gap junctions, role and functions of cadherin's and selectins. Plant vacuole: Tonoplast membrane, ATPase storage organelle. Structure and functions of micro bodies: Golgi apparatus, lysosomes, endoplasmic reticulum. Transport from ER to Golgi and then to lysosomes; Molecular basis of endocytosis and exocytosis.

Chloroplast and mitochondria

Structure, genome organization, gene expression, nucleochloroplastic interactions, biogenesis of mitochondria.

Nucleus

Structure, nuclear pores, nucleosome organization, nucleolus.

The cytoskeleton

Organization and role of microtubules and microfilaments, motor movements. Implications in flagella and other movements.

Cell cycle and apoptosis

Control mechanisms, role of cyclins, cyclin-dependent kinases, cytokinesis and cell plate formation, mechanisms of programmed cell death and its regulation.

Cell signalling through

Protein tyrosine kinase receptors, JAK-STAT, camp, MAP kinase, NF-kB signalling pathways; insulin and Integrin signalling.

Cancer (progenitor cells, oncogenes, tumor suppressor genes) and therapeutic

interventions of uncontrolled cell growth.

Gene expression

Structure and types of DNA; replication, DNA damage and repair.

Transcription, promoters and transcription factors, splicing, mRNA transport, rRNA biosynthesis, differences in prokaryotes and eukaryotes.

RNA splicing: Nuclear splicing, spliceosome and small nuclear RNAs.

Translation; structure of ribosome, mechanism of translation initiation, elongation and termination, structure and role of tRNA.

Regulation of gene expression

In prokaryotes (Run off transcription, Britten-Davidson and Mated models of gene regulation) and eukaryotes.

Protein sorting

Targeting of proteins to organelles.

Suggested Readings:

- Alberts, B. (2008). Molecular Biology of the Cell. Garland Science.
- Alberts, B. Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1999,

- Molecular biology of the cell. Garland Publishing, Inc. New York.
- Benjamin Lewin (2000) Genes VII. Oxford Univ. Press, Oxford.
 - Berg, J.M., Tymoczko, J.L., & Stryer, L. (2002). Biochemistry, Fifth Edition. W.H. Freeman.
 - Berridge, M.J. (2014) Cell Signalling Biology. Portland Press.
 - Bradshaw, R. A. and Dennis, E. A. (2003) Handbook of Cell Signaling. Vol. I, II and III. Academic Press.
 - Cooper, G. M., & Hausman, R. E. (2004). The Cell: A Molecular Approach. ASM Press.
 - Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
 - De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
 - Frifelder, D. Molecular Biology. John and Bartlett Publishers, inc., Boston, USA.
 - J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick (2004)
 - Molecular Biology of the Gene, 5th edn. Pearson Education Inc.
 - Karp, G. (2013) Cell and Molecular Biology: Concepts and Experiments. 7th edition. John Wiley & Sons. Inc.
 - Lewin, B. 2000. Genes VII Oxford University, Press, New York.
 - Lodish, H. (2008). Molecular Cell Biology. W. H. Freeman.
 - R. Basega. Cell Growth and Division. A Practical Approach., IRL Press, Oxford University.
 - Strachan T and Read AP (2004) Human Molecular Genetics, Garland Science.
 - Wolfe, S.L. 1993, Gruissem, W. and Jones, R.L. 2000, Biochemistry and molecular biology of plants, American society of plant physiologists, Maryland, USA

Practical Exercises

Cell and Molecular Biology

- Microscopy: Bright field, phase contrast and Fluorescence microscopy.
- Cell Isolation (plants and Animals), Microscopy and Micrometry: Fixed and live-cell imaging, Radioisotopes, Fluorescent Probes/Dyes as tools to study cellular functions, basics of FACS.
- Determining cell number using hem cytometer.
- Determining cell viability using Trypan blue staining and other cytotoxicity assays such as MTT assay, Alamar blue assay, LDH assay.
- Discuss methods used to transfect mammalian cells. Transfect cells with green fluorescent protein and visualize cells under the fluorescence microscope.
- Distribution of mammalian cells in different phases of cell cycle using flow cytometer.
- To study the chromosomes of different stages of mitosis (Onion root tip) and meiosis (Flower buds).
- Blood smear preparation and its analysis.
- Identifying apoptotic and necrotic cells by the cell staining procedure.
- Isolation of RNA from Blood/yeast.
- Plant DNA extraction using standard protocols

- Staining methods: Simple, negative, Acid fast, Gram staining, spore staining, capsule staining, lacto phenol cotton blue staining.

M.Sc. Zoology

SEMESTER-I

BIOCHEMISTRY & METABOLISM

COURSE CODE: MZOO-103

Biomolecules

Carbohydrates – Monosaccharides, disaccharides and polysaccharides

Proteins- Classification and structure, Amino acids classification and general characters. Lipids- classification and functions of lipids and fatty acids

Nucleic acids – purines, pyrimidines, nucleotides, structure of DNA & RNA and types of RNA, Biosynthesis and degradation of purines and pyrimidines.

Enzymes

Nomenclature and classification of enzymes, vitamins as co-enzymes; Enzyme Kinetics – Michaelis –Menten equation. Determination of V_{max} and K_m , Factors affecting the enzyme activity. Enzyme inhibition – Competitive & non-competitive

Mechanism of enzyme action – active sites, Chymotrypsin as a model, Regulation of enzyme activity, allosteric enzymes, PFK, ATC (Phosphofructokinase /Aspartate trans carbamylase)

Bioenergetics

Basic Principles of thermodynamics free energy, Enthalpy and Entropy. Redox Potential and electron transport. ATP- Production (Chemiosmotic model), high energy phosphates, Coupled reactions

Metabolism

Carbohydrate metabolism, - Glycolysis, Krebs cycle, pentose Phosphate pathway, Glycogenesis, Gluconeogenesis, hex monophosphate shunt. Protein metabolism – Transamination and deamination, incorporation of amino acids into TCA cycle, integration between urea cycle and TCA cycle. Lipid metabolism – fatty acid oxidation and biosynthesis, ketone bodies. Metabolic defects of carbohydrate and amino acid metabolism.

Secondary Metabolites

Biosynthesis and function of secondary metabolites phenolic, flavonoids, terpenoids, alkaloids, steroids. Importance of Acetyl Co.A and Shikimic acid in intermediary metabolism.

Suggested Readings:

- Zubay, G.1988, biochemistry(2nded), Macmillan Publ. House N.Y.
- Mahler, H.R. and codesF.H.1971.Biologicalchemistry, Harper International.
- Lehinger.A.L.1978, Biochemistry Kalyani Publishers, Ludhiana
- GoodwinT.W.adnMeriarL.E.I.1989IntroductoryplantBiochemistrypergam onPressVY.
- Conn, E.E. and Shimpap, P.K. 1976. Outlines of Biochemistry Wiley Eastern
- Styer, Biochemistry.
- Freifelder Molecular Biochemistry.

Practical Exercises

Biochemistry& Metabolism

- To perform qualitative test for analysis of carbohydrates.
- To determine the reducing sugar content in a given solution qualitatively.

- To determine glucose content in given solution spectro photo metrically.
- To determine the saponification value of given fats and oils.
- To determine acid number in a given fat or oil by qualitatively.
- To perform qualitative test for amino acid and proteins.
- To determine the amount of phenol in given solution.
- To determine the protein content by Lowry's method.
- To study the action of acid and alkali on starch.

M.Sc. Zoology
SEMESTER-I
TOOLS AND TECHNIQUES IN BIOLOGICAL SCIENCES
COURSE CODE: MZOO-104

Instrumentation in Biology

Centrifugation: Principle and applications of Centrifugation; differential and density gradient Centrifugation. Electrophoresis: Principle, structural components and applications of electrophoresis. Chromatography: Principle and applications of chromatography; adsorption, Ion exchange, gel permeation and affinity. Spectrophotometer: Principle, pH meter and applications of Spectrophotometer.

Microscopy and Histological techniques in Biology

Microscopy: Principle, and applications of different types of microscopes Light, Phase Contrast, SEM & TEM. Microtome: Types and applications. Collection & preservation of animal tissue – fixation, embedding, Sectioning, Staining, Identification of deferent components. Tissue preparation for light microscopy. Cryotechniques: History and applications of Cryotechniques, cryopreservation of cells, tissue, organisms.

Cell Culture Techniques

Cell Culture System, and History of development of cell culture. Culture media preparation and cell harvesting methods. Commonly used Cell Lines and their Uses. Design and functioning of tissue culture laboratory.

Radiolabelling Techniques and Methods in Field Biology

Detection and measurement of different types of radioisotopes normally used in biology, Molecular imaging of radioactive material Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations. Sampling methods in the study of behaviour, habitat characterization: ground and remote sensing methods

Suggested Readings:

- inciples and Techniques in biochemistry and molecular biology - Wilson &Walkes
- Culture of animal cells – Freshuay
- Sharma V.K. (1991), Techniques in microscopy and cell Viology, Tata-Mc Craw Hil.
- Robert Braun Introduction to instrumental analysis - Mc.Crew.Hil
- Bisen&Mathw. Tools and Techniques in Life Sciences,- CBS Publishers & distributors.
- Principles of Animal Cell Culture - Basant Kumar &Rinesh Kumar, Int.Bork 2008,XXII edn.

Practical Exercises

Tools and Techniques in Biological Sciences

- Separation of cell organelles by Differential centrifugation.
- Separation of protein by electrophoresis (Native & SDS page).
- Separation of amino acids, etc. by paper and thin layer Chromatography
- Demonstration of column Chromatography.
- Validation of Beer-Lambert's law of a colored compound (CuSO_4).
- Measurement of pH meter and preparation of buffer.
- Light microscope and its parts observation of unstained and stained cells.
- Demonstration of a fixation, dehydration, sectioning and staining of any animal tissue.
- Demonstration of Carbohydrates, Proteins Lipids and nuclear acids in tissue sections.
- Preparation of chick fibroblast culture and viability testing.

M.Sc. Zoology

SEMESTER-II

STRUCTURE AND FUNCTIONS OF INVERTEBRATES AND VERTEBRATES

COURSE CODE: MZOO-201

Structure and functions of Invertebrates

Basic concept of coelom and its organisation: Acoelomates, Pseudocoelomates, Coelomates: Protostomia and Deuterostome. **Locomotion:** Mechanism of flagella and ciliary movement in Protozoa, Hydrostatic movement in Coelenterate, Annelida and Echinodermata

Digestion: Filter feeding in Annelids, Arthropoda, Mollusca and Echinodermata and digestion in lower metazoan

Respiration: Organs and mechanisms of respiration in Annelids, Arthropoda, Mollusca and Echinodermata.

Excretion: Organs and mechanisms of excretion in Annelids, Arthropoda, Mollusca and Echinodermata.

Nervous System: Basic concepts of nervous system in Annelids, Arthropoda (crustaceans and insects), Mollusca (cephalopods) and Echinodermata.

Invertebrates Larvae: Crustaceans larvae their types and evolutionary significance

Structure and functions of Vertebrates

Origin and Classification of Vertebrates: Concept of Protochordata, Urochordata, Cephalochordata and Chordata

Vertebrate Integument and its Derivatives: Development, general structure and functions of skin and its derivatives, glands scales, horns, claws, nails, hoofs, feathers and hairs

Circulatory System: Origin and evolution of heart and aortic arches

Skeletal System: Form function, body size and skeletal elements of the body, jaw suspension & vertebral column, limbs and girdles

Evolution of Urinogenital system in vertebrates' series. Basic concepts of Sense organs (lateral line system, electroreception)

Nervous system: anatomy of the brain in relation to its functions, Nerves- Cranial, Peripheral and autonomous nervous systems
Evolutionary histories, of horse, elephant and man

Suggested Readings:

- Hyman, L.H. The Invertebrates. Vol. I protozoa through Ctenophore, McGraw Hill Co., New York.
- Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and sons Ltd. London.
- Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
- Hyman, I.H. the Invertebrates. Vol. 2 Mc Graw Hill. Co., New York.
- Hyman, L.H. The Invertebrates Vol. 8, McGraw Hill. Co., New York. & London.
- Barnes, R.D. Invertebrate Zoology, 11th edition, W.B. Saunders Co., Philadelphia
- Russel Hunter, W.D. A biology of higher invertebrates, the Macmillan co. Ltd. London.
- Hyman, L.H. The invertebrates smaller coelomate groups. Vol. V McGraw Hill Co. New York
- Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
- Sedgwick, A. a. Student text book of Zoology. Vol. I, II, and III Central Book Depot, Allahabad.
- Parker, T.J. Haswell, W.A. Textbook of Zoology, Macmillan Co., London.
- Alexander, P.M. The chordates Cambridge University Press London
- Barrington, E.J.W. The biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
- Boume, G.H. The structure and function of nervous tissue. Academic Press, New York and London.
- Center, G.S. Structure and habit in vertebrate evolution-Sedgwick and Jackson, London.
- Kent, G.C. Comparative anatomy of vertebrates
- Monelli, A.R. the chordates. Cambridge university Press, London.
- Smith, H.S. Evolution of chordate structure. Hold Rinehart and Winston Inc. New York.
- Waters, H.E. and Sayles, L.D. biology of vertebrates. Mac Millan & Co., New York.
- Weichert, C.K. and Preesch, W. Elements of chordate anatomy, 4th Edn. Mc. Graw Hall Book Co., New York.
- Montagna, W. Comparative anatomy, John Wiley and Sons Inc.

Practical Exercises**Structure and Functions of Invertebrates and vertebrates**

Based on the syllabus

SEMESTER-II
ECOLOGY AND ENVIRONMENT
COURSE CODE: MZOO-202

Ecosystem organization

Life zones, major biomes, concepts of community, ecological succession, structure and functions of ecosystem, primary production, energy dynamics, litter fall, arid decomposition, global biogeochemical cycles, minerals cycles in terrestrial and aquatic ecosystems.

Population growth and dynamics

Models of population growth (Stochastic and time lag), reproduction strategies, mating preference, spacing system, r and k selection, case studies in population dynamics.

Predation

Predators-Prey interaction, host parasite interaction, role of predation in nature.

Competition and mutualism

Types and theories of competition, commensalism and mutualism, plant - pollinator and animal - animal interactions. Niche theory.

Biological diversity

Concepts and levels, role of biodiversity in ecosystem functions and stability, speciation and extinction, IUCN, categories of threat, distribution and global patterns, terrestrial biodiversity hotspots.

Environmental pollution

Types, sources, effects on plant and animal ecosystems, greenhouse gases, ozone layer and ozone hole, consequences of climatic change.

Ecological management

Concepts, sustainable development, sustainability indicators, degraded ecosystem and their regeneration with special reference to waste lands, forests and aquatic ecosystems

Suggested Readings:

- Begon and Mortimer, Population Ecology.
- Horace and Quick, Population Ecology.
- Elseth, G.D., Population Biology.
- Thomas, C. E., Population Biology.
- Kerbs, C.J., Ecology.
- Kerbs, C.J., Ecological Methodology.
- Slandenand Bang, Biology of populations.
- Hillary, S.E. Ecology 2000.
- MerritEmlern, J., An Evolutionary Approach
- Brewer, Principles of Ecology.
- Price, P.W.,Slobodchikoff, and Gand, W.S., A New Ecology.
- Odum, Fundamentals of Ecology.
- H.D. Kumar. General Ecology- 1997
- J. Merritt Emlen, Ecology –1973

Practical Exercises

Ecology and Environment

- To determine the minimum size of quadrat by species area curve method.
- To collect plant and animal species and get them identify.
- To measure the temperature of soil at different depth.
- To study the biotic component of pond ecosystem or man-made ecosystem.

- To determine the water holding capacity of different soil (Sandy, loamy and clay soil)
- To study the physio-chemical properties of given soil sample and find: i) Moisture content ii) Bulk density iii) soil porosity.
- To study community by quadrat method and determine relative frequency, relative density, relative dominance, abundance, and IVI value of different species.
- To determine the biomass of a given area.
- To confirm the presence of carbonate, nitrate and pH in the given soil samples.
- To compare the percentage humus content in the given soil samples.
- To determine the CO₂ level in the different water samples.

M.Sc. Zoology
SEMESTER-II
CYTOGENETICS AND EVOLUTION
COURSE CODE: MZOO-203

Chromosome Organization

Structure of chromosomes, DNA packaging and replication. Structure of chromosomes, DNA Packaging & replication. Metaphase chromosomes, centromere, kinetochore, telomere and its importance. 1.3. Heterochromatin and euchromatin. Chromosome banding. Polytene and lampbrush chromosomes

Sex chromosomes

Sex determination and dosage compensation in *Drosophila* and human

Mendelian and non-Mendelian Inheritance

Mendelian inheritance and its modification, Maternal effect, Epigenetic inheritance, Extra nuclear inheritance

Variation in chromosome structure and number

Brief description of gene expression

Genetic code, Transcription and translation, Regulation of gene expression

Gene mutation and DNA repair

Consequences of mutations, Occurrence and causes of gene mutation
DNA repair

Quantitative genetics

Quantitative traits, Polygenic inheritance, Heritability

Population genetics and evolution

Genes in populations, The Hardy-Weinberg Equilibrium, Factors that change allele frequencies in populations. Origin and evolution of species, Biological species concept, Anagenesis and cladogenesis, Allopatric, parapatric and sympatric speciation, Gradualism and punctuated equilibrium, Neo-Darwinism

Molecular evolution

Experimental approaches used to compare species at molecular level
Phylogenetic trees, Molecular clock- cohesive mode of species evolution
Neutral theory of molecular evolution

Suggested Readings:

- Gardner, E.J.; Simmon, M.J. and Snustad, D.P. Principles of Genetics, John Wiley & Sons, inc. NY
- Weaver, R.F. and Hedrick, P.W. Genetics. WmC. Brown Publishers.
- Brown, T.A. Genetics-A Molecular, Approach, Chapman & Hall.
- Mitra, S. Genetics-A Blueprint of life, Tata Mc Graw Hill
- Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
- Dobzhansky, Th; Ayala, F.J.; Stebbins, G.L. and Valentine, J.M. Evolution, Surjeet Publishers, Delhi.

- Futuyama, D.J. Evolutinary Biology, Suinuaer Associations. INC Publishers. Dunderand.
- King, M. Species, Evolution –Therole of chromosomal change. The Cambridge University Press, Cambridge.
- Merrel, D.J. Evolution and Genetics Holt. Rinchart and Winston, Inc.
- Strikberger,M.W.EvolutionJonesandBarlettPublishers.BostonLondon.

Practical Exercises

Cytogenetics &Evolution-Practical

- To study the various stages of mitosis in onion root tips.
- To study the mitosis in the colchicine treated onion root tips.
- To study the various stages of the meiosis in floral buds of onion to determine the mitotic division.
- To study the multiple alleles or blood group in human.
- To prepare the slides of salivary gland chromosomes of *Drosophila* larva.
- To study the multiple alleles in *Trifolium* spp. leaves.
- To study nuclear inheritance and cytoplasmic inheritance in the given plant material.
- To study laws of probability by tossing single coins.
- To study laws of probability by tossing two coins.
- To study xenia and metaxenia in maize cob.
- To study human traits and to find frequencies of hereditary characters.
- Visit to a fossil park/Geology and Anthropology museums.

M.Sc. Zoology
SEMESTER-II
BIostatISTICS AND BIOinformatics
COURSE CODE: MZOO-204

Introduction to Biostatistics

Definition and scope, Probability, Discrete and continuous variables, Presentation of Data. Measures of central tendency: Mean, median, mode, Standard deviation

Biostatistics Software

Analysis of variance, Correlation and regression. Sampling: techniques, Errors, Framing Hypothesis, Level of Significance, Hypothesis testing, Student's t test, Chi Square test

Introduction to Bioinformatics

Introduction to bioinformatics, genomics and proteomics databases, Nucleic acid sequence database. Genbank, UCSC, ENSEMBL, EMBL, DDBJ, protein sequence databases: Swiss- PROT, PDB, BLAST, BLAST vs FASTA, Bioinformatics & drug discovery, Introduction to computational genomics and proteomics

Suggested Readings:

- Gupta, S.C. (2018). Fundamentals of Statistics. Himalaya Publishing House.
- Behera, S.R. (2019). Computer Application. B.K. Publications Pvt. Ltd.
- Lesk, M. (2014) Introduction to bioinformatics. 4th ed. Oxford University Press
- Krawetz, S.A. and Womble, D.D. (2003) Introduction to Bioinformatics. Humana Press.
- Ghosh, Z. and Mallick, B. (2008). Bioinformatics: Principles and Application OUP India; Illustrated edition.
- Mount, D.W. (2005). Bioinformatics sequence and genome analysis 2nd ed. CBS.
- Ahuja, V.K. (2015). Intellectual property rights in India. Lexis Nexis Nagpur.

Practical Exercises

Biostatistics & Bioinformatics - Practical

Based on the syllabus

M.Sc. Zoology
SEMESTER-III
INSECT DIVERSITY AND PHYSIOLOGY
COURSE CODE: MZOO-301

Insect Diversity

An introduction to Insect classification including historical development, Basis of Insect classification; Classification of insects up to orders with focus on local examples; Newer trends in Insect taxonomy.

Insect Morphology

Comparative morphology of head thorax, abdomen and their appendages; functional morphology of mouth parts and genitalia

Anatomy and Physiology

Anatomy and elementary physiology of the following systems of a typical Insect:

- (i) Integumentary system
- (ii) Digestive System
- (iii) Excretory System
- (iv) Respiratory System
- (v) Nervous System
- (vi) Reproductive System

Receptors and Stridulatory organs

Insects growth and metamorphosis

Insect pheromones and Diapause

Insects as vectors of human diseases

Insects of commercial Importance and their culture; honeybees, Silkworm and Lac Insect

Brief idea about chemical and biological control of insect pests

Insects in the service of Forensic Science

Suggested Readings:

- Chapman, R.F. 1998. The insects structure and Function. Cambridge Univ. Press, Cambridge.
- Daly, H.V. Doyen, J.T. and Ehrlich, P.R. 1988. Introduction to insect Biology and Diversity. McGraw Hill Ltd. London.
- Imms, A.D. 1992. A. General Text book of entomology. Chapman & Hall, London.
- Snodgrass. R.E. 1989 Principles of Insect Morphology. Mc Graw Hill, New York.
- Blum, M.S. 1996. Fundamentals of Insect Physiology John Willey & Sons. New York.
- Tembhare, D.B. 1997. Modern Entomology. Himalaya Publishing House, Mumbai.
- Mani, M.S. 1997. General Entomology Oxford & IBH Publishing Co., New Delhi
- Srivastva, K. P. 1998. A Text Book of Applied Entomology (Vol. I & II) KalyaniPublihshers, New Delhi.
- Nayar, K. R. Ananthakrishnan, T.N. and David, B.V. 1998 General and Applied Entomoloty. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
- Wigglesworth, V.B. 1992. Principles of Insect Physiology ELBS edition

Practical Exercises

Insect Diversity and Physiology - Practical

Based on the syllabus

M.Sc. Zoology
SEMESTER-III
ANIMAL PHYSIOLOGY
COURSE CODE: MZOO-302

Nutrition and Digestion

Digestion and absorption of proteins, fats and carbohydrates, Vitamins, minerals and their role, Coordination and control of digestion

Body fluids

Structure and functions of blood vessels, Pressure, blood flow, resistance and inter relationship, Vascular distensibility and vascular compliance, Different types of body fluids, their importance and regulation

Respiration

Transport of O_2 and CO_2 , Capacities & volumes of lungs, Distribution and physiology of respiratory pigments, Carbon monoxide poisoning, Buffer systems, Respiratory regulation of acid base balance, respiratory Quotient

Excretion

Functional anatomy of mammalian kidney and its renal unit, Ultrafiltration, absorption and secretion mechanism in urine formation, Role of antidiuretic hormone and aldosterone. Kidney in acid base balance

Muscular System

Ultrastructure of skeletal muscle, Differences between skeletal, cardiac and smooth muscle, Mechanism of contraction of skeletal muscle, Biochemistry of actin myosin ATP as reaction

Endocrine System

Structural and functional organization of pituitary and, Hormones secreted by thyroid, parathyroid, adrenal gland, pancreas and their functions. Feedback inhibition

Hormones and metabolism

Reproductive physiology

Histophysiology of mammalian gonads (Testis, Ovary), Hormones secreted by gonads,

Environment Physiology

Basic concept of stress and strain, Adaptation, acclimation and acclimatization
Adaptation to high altitude and deep diving

Suggested Readings:

- Ruegg, J.C., Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York.
- Hoar, W.S. General and comparative physiology, Prentice, Hall Inc./England Woodcliffs, New Jersey.
- Guyton, A.C. and Hall, J.E.; Textbook of medical physiology, 10th Ed, Saunders, Harcourt, India.
- Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, Springer-Verlag, Berlin Heidelberg, New York.
- Prosser, C.L. and Brown, F.A. comparative Animal Physiology 2nd Ed. W.B. Saunders, Philadelphia.

- Karpati, G., Jones, D.H. and Griggs. R.C. Disorders of Voluntary Muscle, 7thEdn, Cambridge University Press.
- Turner, C.D. General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia London.
- Prosser, C.L., Comparative Animal Physiology, W.B. Saunders, Toppen Publication.

Practical Exercises

Animal Physiology

- Qualitative estimation of carbohydrates, proteins and lipids in the given sample
- To estimate the amount of amylase, present in the human saliva.
- Detection of urea, uric acid, ammonia in the given sample
- Counting of red blood corpuscles in the given blood sample
- Counting of white blood corpuscles in the given blood sample
- Determination of hemoglobin percentage in the given blood sample
- Detection of blood groups and Rh factor in given blood sample
- Determination of blood clotting time and preparation of haemin crystals
- Determination of Blood Pressure
- To study Barr body from buccal epithelium
- To study the standard curve for glycogen and find concentration of unknown samples

M.Sc. Zoology
SEMESTER-III
PROTEIN STRUCTURE, FUNCTION AND EVOLUTION
COURSE CODE: MZOO-303

Chemical Nature of polypeptide:

Various types of amino acids and their side chains, nature of amino acids, L and D amino acids in nature and their importance, non-ribosomal peptides, Extracellular matrix and proteoglycans, Glycoproteins and their role in cellular processes, Super molecular assembly involving proteins, nucleic acid and lipids using examples of multi-enzyme complex, chromatin and chylomicrons.

Structure of Protein

Functional and Structural Proteins, Regular conformations of polypeptides: α -helices and β -sheets, Secondary, tertiary and quaternary structure of proteins, Forces which decide protein structure, Ramachandran Plot, Structural motif and functional domains, Protein folding, Protein Families, Protein data bases, convergent and divergent evolution of protein structure and functions; protein engineering.

Overview of Protein biosynthesis, and the Cellular signal transduction

Membrane and intracellular receptors, Receptor-ligand interaction, Protein mediated signalling in mammalian and bacterial system (G-proteins, Tyrosine kinase, Serine/threonine kinase, histidine/aspartate kinases, arginine kinase). Role of ten major modifications in protein structure and function. Small G-proteins in cell signalling.

Protein half-life and Protein Degradation

Protein as source of Energy, Protein denaturation, genetic disorder affecting functional proteins, Diseases by protein aggregation and Prion, Protein Separation techniques. Techniques for protein identification.

Suggested Readings:

- Proteins-Structure and Molecular Properties, Creighton T.E., Freeman Company New York, USA
- Introduction to protein structure, Braden and Tooze, Garland Pub., London, UK
- Biochemistry, Voet D., AND J. G. Voet, Jon Wiley and Sons Inc., USA

M.Sc. Zoology
SEMESTER-III
MAMMALIAN NEUROBIOLOGY
COURSE CODE: MZOO-304

Organization of the nervous system

Brain structure, Cerebrospinal fluid

Cells and connection of the nervous system

Nuerons, Glial cells, Synapses, Neural network, Blood-brain barrier,

Neurotransmitters and Neuropeptides

Learning and Memory

Types of learning and memory, Molecular basis

Brain and behaviour

Motivation, Sleep,

Brain aging

Brain imaging

CAT, PET, MRI

Neuropathology

Strokes, Epilepsy, Alzheimer's disease, Huntington's disease, Parkinson's disease

Suggested Readings:

- Long staff: Neuroscience, Viva Books Pvt. Ltd., 2002
- Shepherd: Neurobiology, Oxford Univ. Press
- Ganong: Review of Medical Physiology (21st Ed.), Lange Medical Publ., 2003
- Guyton & Hall: Textbook of Medical Physiology (10th Ed.), WB Saunders, 2001.

Practical Exercises

Mammalian Neurobiology

- Study of X ray, CT Scan and MRI report
- Study of electron micrographs
- To dissect out nervous system of animal (under IAEC guidelines)
- Visit to hospital for demonstration of various neurological techniques

M.Sc. Zoology

SEMESTER-III

BIOLOGY OF PARASITES

COURSE CODE: MZOO-305

Parasitism

Introduction, origin and evolution of parasitism, paleoparasitology and its significance, Parasitic adaptation, parasites and their types, host parasitic interaction and host ranges, ecological importance of parasites and their transmission.

Protozoa

Classification with important characteristics, reproduction, morphology, life cycle, pathogenicity and prophylaxis of *Leishman asp*; *Trypanosome sp.*, *Plasmodium sp.*, *Giardia sp.*

Platyhelminthes trematode parasites

General characters and geographical distribution, morphology, life cycle, pathogenicity and prophylaxis of trematode parasites, *Fasciola sp.*, *Fasciolopsis sp.*, *Dicrocoelium sp.*, *Echinostoma sp.*, *Schistosoma sp.*, *Polystoma sp.*

Platyhelminthes cestodes parasites

General characters and geographical distribution morphology, life cycle, pathogenicity & prophylaxis of cestode parasites; *Taeniasp.*, *Echinococcus*, *Hymenolepis* sp., *Dipylidium sp.*

Nematode parasites

General characters and geographical distribution, morphology, life cycle, pathogenicity and prophylaxis of - *Ascaris sp.*, *Trichinella sp.*, *Enterobius sp.*, *Ancylostoma sp.*, *Wuchereria sp.*

Acanthocephala parasite

General characters and geographical distribution, morphology and life cycle, pathogenicity and prophylaxis of Acanthocephalan parasite; *Macracanthorhynchus* sp.

Disease Transmission

Mode of transmission and brief epidemiology of some important diseases. Cholera, Typhus, smallpox, plague, Malaria, Dengue fever, Filariasis, AIDS & COVID-19

Vaccination: Immunization; it's history and different types of vaccines

Suggested Readings:

- Cheng, T.C. General parasitology Academic Press, Inc. (1986)
- Noble, E.R. and Noble, G.A: Parasitology, The biology of Animal parasites Lea and Fabiger
- Andeson, D.R.: Comparative Protozoology, Cambridge Uni. Press.
- Chandler, A.C. and Read, C.P.; Introduction of Parasitology, Willy Eastern,
- Belding, D.A. A text book of Parasitology, Meredith pub. Co.
- Baker, J.R. Parasitic Protozoa, Academic Press
- Grell, K.G. Protozoology, Springer Verlag

Practical Exercises

Parasitology-Practical

- Study of the protozoan parasites through slides: Study of malaria- infected blood smear of mouse with *Plasmodium* sp. signet ring stage, trophozoite stage, Schizont stage and Study of permanent slides-*Giardia*, *Nyctotherus*, *Balantidium*, *Opalina*, *Entamoeba histolytica*, *Leishmania* promastigotes.
- Study of permanent slides of cestodes parasites- *Taenia scolex*, mature proglottids, cysticercus larva, T.S. of mature proglottid to demonstrate tegument, *Echinococcus granulosus* W.M., Hydatid cyst, *Diphylobothrium latum* mature proglottid, *Dipylidium caninum* scolex, mature proglottids, *Moniezia expansa*, *Amphilin foliacea*
- Detailed morphological studies of *Taenia* sp.: Dissect and expose the digestive and reproductive system
- Study of permanent slides of trematodes parasites- *Fasciola hepatica* W.M., *Echinostoma* W.M., *Fasciolopsis buski* W.M., T.S of *Fasciola* sp. to demonstrate tegument, larval forms of *Fasciola* sporocyst, redia, cercaria, *Polystoma integerrimum*
- Study permanent slides of nematodes i.e. *Trichuris globulosa*. *Oxyuris*, *Ancylostoma* male & female, *Wuchereria* female. *Trichinella* sp., *Trichuris* sp., *Enterobius* sp., *Strongyloides* sp., *Necator* sp., *Ancylostoma* sp., *Wuchereria* sp. *Dracunculus medinensis*
- Detailed morphological of Ascaris: Dissect and expose the digestive, male and female reproductive system and study the permanent slides- T. S. Ascaris male, T.S. Ascaris female.
- Detailed morphological of Whipworm and Pinworm: Dissect and expose the digestive and reproductive system of parasite.
- Collection and identification of indigenous ectoparasites and end parasites

- Preparation of temporary slides of the collected identified samples of parasites.

**M.Sc. Zoology
SEMESTER-III
DISEASE BIOLOGY
COURSE CODE: MZOO-306**

General diseases

Communicable human diseases and their control, Non-communicable human diseases and their control, Brief outline and pathophysiology of diseases caused by bacteria, viruses and salient metabolic disorders

Transgenes is and Pandemic

Characteristics of plasmid and phage vector, Prokaryotic and eukaryotic expression vectors. Transgenes is and knockout animals. Covid-19 pandemic: origin, transmission and vaccination

Diagnosis of diseases

Polymerase Chain Reaction as a tool for disease biology, Nested PCR, Taqman assay, RACE PCR, RAPD, site directed mutagenesis, Omics technology to address genetic basis of human diseases

Stem Cell and Nanotechnology

Gene therapy in disease biology, Stem cells as tool to repair damaged tissue, Nanotechnology and targeted tissue engineering

Practical Exercises

Disease Biology-Practical

- Demonstration of respiratory disorder using animal model (under IAEC rules)
- Demonstration of VIDAL test using test kit
- To study antigen antibody reaction
- To demonstrate healthy and damaged tissue using different tools

**M.Sc. Zoology
SEMESTER-III
LIMNOLOGY
COURSE CODE: MZOO-307**

Introduction

Definition and facets of Limnology; Limnology as an applied science. Inland water types: Lentic and lotic habitats – their identities and distribution, ponds and lakes, streams and rivers; Major rivers and lakes of India. Anomalous properties of water, their influence on biota in inland waters. Temperature and Light: Thermal stratification and its overall impact, thermal classification of lakes; Factors affecting light penetration in natural waters.

Role of Gaseous in Limnology

Dissolved oxygen: Sources, losses and distribution patterns. Identification of oxygen depletion problems and control mechanisms in fish ponds. Carbon

dioxide: Sources, losses and distribution patterns; role of carbon dioxide in chemical buffering. Bio-geochemical cycles: General account of nutrients; Nitrogen and Phosphorus cycles.

Aquatic Animals

Plankton: Composition, classification and distribution patterns in lakes and rivers. Benthos: Composition, classification and distribution of benthos in lakes and rivers. Nekton and its significance. Large Aquatic Plants: Classification, distribution and limnological significance.

Productivity and Eutrophication

Productivity: Concept of productivity; methods for the estimation of primary, secondary and tertiary productivity; Classification of lakes based on productivity; indices of productivity in lakes. Turbidity: Causes, consequences and control. Eutrophication: Causes, consequences and control mechanisms. Bio-manipulation Concept: Zooplankton as a tool in lake management.

Suggested Readings:

- Allan JD. 1995. *Stream Ecology: Structure and Function of Running Waters*. Chapman & Hall
- Cole GA. 1983. *Text book of Limnology*. C.V Mosby Company, St. Louis, Missouri, USA.
- Goldman CR. and Horne AJ. 1983. *Limnology*. Mc Graw-Hill International Book Company.
- Golterman HL. 1975. *Physiological Limnology*. Elsevier Publishing Co., Amsterdam.
- Hutchinson GE. 1957. *A Treatise on Limnology: Vol I. Geography, physics and chemistry*. John Wiley and Sons, Inc., New York.
- Hutchinson GE. 1967. *A Treatise on Limnology. Vol II. Introduction to lake Biology and the Limnoplankton*. John Wiley and Sons, Inc., New York.
- Reid GR. 1961. *Ecology and Inland waters and Estuaries*. Reinhold Corp., New York.
- Ruttner F. 1953. *Fundamentals of Limnology*. Uni. of Toronto press, Toronto.
- Welch PS. 1952. *Limnology*. 2nd Ed. Mc Graw-Hill Book Co. New York.
- Wetzel RG. 1975. *Limnology*. W.B. Sanders Company, Philadelphia.

Practical Exercises

Limnology-Practical

- Determination of temperature, pH and salinity in the pond water sample.
- Estimation of total alkalinity and total hardness.
- Estimation of dissolved oxygen and free carbon dioxide.
- Estimation of phosphates and nitrites.
- Estimation of COD and BOD.
- Identification of Plankton.

M.Sc. Zoology
SEMESTER-III
ANIMAL BEHAVIOUR
COURSE CODE: MZOO-308

Introduction

Definition, historical outline, patterns of behaviour, objectives of behaviour, mechanism of behaviour. Reflexes- reflex action, types of reflexes, characteristics of reflexes and complex behaviour. Orientation primary and secondary orientation

Eusociality

Social organization in honey bee, various types of communications, production of new queen and hive, swarming, honey bee as super organism. Fixed action pattern: mechanism, deprivation experiment, controversies. Learning and instincts: conditioning, habituation, sensitization, reasoning.

Innate releasing mechanisms

Key stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour, motivational conflict and decision making. Hormones and pheromones influencing behaviour of animals.

Altruism

Reciprocal altruism, groups election, kin selection and inclusive fitness, cooperation, alarm call. Parental care, Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice).

Suggested Readings:

- Mechanism of Animal Behavior, Peter Marler and J. Hamilton; John Wiley & Sons, USA
- Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
- Animal Behavior, John Alcock, Sinecure Associating, USA
- Perspective on Animal Behavior, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
- Exploring Animal Behavior, Paul W. Sherman & John Alcock, sinecure Associating, Massachusetts, USA
- An Introduction to Animal Behavior, A. Manning and M.S Dawkins, Cambridge University Press, UK

Practical Exercises

Animal Behaviour

- To study the response of woodlice to hygrostimuli.
- To study the geotaxis behaviour of earthworm.
- To study the orientational responses of larvae to photostimuli.
- To study the median threshold concentration of sucrose solution in eliciting feeding response of housefly.
- To study the orientational responses of larva to volatile and visual stimuli

SEMESTER-IV
DEVELOPMENTAL BIOLOGY
COURSE CODE: MZOO-401

Introduction development Biology

Scope, Science of development albiologyan disappication's, Differentiation of germ cell sin to spermoregg.

Gametogenesis and Fertilization

Gametogenesis, fertilization, and early development: Production of gametes, embryo sac development, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation, and formation of germ layers in animals; embryogenesis

Creation of Multicellularity

Cleavage characteristics, Pattern so cleavage (Radialholoblastic, bilateralholoblastic,spiralholoblastic,Rotationalholoblasticand meroblastic), Concept off ate maps (Chick, frog)

Basic Concepts in Development

Potency, induction, specifcation, Determination and Determination, Stem cells, imprinting, Mutants and transgenic in analysis of development

Morphogenesis and organogenesis in animals

Cell aggregation and differentiation, axes and pattern formation in *Drosophila*, amphibian and chick, Organogenesis – vulva formation in *Caenorhab ditiselegans*, eye lens induction, limb development and regeneration in vertebrates; Differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Placenta

Development of placenta, different types, Place ntal hormonesandtheirfunctions/importance

Cell Programming

Programmed Cell Death, Ageing, Senescence

Multiple ovulation an embryo transfer technology

Superovulation, In-vitr of ertilization and In Vitroo ocytematuration, Cryopreservation and Embryo transfer technology

Suggested Readings:

- Reproduction in animals by Austen and short
- Molecular Biology of Development by Scott. F. Gilbert
- Human Reproduction by R.G. Edwards
- Introduction to Embryology by Babinski
- Molecular Biology of Fertilization by Schettino and Schettino.

Practical Exercises

Developmental Biology

- To study the different stages of development in frog and chick embryo
- To study the spermatogenesis of rat and grasshopper from smears of testis

- To prepare the permanent stained slides of developing stages from fertilized eggs of hen
- Influence of temperature and teratogens on animal development
- To study different larvae in invertebrates from permanent slides
- Study of sex chromatin in buccal smear and hair bud cells (Human)
- Study of development of chick by window method

M.Sc. Zoology
SEMESTER-IV
APPLIED ZOOLOGY
COURSE CODE: MZOO-402

Apiculture, Sericulture and Lac Culture

Introduction to apicultural and related practices, Hive products, Bee pasturage, apiculture and crop pollination, Pests, diseases and effect of pesticides on honeybees

Beekeeping industry in India with special reference to Himachal Pradesh. Silkworm and its strains, rearing of silkworms, sericulture and its components, silk reeling, Pests, and diseases of silk moth Non-mulberry sericulture: Taser, Mega and Eri culture, Sericulture industry in India. Lac culture: Introduction, history, life cycle, distribution and economic importance

Crop Pests and their Management

Biology and control of following insect pests of agricultural importance: Termites, Rice weevils, castor hairy caterpillar, codling moth, mango mealy bug, Cotton white fly, citrus psyllid, aphids and cabbage Caterpillar. Biology and control of some important Phytoparasitic nematodes: *Anguina*, *Xiphinemas*, *Meloidogynesp* & *Heteroderasp.*, Principles and practices of pest control, Methods of pest Control-Chemical Biological, Microbial, integrated control, Phenomenal and Hormonal control, Chemo sterilants and genetic control

Animal Husbandry and Dairy farming

Animal Husbandry: Purpose, scope & management, Dairy Animals, Breeds & Economic importance of Cow, Buffalo, Goat and Sheep, Modern methods of breeding for improvement of Dairy animals, Poultry: Breeds & economic importance

Transgenic Animals, Vermicomposting and its significance

Pisci culture

Major cultivable fish species for pisci culture, a knowledge of inland water bodies suitable for culture in India. General information about the fishes of Himachal Pradesh, Culture of Indian major carps & exotic carps, Fish hatcheries and their management

Preparation and management of Indian major carp culture ponds-nursery, rearing and production ponds, monoculture and composite culture. Fresh water, brackish and marine fisheries, induced breeding & its techniques in pisciculture.

Fish enemies and their control, fish diseases and their control, importance of fish culture, fishing gears and fish preservation

Wildlife and its Management

Introduction and importance of wildlife, Status of wildlife in India with special reference to Himachal Pradesh, Endangered and endemic faunal species of India
Objectives of wildlife conservation and its strategies.

Suggested Readings:

- Jhingran, V.G.1995.Fish and Fisheries of India, Hindustan Publ. Corp., New Delhi.
- Lagler, K.F. Bardach, J.E. Miller, R.R. and Pasina, D.R.M. 1987. In ornithology John Wiley and Sons, New York.
- Deshmanna, R.F. 1992. Wildlife biology. Wiley Eastern Publisher, New Delhi.
- Sharma, V.B. 1995. Wildlife in India. Natral Publisher, Dehradun.
- Verman, L.R. 1990. Beekeeping in integrated mountain development. Oxford & I BHPubl.Co., New Delhi.
- Stine, K.E. and Brown, T.M. 1996. Principles of Toxicology. Lewis Publishers London.
- Atwal, A.S. 2000, Essentials. Of beekeeping & Pollination. Kaylan Publ. New Delhi.
- Hassal, A.K. 1990. The Biochemistry and uses of Pesticides EELBSEditions
- Atwal, A.S. and Dhaliwal G.S. 1997. Agriculture pests of South Asia and their management. Kalyani Publishers New Delhi.
- Aruga, H. 1998. Principles of Sericulture. Oxford & IBHPublishing Co. New Delhi.
- Harper, Physiological Chemistry
- Karpati, G. Jones. D.H. and Griggs, R.C. Disorders of voluntary muscle, 7th edition. Cambridge Univ. Press.

Practical Exercises

Applied Zoology-Practical

- Study of morphology of honey bee and caste system.
- Mounting of mouth parts, hypo pharyngeal gland, stinging apparatus of honey bee.
- Study of structure of honey comb.
- Estimation of quality control parameters of honey to check its purity
- Study of morphology of lifecycle of *B. mori*
- Study of cocoons and food plants of silkworm
- Physic- chemical parameters of freshwater bodies
- Study of morphometric characters of Indian major carps. a) Diversity of fishes. b) Biological analysis of water and estimation of primary productivity
- Toxicity testing with zooplankton/fish
- Visit to freshwater/ marine fish farms, beekeeping, silk farm
- Identification of major cultivable fishes of Himachal Pradesh
- Aquarium design and maintenance
- Induced breeding of Indian major carps and catfishes
- Demonstration of vermicomposting technique

- Study the status, importance and future prospect of one wild animal of Himachal Pradesh.
- Visit to national park, sanctuary or protected area

M.Sc. Zoology
SEMESTER-IV
ADVANCE TOPICS IN ENTOMOLOGY
COURSE CODE: MZOO-403 (i)

Agricultural Entomology

Biology and control of following insect pests of Agricultural importance: Senses scale, Woolly apple aphid, Rice stem borer, Maize, borer, Diamond back moth, Mustard aphid, Mango-hoppers, Melon fruit fly, Potato cutworm, Potato, tuber moth, Sugarcane borers, Pink boll worm of cotton, Cotton Jessed, Citrus caterpillar, rice weevil, Khapra beetles, Lesser grain borer, Angoumois grain moth, Locusts.

Insect Control and Toxicology

Basic principles and types of insect control: cultural, physical, mechanical, biological and chemical control. Mode of action of insecticides: inorganic insecticides; botanical pesticides and synthetic organic insecticides. Physiology of insecticidal resistance. Insecticides and environmental pollution. Newer methods of insect control including genetic methods. Uses of chemo sterilants, radiations, hormones and pheromones in insect control. Principles and practices of integrated pest management Microbial control.

Insect Socio-biology

Basic attributes of social life, social organization in honeybee, wasp, termite and ant. Kinds of societies among bees; social significance of the nest; caste determination in bees; Foraging and orientation; Defence mechanisms in bees Species of honeybees, their general characteristics and economic importance; Honey plant resources; Bee Genetics, Dances and languages of honeybees Foraging behaviour of bees in relation to pollination, Honeybee pests and diseases. Bee products: their composition and uses.

Insect Ecology

Abiotic and biotic factors of environment concerning distribution and abundance of insects. Current theories to explain insect number. Ecology of pest control. Insect mimicry. Entomoparasitous insects.

Insect Sense and Insect Bio-indicators

Application of insect in technology solutions and assessing the health of ecosystem.

Suggested Readings:

- Atwal, A.S. and Dhaliwal, G.S. 1997. Agriculture pests of South Asia and their management Kaylan Publishers, New Delhi.
- Pedigo, L.P. 1996. Entomology and Pest Management. Prentice Hall of India, New Delhi.

- Clarke, L.R. Geiger, P.U, Hughes, R.D. and Morris, S.R.F. 1982 The Ecology of Insect population-in theory and practice. ELBS edition
- Michener, C.D. 1981. The social behavior of the bees. The Belknap Press of Harvard Univ. Cambridge.
- Verme, L.R. 1990. Beekeeping in integrated mountain development Oxford & IBH Publ. Co., New Delhi.
- Wilson, E.O. 1981. The Insect Societies. Harvard Univ. Press, Cambridge.
- Hassall, A.K. 1990. The biochemistry and uses of pesticides ELBS edition
- Hill, D.S. 1993. Agricultural insect pests of tropics and their control. Cambridge unit Press. Cambridge.
- Stine K.E and Brown. T.M. 1996. Principles of Toxicology, Lewis Publishers, London.
- Atwal, A.S. 2000, Essentials of beekeeping & Pollination Kalyani Publ. New Delhi.
- Stewart, A.J.A., New, T.R. and Lewis, O. T. 2007. Insect conservation biology. CABI book.
- Mohamed A.A.A. 2012. Studies on some aquatic insects as bioindicators of heavy metals. LAP Lambert Academic Publishing.

Practical Exercises

Advance Topics in Entomology

Based on the syllabus

M.Sc. Zoology

SEMESTER-IV

MEDICAL ENTOMOLOGY AND VECTOR BIOLOGY

COURSE CODE: MZOO-403 (ii)

Arthropods as vectors

Classification of arthropod vectors, Modifications in the mouth parts of insect vectors, Ticks and their role in disease transmission, Mites as vectors

Important vectors from the following orders

Hemipteran, Anoplura, Siphonoptera

Life histories of vectors belonging to following families and their disease relationships

Psychodidae, Simuliidae, Glossinidae, Tabanidae, Myiasis: Causes, symptoms, diagnosis & epidemiology

Systematics, biology and control of major insect vectors belonging to Diptera.

Mode of transmission, control of vectors and epidemiology of

Malaria, Filariasis, Dengue and Plague.

Insects in the service of Forensic Science

Insects of forensic importance, collection of entomological evidences during death investigation. The role of aquatic insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to forensic entomology.

Suggested Readings:

- Herms, W.B., 1962: Medical Entomology, the Macmillan Co. New York.
- Kettle, D.S., 1984: Medical and Veterinary Entomology, John Wiley and Sons, New

York.

- Herms W.B., James and M.T., 1961: Medical Entomology, Macmillan Co., New York.
- Harwood, R.f. and James, M.T., 1979: Entomology in Human and Animal Health. Collier Macmillan Pub., London
- Goddard, J. 1993: Physician's guide to arthropods of medical importance, CRC Press, Florida.
- Herms, W.B. & James, M.T., 1961: Medical Entomology, Macmillan Co., New York.
- Roy, D.N.: Entomology (Medical and Veterinary) Calcutta, India.

Practical Exercises

Medical Entomology and Vector Biology

Based on the syllabus

M.Sc. Zoology
SEMESTER-IV
FISH & FISHERIES-I
COURSE CODE: MZOO-404 (i)

(Origin, Selective Physiological Aspects, Aquatic & Fishery Resources of India, Ecology & Management)

Fish origin & selective physiological aspects

Origin, diversity, and distribution- origin and evolution of major groups of fishes, evolutionary strategies, and morphological innovations. Gas exchange and swimming: Air breathing organs and gas bladder; Swimming modes (fin versus body trunk), swimming muscles and tail beat. Fish Reproduction: Sexual maturity and breeding season of various cultivable species; Reproductive cycles, reproductive behaviour, development of gametes in male and female; Endocrine control of fish reproduction. Fecundity, Fish egg and embryonic development, parental care, and migration.

Capture fisheries & its types

Indian fisheries, freshwater resources (Coldwater fisheries, riverine fisheries, reservoir fisheries, lacustrine fisheries. Classification of lakes, concepts of productivity based on trophic status, types of eutrophication, important riverine ecosystems of India and their hydrological conditions with special reference to fisheries, dams, and their influence on riverine fisheries. Estuarine and marine resources of India.

Freshwater faunal diversity except fishes

Different categories of freshwater fauna based on zonation in a habitat & mode of life such as Plankton, Neston, Nekton, Benthos Paraphyte n and benthic macroinvertebrates Sampling identification and counting.

Tools and techniques for Fish identification

Standard methods and techniques for the survey of the fish faunal diversity, fishing gears & methods used for fishing in lotic and lentic waters, fish diagnostics, collection, preservation and care of fish

Various body measurements, morphometric and meristic characters for fish identification, methods of fish classification, use of hard parts such as scale,

vertebrae and otolith for fish stock identification, role of DNA markers in fish stock identification.

Fish diversity & its status

Fresh water and marine fish diversity in India and its status according to Indian Wildlife Protection Act (IWPA) -1972 & IUCN, CBD

International agreements for conserving marine life, convention on wetlands of International Importance (Ramras convention)

Setting up of freshwater and marine aquaria, assortment of compatible fish species, breeding of aquarium fishes. Impact of aquatic pollution on fish, different methods to control aquatic pollution, environmental factors, and fish health.

Fish ecology

Criteria of water quality in terms of abiotic parameters for fish- role of temperature, pH, TDS, hardness, total alkalinity, conductivity, salinity, dissolved oxygen, ammonia, nitrate, phosphate, biological oxygen demand & Chemical oxygen demand.

Ecological conditions & classification of hill streams & rivers of Western Himalaya.

Biology of important cold-water fishes of India, protecting role of reefs, reasons of reef erosion, marine fishes, and their variation. Migration of fishes.

Suggested Readings:

- Allan JD. 1995. *Stream Ecology: Structure and Function of Running Waters*. Chapman & Hall
- APHA 2005. Standard methods for the examination of water and wastewater, 21st end. American Public Health Association, Washington, DC.
- Aquaculture Production. 1998. FAO. Fisheries Circular No.815, No.4, Rev. FAO, Rome.
- Arrington, J. 1999. Management of Freshwater Fisheries, Oxford and IBH, New Delhi.
- Bartech, JE *et al.* 1972. Aquaculture – The farming and husbandry of freshwater and
- marine organisms. John Wiley & Sons, New York.
- Bangenal, T. 1970. Methods for Assessment of Fish Production in Freshwaters 3rd Ed
- IBH Handbook No.3, Blackwell Scientific Publication, Oxford.
- Bad panda, K.C. 2013. Basics of Fisheries Science: Fishing Craft & Gear Technology. Narendra Publishing House, Delhi.
- Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Diya Publ.
- Bond, *et al.* 1971. Fish Inspection and Quality Control. Fishing News Books, England.
- Clucas IJ. 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO.
- Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, 2006. DIPA, New Delhi, India
- Datta Munshi, J. and Datta Munshi, J. 1995. Fundamentals of Freshwater Biology, Narendra Publishing House, Delhi.

- Jay Aram, K.C. 2013. The Freshwater Fishes of the Indian region, Narendra Publishing House, Delhi, New Delhi.
- Jayaram, K.C. 2013. Fundamentals of Fish Taxonomy, Narendra Publishing House, New Delhi.
- Jhingran, V.G. 2002. Fish and Fisheries of India, Hindustan Publishing House (India), New Delhi.
- Talwar, P.K. and Jhingran, A.G. 1991. Inland Fishes of India, Vols. I & II, Oxford and IBH, New Delhi.
- Lagler K.F. 1969. Freshwater Fishery Biology, Wm. C. Brown Company Publ., Dubuque, Iowa.
- Odom, E.P. 1971. Fundamentals of Ecology, W.B. Saunders Co. Philadelphia.
- Moyle Peter B. and Joseph J. Cache. 1986 Fishes: An Introduction to Ichthyology. Prentice – Hall, Inc. Jersey, U.S.A.
- Ward, H. B. & G. Ch. Whipple 1957. Fresh Water Biology, edited by W. T. Edmondson: 2 ed. London & New York: John Wiley & Sons.
- Welch, P.S. 1952. Limnology, McGraw Hill, New York.
- Wetzel, R.G. 1983. Limnology, W.B. Saunders Co. Philadelphia.

Practical Exercises

Fish & Fisheries

- Assessment of DO of the water by Winkler's method.
- Assessment of BOD of the water sample.
- Estimation of free carbon dioxide content in water sample.
- Estimation of total hardness in the given water sample.
- Estimation of pH, total alkalinity, conductivity in the given water sample.
- Estimation of Nitrates and Phosphates in water.
- Collection techniques of phytoplankton and zooplankton from natural resources and their identification.
- Quantitative and qualitative analysis of phytoplankton and zooplankton from natural resources
- Study of benthic macroinvertebrates in a natural water bodies.
- Study of fishing gears and nets with the help of models.
- Identification of important fishes of Himachal Pradesh up to species level.
- Determination of age and growth in a fish.
- Length-weight relationship and condition factor determination.
- Toxicity testing with zooplankton/fish.
- Visit to a stream/river/fish farm/lake/fish market/hatchery and submission of report.
- Quality control of fishes: Crude protein analysis of fish muscle by Lowry method.
- Isolation and maintenance of bacteria from fishes.
- Identification of spawn, fry, fingerling of male and female adult of *Bariliu sbendelisis*.
- Histological studies of developmental stages of ovary and testes.

- Study of fish eggs and embryonic developmental stages.
- Identification of larval stages of important crustaceans.
- Identification of common ornamental fishes.
- Collection and identification of aquatic weeds and aquatic insects.
- Study of feeding habits of fishes by gut content analysis.
- Formulation and preparation of artificial fish food for Indian major carps and Prawns.

M.Sc. Zoology
SEMESTER-IV
FISH & FISHERIES-II
COURSE CODE: MZOO-404 (ii)
(Aquaculture)

Aquaculture system

Different types of culture practices: Monoculture, Polyculture, Cage culture, Pen culture, and Integrated culture. Culture of Freshwater Indian major carps and ornamental (lacustrine) fish culture; Management of Shellfish culture (prawns) practice and scope in India. Fish seed technology - natural collection, bundh breeding, induced breeding, cryopreservation of gametes

Integrated farming

Fish-cum-livestock farming, paddy-cum-fish farming. Aquaculture engineering: aqua house, hatchery, ponds, race ways, recirculating system, cage

Pond management

Lay out and construction of different types of ponds, formulation, and operation of different types of hatcheries, hatchery management and hatchery breeding. Brood pond management for cultivable indigenous and exotic carps, stocking, rearing and nursery pond. Physio-chemical properties of pond water and soil, and their maintenance, manuring (organic and inorganic) and liming, weed control.

Fish nutrition

Fish food organisms, nutritional requirements of commercially important fishes, dietary requirements of fish during different stages of development including brooders, feed types, methods of storage and degradation. Use of preservatives and antioxidants in feed. Feed evaluation: Feed Conversion Ratio (FCR); Feed Efficiency Ratio (FER); Protein Efficiency Ratio (PER), Net Protein Utilization (NPU) and Biological Value (BV); Digestive enzymes, feed digestibility; Factors affecting digestibility, manufacture and ingredients.

Fishery technology, industry and economics

Fishing gears and crafts used in Indian coasts. Fish Industry: biochemical and microbial spoilage of fish, factors affecting spoilage of fish, transportation of fish. Fish preservation, transportation, processing Industries in India. Fishery economics: Status of Indian and global scenario. Major pelagic and demersal fisheries of Indian coasts and strategies for its development and conservation. Stock replenishment, Sea ranching and FADs. Fish supply chains and export.

Role of genetics and Environment in aquaculture

Application of genetics and biotechnology for producing quality strains, Glycogenesis, androgenesis, triploid, tetraploid, hybridization, sex reversal and breeding, production of transgenic fish, impact of GMOs on aquatic biodiversity. Aqua cultural wastes and future developments in waste minimization, environmental consequences of hyper nitrification.

Fish toxicology & health

Drug toxicity and toxicity caused by agrochemicals. Toxicity of drugs in Aquaculture: Maximum Residual Limits (MRL) of various drugs and chemicals in fish Metabolism. Endocrine Disruptor Chemicals (EDC). Infection and diseases in fish, common fish pathogens, routes of pathogen entry in fish, methods of colonization and spread of pathogens, immune - evasion mechanisms of fish pathogens, strategy, and use of vaccines in aquaculture.

Suggested Readings:

- APHA 2005. Standard methods for the examination of water and wastewater, 21st ed. American Public Health Association, Washington, DC.
- Aquaculture Production. 1998. FAO. Fisheries Circular No.815, No.4, Rev. FAO Rome.
- Bartech, JE et al. 1972. Aquaculture – The farming and husbandry of freshwater and marine organisms. John Wiley & Sons, New York.
- Bangenel, T. 1970. Methods for Assessment of Fish Production in Freshwaters 3rd Ed.
- IBH Handbook No.3, Blackwell Scientific Publication, Oxford.
- Datta Munshi, J. and Datta Munshi, J. 1995. Fundamentals of Freshwater Biology, Narendra Publishing House, Delhi. ISBN 81-85375-34-8.
- Hut J. 1986. A textbook of Fish Culture. Fishing News Books Ltd.
- ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR.
- Jhingran V.G. 1991. Fish and Fisheries of India. Hindustan Publ. Corporation, India.
- Landau M. 1992. Introduction to Aquaculture. John Wiley & Sons.
- McVeigh JP. 1983. Handbook of Mari culture. CRC Press.
- Pandey, G. 2017. Fish Pharmacology and Toxicology. Daya Publishing House, New Delhi.

Practical Exercises

Fish & Fisheries -II

- Estimation of hydro biological parameters- temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand of nursery, rearing, stocking and breeding ponds.
- Estimation of ovarian egg counts.
- Culture of live food organisms and assay of nutritional quality of live food; estimation of population density of live food organisms.
- DE capsulation and hatching of Arteria cysts for use in hatcheries.
- Demonstration of breeding pools and hatcheries. Induced breeding of Indian major carps and catfishes.
- Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
- Collection and identification of aquatic weeds and aquatic insects.

- Study of feeding habits of fishes by gut content analysis.
- Isolation and estimation of fish immunoglobulins; Molecular techniques in fish health management.
- Aquarium design and maintenance.
- Formulation and preparation of artificial fish food for Indian major carps and Prawns.
- Analysis of proximate composition of fish and processed products.
- Visit to freshwater/ marine fish farm.

M.Sc. Zoology
SEMESTER-IV
CYTOGENETICS-I
COURSE CODE: MZOO-405 (i)
(Molecular Genetics)

Basic frenetic analysis

Terminology, Mutant sand revertants, Uses of mutants, Genetic analysis of mutants

Site directed mutagenesis

Genome analysis

Cytogenetic mapping, Genetic linkage mapping using molecular markers

Physical mapping

Recombination and transposition molecule level

Sister chromatid exchanges and homologous recombination, Site specific recombination, Transposition

Computer analysis of genetics sequences

General concepts in sequence analysis, Identification of functional sequences

Homology, Structure prediction

Recombination DNA and genetic engineering

Gene cloning, Detection of, Analysis of alteration of DNA sequences, use of microorganism in biotechnology, New methods for genetic manipulation of plants and animals, Applications of transgenic plants and animals, Gene therapy, DNA fingerprinting

Metabolic Reprogramming and Epigenetics

Epigenetics and genome imprinting - DNA methylation in mammals. Genomic imprinting in mammals, germ line and pluripotent stem cells. Epigenetics and human disease, Epigenetic determinants of cancer

Suggested Readings:

- Atherly, A.G. Girton, J.R. and McDonald, J.F., The Science of Genetics. College, Publishing, Harcourt Brace College, Publishers. NY.
- Watson, J.D.; Hopkins, N.H.; Roberts, J.W.; Steitz, J.A. and Weiner, A.M. Biology of Genes, The Benjamin/Cummings Publishing Company Inc. Tokyo
- Griffiths, A.J.F., Gelbart, W.M.; Miller, J.H.; Lewontin, R.C. and Modern Genetic Analysis. W.H. Freeman and Company, New York.
- Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cumming, Longman Inc.
- Manag, E.J. and Manag, A.P. Basic Human Genetics. Sinauer, Associates, Inc.
- Hartl, Daniel L. Human genetics. Harper and Row
- Rothwell, N.V. Human Genetics. Prentice-Hall.
- Winchester, A.M. Heredity, Evolution and Humankind. West Publishing Company
- David, Allis and Jenuwein, Thomas. Epigenetics. Cold Spring Harbor Laboratory Press, New York, USA

Practical Exercises

Cytogenetics- I

Based on the syllabus

**M.Sc. Zoology
SEMESTER-IV
CYTOGENETICS-II
COURSE CODE: MZOO-405 (ii)
(Human Genetics)**

Human population genetics

Polymorphic nature of human proteins, Biology of human races, Mutation and human diversity, Determination of mutation rates

Large scale mutagenesis and interference

Genome wide gene targeting; systematic approach, random mutagenesis, insertional mutagenesis. libraries of knock-down photocopies created by RNA interference; transcriptome analysis, DNA micro-array profiling, data processing and presentation, expression profiling. Protéomes - expression analyses, protéine structure analysis, protein - protein interaction. Introduction to Pharmacogenomics, Metabolomics, Nutrigenomics.

Mapping genomes

Physical maps, EST, SNPs as physical markers, radiation hybr ids. FISH, optical mapping, gene maps, integration of physical and genetic maps. sequencing genomes: high-throughput sequencing, strategies of sequencing. Recognition of coding and noncoding regions and annotation of genes. Quality of genome-sequence data, base calling and sequence accuracy.

Prenatal diagnosis and genetic counseling

Prenatal diagnosis of birth defects, Uses of amniocentesis, Ultrasonography, Prenatal diagnosis by DNA analysis, Chorion-villi sampling, Genetic counselling

Human immuno genetics

Immunological reactions, Immuno globin genes and structure of immunoglobins Generation of antibody diversity, Human leucocyte antigens, Treatment of autoimmune diseases, Allergy and applied immunology, Blood and antigens, Transplantation antigens

Genetic basis of cancer

Transformed cells, Oncogenes, Carcinogens, Teratoma and teratocarcinomas
Cancer therapy

Suggested Readings:

- Atherly, A.G. Gorton, J.R. and McDonald, J.F., The Science of Genetics. College, Publishing, Harcourt Brace College, Publishers. NY.
- Watson, J.D.; Hopkins, N.H.; Roberts, J.W.; Steitz, J.A. and Weiner, A.M. Biology of Genes, The Benjamin/Cummings Publishing Company Inc. Tokya
- Griffiths, A.J.F., Gelbart, W.M.; Miller, J.H.; Lewontin, R.C. and Modern Genetic Analysis. W.H. Freeman and Company, New York.
- Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cumming, Longman Inc.

- Manage, E. J. and Manage, A. P. Basic Human Genetics. Sinauer Associates, Inc.
- Hartl, Daniel L. Human genetics. Harper and Row
- Rothwell, N. V. Human Genetics. Prentice-Hall.
- Winchester, A. M. Heredity, Evolution and Humankind. West Publishing Company.
- Primrose, S. B. and Twyman, R. M. Principles of Gene Manipulation and Genomics, Blackwell Publishing, West Sussex, UK

Practical Exercises

Cytogenetics- II

Based on the syllabus

M.Sc. Zoology SEMESTER-IV

BIODIVERSITY AND WILDLIFE- I

COURSE CODE: MZOO-406 (i)

(Introduction, Scope & Threats)

Biodiversity

Concepts, definition, Types of Biodiversity (Genetic diversity, species diversity and ecosystem diversity), concept of species distribution, abundance, species evenness and richness, Patterns and scales of Biodiversity (alpha, beta, and gamma), Values and Importance of Biodiversity, Biodiversity Hot Spots, India as megadiverse country, Brief idea of Biogeographic zones of India,

Wildlife

Basic concept, importance and significance of wildlife, wildlife zones of the world and India, Keystone species, Umbrella species and Flagship species, faunal diversity of India. Wildlife of India, Wildlife of Himachal Pradesh. Basic idea of zoogeography (different realms of the world)

Threats to Biodiversity and wildlife

Loss of Genetic diversity, species diversity and ecosystem diversity (Habitat Destruction, Fragmentation, Transformation, Degradation, and invasive species spread), Human wildlife conflict, wildlife depletion, poaching, commercial wildlife exploitation, overgrazing etc. Major Wildlife diseases and their control. IUCN Threatened Categories, Extinction, Threatened Wildlife fauna of India and Himachal Pradesh

Methods to study Biodiversity and Wildlife

Wildlife census, principles, practices, Field Techniques for invertebrates (planktons; insects/arachnids) and vertebrates (amphibian, reptile, Aves and mammals), Line/belt transects, Quadrat sampling, counting methods (total count, road count, pellet count, nest count), pugmark census, camera traps, Introduction of Wildlife telemetry, remotely triggered Camera Trapping, Avian acoustics and identification based on calls. Introduction to Population indices.

Suggested Readings:

- Introduction to Biodiversity, Belsare DK, (2007) A. P. H. Publishing Corp. New Delhi.

- A Textbook of Biodiversity, K.V.Krishnamurtys, 2003, Talor and Francis
- Biodiversity, Wilson, E O (1998), National Academy Press, New York
- Global Biodiversity: Status of Earth's Living Resources. Groombridge B. (2011) Chapman and Hall Publ. London
- Biodiversity and its conservation in India 1993 Negi, S.S. Indus Publishing Co., New Delhi.
- Threatened Animals of India, B.K. Tikadar. (1983) ZSI Publication, Calcutta.
- Treasure of Indian Wildlife Kothari, A.S. & Chapgar. (2005), BNHS, Mumbai.
- The Book of Indian Birds, Ali, Salim, 1997 Oxford University Press, Mumbai
- Zoogeography of India and Asia. Tiwari, S.K. CBS Publisher and Distributors, New Delhi
- Book of Indian Animals. Prater, S.H (1988) Bombay Natural History Society, Mumbai

Practical Exercises

Biodiversity and Wildlife-I

- Study of Bird Census techniques in field-Transect, point count and call count methods.
- Ornithological statistical analysis of field identified birds based on their colour, size, flight, calls and nest building.
- Comparative study of avian fauna with respect to habitat variation.
- Acoustic analysis of Bird calls and songs.
- Beta diversity of faunal diversity in Himachal Pradesh University campus
- Estimation of abundance and distribution of any one mammalian species of Himachal Pradesh
- Call Identification of common birds – any five birds
- Pugmark analysis and Camera trap methods.
- Animal Scat, pellet, dung, droppings analysis (Indirect evidences)

M.Sc. Zoology

SEMESTER-IV

BIODIVERSITY AND WILDLIFE- II

COURSE CODE: MZOO-406 (ii)

(Conservation and Management)

Conservation and Protected Area Network

Conservation - meaning, principles, strategies. *in situ* and *ex situ* conservation. Protected Areas: Concept and design, Biosphere Reserves, National Parks, wildlife sanctuaries, Ecological sensitive areas, Community Reserves. Protected Area Network in India, and Protected Area Network in Himachal Pradesh.

Behavioural Ecology and Captive Breeding of Wild animals

Communication and Signalling, modes of communications, Home range and territory, size of territory, cost and benefits of territorial defence, animal migration, courtship display and mate selection, courtship behaviour among birds, biological significance of courtship display, evolutionary significance of mate choice, concept and advantages of captive breeding.

Organizations for the conservation and management

History of wildlife management and conservation in India, , Endangered and Endemic species of India, role of WWF, IUCN, UNEP, Red Data Book, Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), ZSI, and Wildlife Institute of India in the conservation of biodiversity and wildlife, Ramsar Convention.

Special management projects and legislations in India

Introduction and concepts of special wildlife management projects in India, brief introduction of Project Tiger, Elephant, Rhino and Project Crocodile. Animal rights and ethics. Salient Features and Importance of Indian Forest Act and Wildlife Protection Act of India.

Suggested Readings:

- Biodiversity: An Introduction 2nd Edition Kevin J Gaston and John I Spicer 2004, Blackwell Publishing Company
- The Biology of Biodiversity, M. Kato. (2000) Springer.
- Concepts in Wildlife Management. B. B. Hosetti. (2005) 2nd Revised & Enlarged Edn, 2005. Daya Publishing House, Delhi.
- Indian Wildlife Resources Ecology and Development Sharma, B.D 1999 Daya Publishing House, Delhi
- Manual for Wildlife Management in India, 1993 Negi, S.S. International Book Distributors
- Wildlife Biology An Indian Perspective, Goutam Kumar Saha and Subhendu Mazumdar 2021 PHI Learning Private Ltd. Delhi
- Wild Animals, Their Minds and Manners, Hornaday, W.T. 1989 IBD, Dehradun

Practical Exercises

Biodiversity and Wildlife-II

- On a political map of India and Himachal Pradesh, locate & demarcate major sanctuaries / national parks.
- Mention the location and functions of two major scent glands used for territory marking in any two mammal's photographs/pictures.
- Collection of data pertaining to wildlife and Biodiversity component in People Biodiversity Register (PBR) formation.
- make a project report on Ramsar convention or on any management project.
- Visit to Zoo/Wildlife Sanctuary/National Park/ of Himachal Pradesh and preparation of report.

M.Sc. Zoology

SEMESTER-IV

MOLECULAR PHYSIOLOGY

COURSE CODE: MZOO-407 (i)

Digestive System

Metabolism of carbohydrates, lipids and proteins, Nutritional disorders, Neural and hormonal control of Gastrointestinal movements.

Respiratory system

Neural regulation of respiration, Humeral regulation of respiration,

Blood Vascular System

Intrinsic, nervous and humeral regulation of circulation, Cardiac cycle, Conduction system in heart, Control of excitation and conduction in heart

Excretion

Counter-current mechanism (Formation of concentrated and dilute urine), Secretion, Reabsorption of different electrolytes, ions, molecules, Renin-Angiotensin system

Muscular System

Ultrastructure of smooth muscle cell, Mechanism and regulation of vascular, smooth muscle contraction, An introductory idea of "latch" and "Catch", Diversity of slow and fast muscles.

Nervous System

Reflex mechanism, Types of reflexes, Functional compartmentalization of brain and hierarchy of control

Reproductive Physiology

Hormonal regulation of spermatogenesis, and oogenesis, Mammalian reproductive cycles, Implantation, Parturition, Lactation

High Altitude and deep sea Physiology

Effect of low O₂ at high altitude, Acclimatization to low O₂, Angular acceleratory forces and their effects, Artificial climate, and weightlessness, Nitrogen narcosis and oxygen toxicity.

Suggested Readings:

- Guegg, J.C.: Calcium in muscle activation, Springer Verlag Berlin Heidelberg, New York.
- Hoar, W.S.: General and comparative physiology, Prentice, Hall, Inc./England Wood cliffs, New Jersey.
- Guyton, A.C. and Hall, J.E.: Text book of medical physiology, 10th Ed., Saunders, Harcourt, India.
- Heilmeyer, L.M.G. Cellular regulation of protein phosphorylation, Springer-Verlag, Berlin Heidelberg, New York.
- Prosser, C.L. and Brown, F.A.: Comparative Animal Physiology, 2nd Ed. W.B. Saunders, Philadelphia.
- Karpati, G., Jones, D.H. and Griggs, R.C.: Disorders of Voluntary Muscle, 7th Edn, Cambridge University Press.
- Turner, C.D.: General Endocrinology, 4th Ed. W.B. Saunders, Philadelphia, London

Practical Exercises

Molecular Physiology

Based on the syllabus

M.Sc. Zoology
SEMESTER-IV
COMPARATIVE ENDOCRINOLOGY
COURSE CODE: MZOO-407 (ii)

History and Scope

History and scope of endocrinology, Hormone like substances: Ectohormones and phytohormones, Mechanism of hormone action, Hormones and environment

Comparative Account of Glands-I

General and comparative structure of pituitary gland, General and comparative structure of neurohypophysis, General and comparative structure of thyroid and parathyroid, General and comparative structure of pancreas

Comparative Account of Glands-II

Structure of mammalian pineal body, Functional significance of pineal hormones, General and comparative structure of adrenal medulla, General and comparative structure of adrenal cortex

Neuroendocrinology

Neurosecretion and neuroendocrine mechanisms in invertebrates, Role of hypothalamus and neuroendocrine integration in mammals

Endocrine integration

Migration of birds and fishes, bird plumage

Suggested Readings:

- An Introduction to Neuroendocrinology: Michael Wilkinson and Richard E Brown (2015), Cambridge University Press, UK.
- Neuroscience: Exploring the Brain: 4th edition, Mark F. Bear, Barry W. Connors and Michael A. Paradiso (2015). Wolters Kluwer.
- Introduction to Behavioral Neuroendocrinology (5th edition), Randy J. Nelson and Lance J. Kriegsfeld (2016) Oxford University Press.

Practical Exercises

Comparative Endocrinology

- Dissection of endocrine glands in vertebrate and invertebrates (under IAEC regulations)
- Determination of proteins, cholesterol, sugar level using spectrophotometer
- Separation of plasma proteins using electrophoresis
- Microtomy of endocrine material (tissue fixation, processing, paraffin block preparation, sectioning, staining and mounting)
- Study of slides of endocrine material from different animals
- Identification of chemical structures of peptides and steroid hormones
- Study of electron micrographs

M.Sc. Zoology
SEMESTER-IV
PARASITOLOGY
COURSE CODE: MZOO-408 (i)

Parasitic Protozoa

Locomotion, Nutrition, Economic importance of Parasitic Protozoa

Trematodes

Ultrastructure of Tegument, Cercaria of *Digenea*, Life Cycles in *Digenea*

Cestodes

Ultrastructure of Tegument, Adhesive organs, Larval forms and variations in life cycles

Nematodes

Ultrastructure of Tegument, Comparative anatomy of Digestive systems, Protein, Lipid and Carbohydrate metabolism in Nematodes, Infective stages and variations in life cycles

Parasite Transmission

Mechanism for location, penetration into host, nutrition in helminths, uptake and digestion

Suggested Readings:

- Cheng, T.C. General Parasitology Academic Press, Inc. (1986)
- Noble E.R. and Noble, G.A. Parasitology, The biology of Animal parasites Lea and Fabigor.
- Anderson D.R. comparative Protozoology, Cambridge Uni. Press.
- Chandler. A.C. and Read, C.P: Introduction of Parasitological, Willy, Eastern.
- Belding, D.A. A text book of Parasitological, Meredith Publ. Co.
- Bager, J.R. Parasitic Protozoa, Academic Press. Grell. K.G. Protozoology, Springer Verlag.
- Maggenti A:” General Nematology, Springer Verlag.
- Erasmus D.A: The biology of Trematodes, Edward Arnold (Publ.) Ltd.
- Dawes Ben: The Trematodes, Cambridge University Press
- Wardle R.A. & McLeod J.A: The Zoology of Tapeworms, HafnerPubls. Co.,
- Cox F” E.G. Modern Parasitology- A Text book of Parasitology, Blackwell Scientific Publ.
- Chappel L.H.: Physiology of Parasites, Blakie
- Croll N.A. & Mathews B.F: Biology of Nematodes, Blakie
- Lee D. C. & Atkinson J.J: Physiology of Nematodes, The Macmillan Press Ltd.
- Smyth J.D. & Mcmannus D.P: The Physiology and Biochemistry of Cestodes

Practical Exercises

Parasitology

- Study of the protozoan parasites through slides: Study of malaria- infected blood smear of mouse with Plasmodium sp.
- Study of permanent slides of cestodes parasites
- Detailed morphological studies of *Taenia* sp.: Dissect and expose the digestive and reproductive system

- Study of permanent slides of trematodes parasites- *Fasciolasp*.
- Study permanent slides of nematodes
- Detailed morphological of *Ascaris*: Dissect and expose the digestive, male and female reproductive system and study the permanent slides-T. S. *Ascaris* male, T.S. *Ascaris* female.
- Detailed morphological of Whipworm and Pinworm: Dissect and expose the digestive and reproductive system of parasite.

M.Sc. Zoology
SEMESTER-IV
MEDICAL PARASITOLOGY
COURSE CODE: MZOO-408 (ii)

Parasitic Protozoa

Classification of medically important protozoan parasites, epidemiology of parasitic infections, immunology of human parasitic infections. Diagnostic parasitology- General study related to pathogenesis, laboratory diagnosis prophylaxis and serological diagnosis of protozoan parasites

Platyhelminthes

Classification, comparison in ultrastructure of tegument of parasites of important trematodes and cestodes, epidemiology of parasitic infections, immunology of human parasitic infections. different larvae, life cycles of digenea and parasitic transmission. laboratory diagnosis prophylaxis and serological diagnosis of parasites.

Nematodes

General characters of human parasites, comparison of ultrastructure of tegument with platyhelminths. Comparative anatomy of Digestive systems. Infective stages and variations in life cycles and Parasite Transmission. Parasitic pathogenesis, laboratory diagnosis prophylaxis and serological diagnosis of medically important parasites.

Transmission of Disease

Brief epidemiology, mode of transmission and of some important human diseases. Kala azar, Cholera, Malaria, Dengue fever, Filariasis, AIDS & COVID-19 and Vaccination: different types of vaccines

Practical Exercises

Molecular Physiology

Based on the syllabus

Suggested Readings:

1. Cheng, T.C. General Parasitology Academic Press, Inc. (1986)
2. Noble E.R. and Noble, G.A. Parasitology, The biology of Animal parasites Lea and Fabigor.
3. Anderson D.R. comparative Protozoology, Cambridge Uni. Press.
4. Chandler. A.C. and Read, C.P: Introduction of Parasitological, Willy, Eastern.

5. Belding, D.A. A text book of Parasitological, Meredith Publ. Co.
6. Bager, J.R. Parasitic Protozoa, Academic Press.
7. Grell. K.G. Protozoology, Springer Verlag.
8. Maggenti A:” General Nematology, Springer Verlag.
9. Erasmus D.A: The biology of Trematodes, Edward Arnold (Public) Ltd.
10. Dawes Ben: The Trematodes, Cambridge University Press
11. Wardle R.A. & McLeod J.A: The Zoology of Tapeworms, HafnerPubls. Co.,
12. Cox F” E.G. Modern Parasitology- A Text book of Parasitology, Blackwell Scientific Publ.
13. Chappel L.H.: Physiology of Parasites, Blakie
14. Croll N.A. & Mathews B.F: Biology of Nematodes, Blakie
15. Lee D. C. & Atkinson J.J: Physiology of Nematodes, The Macmillan Press Ltd.
16. Smyth J.D. & Mcmannus D.P: The Physiology and Biochemistry of Cestodes