

**CIRCULAR NO.SU/Sci. & Tech./University Deptt./NEP/22/2023**

It is hereby inform to all concerned that, the syllabi prepared by the Departmental Committee and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted **the following curriculum of All Post Graduate Degree Courses as per Norms of National Education Policy - 2020 under the Faculty of Science & Technology run at University Department, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Syllabi of Department of BAMU, Aurangabad.	Semester
1.	M.Sc.Zoology	Ist and IInd Semester
2.	M.Sc.Forensic Science	Ist and IInd Semester
3.	M.Sc.Nanotechnology	Ist and IInd Semester

This is effective from the Academic Year 2023-24 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/NEP/2023/1010-20
Date:- 16.08.2023.

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*Deputy Registrar,
Academic Section*

Copy forwarded with compliments to :-

- 1] Head of the Department, Department of Zoology, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.
- 2] Head of the Department, Department of Nanotechnology, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.
- 3] Head of the Department, Department of Forensic Science, Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.
- 4] The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.

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- 1] The Director, Board of Examinations & Evaluation, Dr.BAMU,A'bad.
- 2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
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**DR. BABASAHEB AMBEDKAR MARATHWADA
UNIVERSITY, AURANGABAD, MAHARASHTRA, INDIA**



FACULTY OF SCIENCE AND TECHNOLOGY

2 YEARS P.G. PROGRAMME

COURSE STRUCTURE AND CURRICULUM

As Per National Education Policy 2020

**Subject - ZOOLOGY
Course Structure for M.Sc. 1st Year**

FOR UNIVERSITY DEPARTMENT

**Department of Zoology (Autonomous)
Dr. Babasaheb Ambedkar Marathwada University,
Aurangabad-431004
(Effective from 2023-24)**

As per NEP 2020

**Credit distribution structure for Two Years PG Program with
Multiple Entry and Exit Options**

Class: M.Sc. First Year Semester: 1st Semester
Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	ZOO/DSC/520	Biosystematics and animal diversity	3	-	3	-	14
	ZOO/DSC/521	Biochemistry	3	-	3	-	
	ZOO/DSC/522	Ecology (Principles and Practices)	3	-	3	-	
	ZOO/DSC/523	Practical based on ZOO/DSC/520	-	3	-	1	
	ZOO/DSC/524	Practical based on ZOO/DSC/521	-	3	-	1	
	ZOO/DSC/525	Practical based on ZOO/DSC/522	-	3	-	1	
	ZOO/DSC/526	Practical Skill/advanced technique	-	4	-	2	
DSE (Choose any one from pool)	ZOO/DSE/527	Helminthology - I	3	-	3	-	04
	ZOO/DSE/528	Protozoology – I	3	-	3	-	
	ZOO/DSE/529	Entomology – I	3	-	3	-	
	ZOO/DSE/530	Endocrinology – I	3	-	3	-	
	ZOO/DSE/531	Practical based on ZOO/DSE/527	-	2	-	1	
	ZOO/DSE/532	Practical based on ZOO/DSE/528	-	2	-	1	
	ZOO/DSE/533	Practical based on ZOO/DSE/529	-	2	-	1	
	ZOO/DSE/534	Practical based on ZOO/DSE/530	-	2	-	1	
RM	ZOO/RM/535	Research Methodology I	4	-	4	-	04
			16	12	16	06	Total credits 22

Class: M.Sc. First Year Semester: 2nd Semester

Subject: Zoology Theory + Practical

Course type	Course Code	Course name	Teaching Scheme (Hrs/week)		Credits Assigned		Total Credits
			Theory	Practical	Theory	Practical	
DSC Core Course	ZOO/DSC/570	Genetics and Bioinformatics	3	-	3	-	14
	ZOO/DSC/571	Cell and Molecular Biology	3	-	3	-	
	ZOO/DSC/572	Biophysics	3	-	3	-	
	ZOO/DSC/573	Practical based on ZOO/DSC/570	-	3	-	1	
	ZOO/DSC/574	Practical based on ZOO/DSC/571	-	3	-	1	
	ZOO/DSC/575	Practical based on ZOO/DSC/572	-	3	-	1	
	ZOO/DSC/576	Practical Skill/advanced technique		4		2	
DSE (Choose any one from pool)	ZOO/DSE/577	Helminthology - II	3	-	3		04
	ZOO/DSE/578	Protozoology – II	3	-	3		
	ZOO/DSE/579	Entomology – II	3	-	3	-	
	ZOO/DSE/580	Endocrinology – II	3	-	3	-	
	ZOO/DSE/581	Practical based on ZOO/DSE/577	-	3	-	1	
	ZOO/DSE/582	Practical based on ZOO/DSE/578	-	3	-	1	
	ZOO/DSE/583	Practical based on ZOO/DSE/579	-	3	-	1	
	ZOO/DSE/584	Practical based on ZOO/DSE/580	-	3	-	1	
RM	ZOO/OJT/FP/585	OJT/FP	-	8	-	4	04
			12	12	12	10	Total credits 22

For Practical – 1 Credit = 30 clock Hrs. (For 13 Practical compulsory – 3 Hours each)

Total credits for theory = 16 credits

Total credits for practical = 6 credits

Total credits = 22 credits

Class: M.Sc. First Year: Zoology First Semester

1: DSC – ZOO/DSC/520 Biosystematics and animal diversity

ZOO/DSC/521 Biochemistry

ZOO/DSC/522 Ecology (Principle and Practices)

ZOO/DSC/523 Practical based on Biosystematics and Animal Diversity

ZOO/DSC/524 Practical based on Biochemistry

ZOO/DSC/525 Practical based on Ecology (Principle and Practices)

ZOO/DSC/526 Practical Skilled-based Advance technique

2: DSE – (Choose any one from Pool/Basket)

ZOO/DSE/527 Helminthology I

ZOO/DSE/528 Protozoology I

ZOO/DSE/529 Entomology I

ZOO/DSE/530 Endocrinology I

ZOO/DSE/531 Practical based on Helminthology I

ZOO/DSE/532 Practical based on Protozoology I

ZOO/DSE/533 Practical based on Entomology I

ZOO/DSE/534 Practical based on Endocrinology I

3: RM-1 - ZOO/RM/535 Research Methodology - I

Second Semester

1: DSC – ZOO/DSC/570 Genetics and Bioinformatics

ZOO/DSC/571 Cell and Molecular Biology

ZOO/DSC/572 Biophysics

ZOO/DSC/573 Practical based on Genetics and Bioinformatics

ZOO/DSC/574 Practical based on Cell and Molecular Biology

ZOO/DSC/575 Practical based on Biophysics

ZOO/DSC/576 Practical Skilled-based Advance technique

2: DSE – (Choose any one from Pool/Basket)

ZOO/DSE/577 Helminthology II

ZOO/DSE/578 Protozoology II

ZOO/DSE/579 Entomology II

ZOO/DSE/580 Endocrinology II

ZOO/DSE/581 Practical based on Helminthology II

ZOO/DSE/582 Practical based on Protozoology II

ZOO/DSE/583 Practical based on Entomology II

ZOO/DSE/584 Practical based on Endocrinology II

3: RM-1 - ZOO/OJT/FP/585 OJT/FP

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
Department of Zoology

M. Sc. First Year (Semester – I)

Paper No. ZOO/DSC/520- BIOSYSTEMATICS AND ANIMAL DIVERSITY

Contact Hours: 45

credits- 3

Learning Objectives:

- To give a thorough understanding in the principles and practice of systematic
- To help students acquire an in-depth knowledge on the diversity and relationships in animal world
- To develop an holistic appreciation on the phylogeny and adaptations in animals

Learning Outcomes:

- The students will learn the basic principle and practices used in systematic.
- The students will learn and understand the diversity in animal world and their adaptations.
- The students will learn about the phylogeny, the tools and salient features of taxonomic publications.

BIOSYSTEMATICS

30hrs

UNIT I:

Concepts Biological Classification and techniques in systematic

8 hrs.

Hierarchy of categories and higher taxa. Taxonomic Procedures-collection, preservation, curation and process of identification.

Taxonomic characters of different kinds-quantitative and qualitative analysis of variation, Process of typification, different zoological types and their significance.

Three Domain Concept in Systematics, two, five and six kingdom classification.

UNIT II:

Methods of Biosystematics and Taxonomic publication

8 hrs.

Classical and modern Methods- Concept of species- taxonomic diversity within species. Typological, Biological, Evolutionary, Phylogenetic, Cladistics and Molecular Taxonomy. Phylocode, Tree of Life and Bar-coding of Life. Molecular Phylogeny-use of Proteins, DNA and RNA. Phylogenetic trees.

. International Code of Zoological Nomenclature (ICZN), Rules and formation of Scientific names of different taxa. Homonymy and Synonymy. Phenetics, Keys, types, use of keys, merits and demerits

ANIMAL DIVERSITY

30hrs.

UNIT III:

Basics of Prokaryotes and Eukaryotes Origin of Protista and lower Metazoans,

9 Hrs

Levels of organization in animal kingdom.

Edicaran and Burgess Shale fauna. Cambrian explosion-causes and consequences. Possible theories of metazoan origin, and Metamerism-evolutionary advantages.

Porifera, Cnidaria-, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudo-coelomata- evolutionary relationships and adaptive modifications (Polymorphism) only.

UNIT IV:

Protostomes; Deuterostomes; Lesser Protostomes and Echinodermata 9hrs.

Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids.

Phylogeny of Arthropod-Monophyly and Polyphyly, Reasons for the success of Arthropods. Major classes under Arthropod and adaptive radiation.

Sipuncula, Echiura, Phoronida, Brachipoda, Onychophora and Chaetognatha, echinodermata-Phylogeny only.

Hemichordates and Ancestry of Chordates

6 hrs.

Position of hemichordate, cephalochordata and urochordata in the animal kingdom, evolutionary significance

Vertebrate Phylogeny-Agnatha, Ostracoderms and Gnathostomes- Placoderms, Acanthodians, Chondrichthyes and Osteichthyes. Structural and Functional adaptations of fishes.

UNIT V

Terrestrial Vertebrates - Birds and Mammals

5 hrs.

Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats.

Reptiles-origin and adaptive radiation (Skull of reptiles and its importance in biosystematics). Mesozoic world of reptiles and extinction.

Origin of birds and mammals. Structural and functional modifications for aerial life. Class Mammalia: Prototheria, Metatheria and Eutheria. Adaptive radiation in mammals.

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1. Alfred, J.R. and Ramakrishna. 2004. *Collection, Preservation and Identification of Animals*. Zoological Survey of India Publications, Calcutta.
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6. Campbell, N.A. and J.B. Reece. 2009. *Biology* (8th edn). Benjamin Cummings Publ. NY, USA
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Waterman,A.J.1971.*Chordate Structure and Function*.MacmillanCo.London
14. Winston, J.E.2000. *Describing species: Practical Taxonomic Procedures for Biologists*. Columbia University Press, Columbia, USA.
15. Young, J.Z. 1950. *Life of Vertebrates*. Clarendon Press, Oxford, UK.

Paper No. ZOO/DSC/521 - BIOCHEMISTRY

Contact Hours: 45

credits- 3

Learning Objectives:

- To understand the chemical nature of life and life process
- To provide an idea on structure and functioning of biologically important molecules
- To generate an interest in the subject and help students explore the new developments in biochemistry.

Learning Outcome:

The students will learn how the metabolic processes are interrelated

The bimolecular interactions

UNIT I

Introduction

5hrs.

1. Water: structure, solvent properties, biological importance. pH and acid-base balance. Henderson–Hasselbalch Equation, Buffers-biological importance.

Carbohydrates

1. Introduction to Carbohydrates - Monosaccharide, and Disaccharides: sugars of biological importance.
2. Structural representations of sugars-Acetal and hemiacetal, ketal and hemi-ketal linkages,
3. Isomerism—structural isomerism and stereoisomerism, optical isomerism, epimerism and anomerism. Mutarotation and inversion of sugars.
4. Polysaccharides: Homopolysaccharides- Starch, Glycogen, Cellulose, Chitin, Dextrins, Inulin, Heteropolysaccharides- Hyaluronic acid, Heparin, Chondroitin sulphate, Keratin sulphate, Dermatan sulphate. Glycoproteins and Mucoproteins.

UNIT II

Lipids

10hrs.

1. Classification of lipids: simple, compound and derived lipids. Biological importance of lipids. Fatty acids: classification.
2. Simple fats: Triacylglycerol (Triglycerides). Compound lipids: Phospholipids- Lecithin, Phosphatidyl inositol, Cephalins, Glycolipids, Sphingolipids. Derived Lipids, Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Ergosterol, Terpenes, Lipoproteins, waxes. Prostaglandins- structure, types, and functions.

Proteins

1. Structure, classification and Properties of amino acids. Reactions (due to carboxyl group, amino group and side chains). Primary structure of protein (e.g. insulin). Classification and properties of proteins. Conformation of proteins-chemical bonds. Secondary structure- alpha helix, Collagen helix, Beta Pleated sheet, stabilizing forces, Ramachandran angles and Ramachandran map.
2. Fibrous proteins- occurrences and importance examples (Keratin, Collagen, Elastin, Resilin, Fibrous muscle proteins). Chaperons. Tertiary structure-e.g. Myoglobin. Quaternary structure-e.g. Haemoglobin.

Nucleic Acids

1. Introduction Nucleic acids. Structural organization of DNA (Watson–Crick model). Characteristic features of A,B,C and Z DNA. Structural organization of tRNA; Protein-nucleic acid interaction. DNA regulatory proteins, folding motifs, conformation flexibilities, denaturation, renaturation. 3. Biological roles of nucleotides and nucleic acids.

UNIT III .

Enzymes

15hrs.

1. Classification- (I.U.B.system),. Enzyme specificity. Mode of action of enzymes. Formation of enzyme substrate complex. Lowering of activation energy, Various theories, Activesite.co-enzymes, iso-enzymes. Enzyme kinetics: Michaelis-Menten equation. Km value and its significance. Enzyme velocity and factors influencing enzyme velocity. Kinetics of enzyme inhibition, suicide inhibition and feedback inhibition. Enzyme regulation: Allosteric regulations- Key enzymes, Covalent modification. Enzyme engineering.

Carbohydrate Metabolism

1. Glycolysis–Fate of pyruvate. Citric acid cycle and its significance; Central role of citric acid cycle. Oxidative and substrate level phosphorylation. Gluconeogenesis – (from aminoacid and lactate).
2. 2.Glycogen metabolism-Glycogenesis, Glycogenolysis, Adenylate cascade system, Ca^{+2} Calmodulin-sensitive phosphorylase kinase. Regulation of glycogen synthesis.
3. 3.Minor metabolic pathways of carbohydrates: Pentose Phosphate pathway, Inborn errors associated with carbohydrate metabolism. Glycogen storage diseases, Lactose intolerance, Galactosuria.

UNIT IV

Metabolism of Proteins

10 hrs.

1. Amino acid Metabolism-Deamination,Transamination and Trans-deamination.Formation and disposal of ammonia.
2. Urea cycle.Fate of carbon skeletons of aminoacids: glucogenic, ketogenic, partly glucogenic and ketogenic with examples.

Metabolism of Lipids

1. Betaoxidation. Metabolism of cholesterol, synthesis and its regulation. Biosynthesis of triglycerides. Metabolism of ketone bodies-Ketogenesis, Ketolysis, Ketosis.

UNIT V

Nucleic Acid and Mineral Metabolism

5 hrs.

1. Catabolism of purines and pyrimidines. Major and minor nutrients. Role of Calcium, Phosphorus, Magnesium, Sodium, Potassium, Chloride, Sulphur and Iron.
2. Free radicals and antioxidants, Generation of free radicals. Reactive oxygen species. Free radical scavenger systems. Lipid peroxidation. Preventive antioxidants.

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Paper No. ZOO/DSC/522 - ECOLOGY: PRINCIPLES AND PRACTICES

Contact Hours: 45

credits- 3

Learning objectives:

- To provide an understanding on the basic theories and principles of ecology
- To help study various disciplines in ecology
- To learn current environmental issues based on ecological principles
- To gain critical understanding on human influence on environment

Learning Outcome

- The student will learn the theories that governs the principle of ecology .
- The students will learn the various aspects of ecology
- The students will learn the environmental issues at local , national and global level.

UNIT I

Ecology and Environment & Ecosystem-Structure and Function

10hrs.

Physical Environment-biotic and abiotic interactions. Concept of Homeostasis; concepts of habitats- host as habitat, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.

Ecosystem and Landscapes, pathways in ecosystem, energy in the environment-Laws of thermodynamics, Cybernetic nature of ecosystem, and Gaia hypothesis.

Energy flow in the ecosystem. Primary productivity, Biomass and productivity measurement. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles-patterns and types (CNP).

UNIT II :

Population and Community Ecology

15hrs.

Population group properties, density and indices of relative abundance, Concept of rate. Natality and mortality. Population age structure, Growth forms and concept of carrying capacity.

Population fluctuations, density dependent and density independent controls. Life history strategies, r & k selection.

Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality.

Population interactions-types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition.

Concept of community-community structure and attributes, ecotone and edge effect. Development and evolution of the ecosystem, concept of climax.

UNIT III

Resource Ecology

15hrs.

Natural Resources: Soil-soil formation, physical and chemical properties of soil. Significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources- deforestation, forest scenario of India. Aquatic resources- Freshwater and water scarcity, water conservation measures-case studies from India; Wetlands and its importance, international initiatives for wetland conservation-Ramsar sites. Sand

mining and its impacts. Wetland reclamation-causes and consequences. Depletion of resources and impacts on quality of life.

Energy Resources-solar, fossil fuels, hydro, tidal, wind, geothermal and nuclear. Energy use pattern in different parts of the world, recent issues in energy production and utilization; Energy audit, Green technology and sustainable development.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques, Ecosystem Modelling (Brief account only).

UNIT IV : Applied Ecology

10hrs.

Environmental Pollution mitigation at international level, International protocols, Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management-aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation-need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters.

Radiation Biology-natural and man-made sources of radioactive pollution; radioisotopes of ecological importance; effects of radioactive pollution; nuclear disasters(two case studies), Disposal of radioactive wastes. Weak radiation LF-EMF.

UNIT V :

Biogeography and Conservation

10hrs.

Major terrestrial Biomes, theory of island biogeography, bio-geographical zones of India; Western Ghats and its significance, Hot spots in India.

Restoration Ecology- need and policies, case studies and success stories - global and national;

Global environmental problems and debates-past and present; Participatory resource management, community reserves, sacred groves, bio villages.

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Practical Paper No. ZOO/DSC/526 (Skill/Advanced techniques).

Biostatistics, Microbiology, and Applied Biotechnology.

1. Preparation of basic liquid media (broth) for the cultivation of bacteria.
2. Solid media for the growth of microorganisms.
3. Isolation of microorganisms by pour plate method.
4. Microscopic execution of bacteria by Gram stain.
5. Assay of antibiotic and demonstration of antibiotic resistance.
6. Biochemical characterization of selected microbes.
7. Solid media for growth of microorganism.
8. Spread plate technique.
9. Isolation of maintenance of microorganisms by streak plate method.
10. Calculate the percentile for the values.
11. Find out the 25th percentile of the following data.
12. Determination of mean, mode, median, standard deviation, variance, standard error using formula/calculator/computer.
13. Problems on probability.
14. Binomial and Poisson distribution.
15. Z score
16. Problems of chi square test with reference to goodness of fit and homogeneity.
17. T test: Unpaired and paired.
18. Analysis of variance (ANOVA) for comparing 3-4 variables.
19. Post hoc test
20. Factorial combination treatment.
21. Problems of hypothesis testing: one and two directional.
22. Problems of randomized completed block design.
23. Completely randomized design with random effect.
24. Problems on randomized block fully randomized incomplete blocks, Lattice design.

25. Extraction of genomic DNA from bacterial cell
26. Synthesis of nano particles.
27. DNA extraction from Agarose Gel.
28. Biological sample preparation for Scanning Electron Microscopy (SEM).
29. Study of vermicomposting and maintenance.
30. Visit to Dairy/Biotechnology industries.

Elective Courses

Paper No. ZOO/DSE/527- Helminthology I

Contact Hours: 45

credits- 3

Learning Objectives:

1. To impart basic knowledge of Helminthes, Cestodes and Trematodes.
2. To orient to major types of important cestodes and trematodes.
3. To develop the ability to collect, and identify important cestodes and trematodes from regions.
4. To develop experts in the field of Helminthology.

Learning Outcome:

1. The students will learn about helminths, cestodes, and trematodes.
2. The students will be able to identify. Parasites and can develop expertise.

Unit I: Introduction, history, and scope of Helminthology.

1. General organization and classification of Platyhelminthes up to order level.
Cestodes (Cestodarians and Eucestodes), Trematodes (*Monogenea*, *Aspidobothria* and *Digenea*)
2. Functional anatomy of Reproductive system
 - a. Trematodes (*Digeneans*)
 - b. Cestodes (*Pseudophyllideans* and *Cyclophyllideans*)
 - c. Eggshell formation, the chemistry of eggshell formation, factor influencing embryonation and hatching.

Unit II:

1. Intramolluscan stages and their effect on molluscan hosts, effect on foot, hepatopancreas, Reproductive system, and general metabolism.
2. Various types of Cercaria.
3. Different types of larvae in cestodes and their pathogenicity.
4. Holdfast organs with their adaptation in cestodes.

Unit III:

1. Pathogenicity, control, treatment, prevention of some important Helminthes of medical and veterinary importance .
2. Life cycle patterns of Digenetic trematodes.
 - a. Single intermediate host life cycles.
 - b. Two intermediate host life cycles
3. Life cycle patterns in Cestodes
 - a. No intermediate host life cycle
 - b. Single intermediate host life cycle
 - c. Two intermediate host life cycle

Unit IV:

1. Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment, and prevention of the following types of cestodes :

1. *Amphilina*
 2. *Diphyllbothrium latum*
 3. *Echinococcus granulosus*
2. Physiology of cestodes.
- Nutrition
 - Carbohydrate metabolism
 - Fat metabolism

Unit V:

1. Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment, and prevention of the following types:
 - Polystoma integrimum*
 - Aspidogaster conchicola*
2. *Digenea*: 1. *Pragonimus westermani* 2. *Gastrodiccoides hominis*.
3. Immunological reactions of trematodes: Basic concept of Immunology, Antigen-Antibody reaction, Innate and Acquired reaction, Host-parasite interaction. Evasion and subversions of immune defenses. Role of Antihelminthes drugs

LIST OF BOOKS

1. Medical Parasitology by Markell, Voge and John, 8th ed. W.B. Saunders Co.
2. The Biology of animal parasites, Cheng T.C. (1964)-Saunders International Student Edition
3. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
4. Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J(1988)
5. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
6. Parasitology (Protozoology and Helminthology) -Sood Pamnik (1993) CBS Publication and Distribution, Delhi.
7. Human helminthology Manual for Clinical, Sanitarians Medical Zoologists - Faust, Emerest Carroll.
8. Systema Helminthum Vol. IV Monogenica and Aspidobothria -Yamaguti S.(1963) Inter- Science Publishers, London.
9. Synopsis of Digenetic Trematodes of Vertebrates - Yamaguti S. (1971) Vol. I & II Keigaku Publishing Co., Tokyo, Japan.

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1. The Invertebrates Vol.II - Hyman L. H.
2. The Trematode - Dausese B
3. Text book of medical Parasitology - Dey
4. Text book of medical Parasitology - Sawitz
5. Parasitology-Nobel and Nobel

6. Structure of Nematode - Allen bird
7. An introduction to Nematodology - Chitwood
8. Organization and Biology of nematodes -Crool
9. Physiology of nematodes - Lee
10. Plant parasitic nematode - Parmonove
11. Principal of Nematodology - Throne
12. Plant Nematodology - Jenkins and Taylor
13. General Parasitology - Cheng
14. Clinical Parasitology - Craig Faust
15. Applied Parasitology - Hiware, Jadhav and Mohekar
16. Biochemistry of parasitism - Von Brand
17. Physiology of nematode parasite - Smith
18. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
19. Laboratory methods of work with plant and soil nematodes -Southey
20. Soil and fresh water Nematodes - Goodey.
21. Practical exercise in Parasitology-Halton, Behave, Marshall.
22. Animal Nematodes from Indian Mammals-Nama, Shinde and Jadhav.
23. Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
24. The Zoology of Tapeworm.- Wardle and Mcleod (1952)
25. The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
26. Systema Helminthum Vol. II Cestoda. - Satyu Yamaguti (1959)
27. The Physiology of Cestodes. - J.D Smyth
28. Vertebrate Nematodes - York and Mapelston
29. Plant Parasitic Nematodes, bionomics & control - Christie
30. Modern Parasitology - Cox
31. Essential Parasitology-Schimdit
32. Parasitism - Cameron
33. Animal Parasitism - Read
34. Parasitism and Symbiology - Read
35. Physiology of nematode parasites - Bee
36. Nematodes Parasites of domestic animal - Levine
37. Structure of Nematodes -Allen Bird
38. Medical Parasitology (Protozoology and Helminthological) - Chatterjee K. D
39. Laboratory Methods for work with plant and soil Nematodes.-Southey
40. An Introduction to Parasitology - Chandler and Read

Paper No. ZOO/DSE/528- Protozoology I

Contact Hours: 45

credits- 3

Course objective:

1. The basic concepts of Protozoan systematic
2. To study the systematic of Subkingdom Protozoa.
3. To study the biological importance of free-living Protozoa.
4. To study the methodology of collection and identification of free-living protozoa.
5. To study culture methods of free-living protozoa.

Learning Outcome:

1. The students will learn the economic importance of protozoans, their systematics, and techniques
2. The students will learn the different culture methods.

Unit - I

1. Classification of Protozoa up to order level
2. Factors influencing Growth of Protozoa
 - i) Balanced growth.
 - ii) Non balanced growth

Unit - II

1. Ecology of free-living Protozoa
 - i) Marine Protozoa
 - ii) Planktonic protozoa
 - iii) Soil protozoa
 - iv) Protozoan blooms

Unit - III

- I. Nutrition in Protozoa
 - a. Methods of feeding
 - i. Filter feeding
 - ii. Raptorial feeding
 - iii. Diffusion feeding
 - b. Digestion
 - c. Nutritional requirements

Unit - IV

1. Metabolism in Protozoa
 - i. Carbohydrate and Respiratory metabolism
 - ii. Nitrogen metabolism
 - iii. Lipid metabolism
 - iv. Excretion and ionic regulation - Functioning of contractile vacuoles.

Unit - V

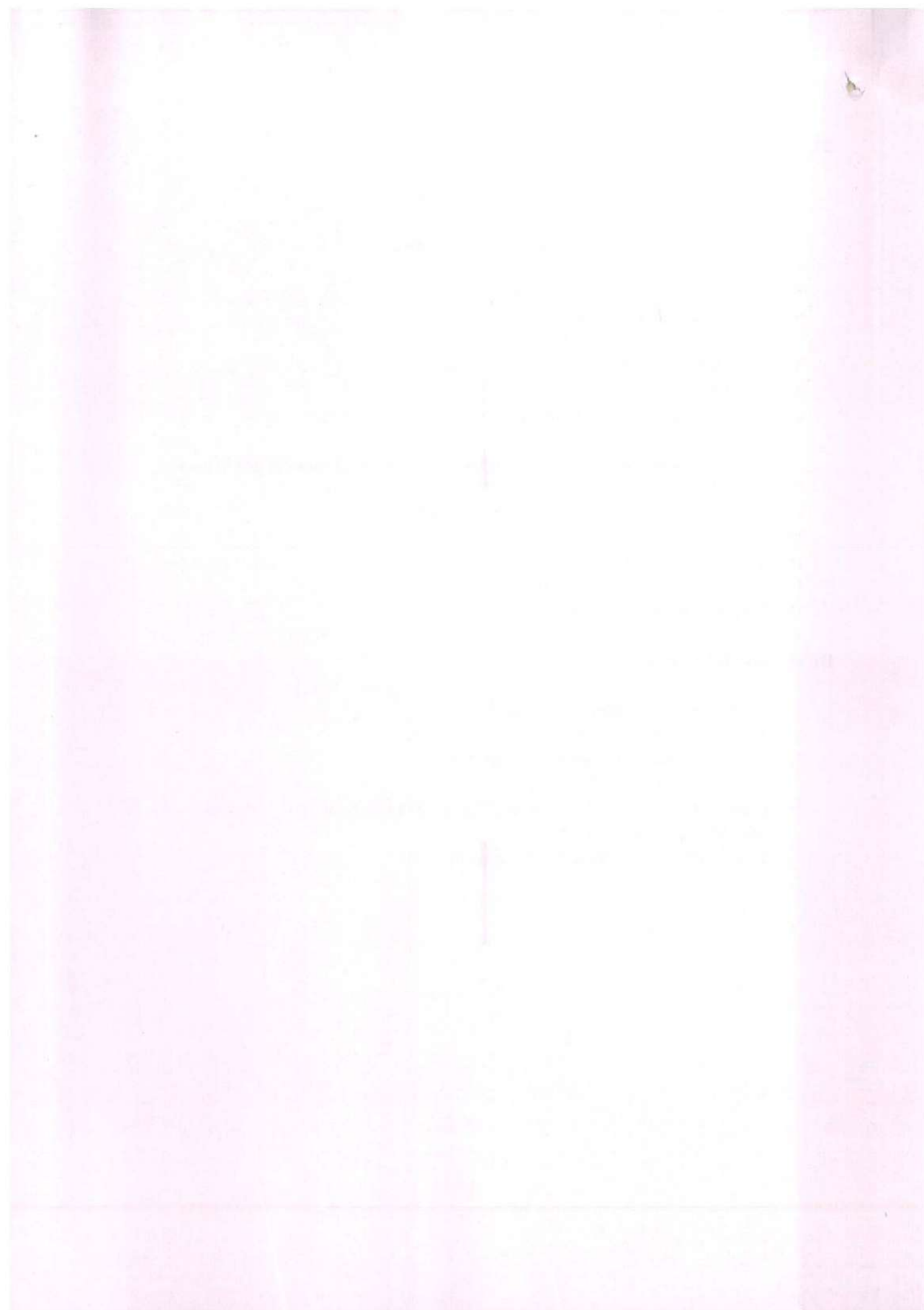
1. Heredity in Protozoa
 - i. Bi-parental reproduction
 - ii. Uni-parental reproduction
 - iii. Non-Mendelian phenomena
 - iv. Mating types in ciliates

TEXT BOOKS:

1. Aikawa and Sterling - Intracellular Parasitic Protozoa
2. Baker - Parasitic Protozoa
3. Chandler and Read - An introduction to Parasitology
4. Chatterjee - Parasitology
5. Thomas C. Cheng-General Parasitology
6. Corliss - The ciliate Protozoa
7. Dogiel - An Introduction to Protozoology
8. Faust, Russel and Jung - Clinical Parasitology
9. Hall - Protozoology
10. Hoare - Trypanosomes of mammals
11. Kudo - Protozoology
12. Levine - An introduction to Protozoan parasites of domestic animals and of man
13. Manwell - An Introduction to Protozoa
14. Richardson & Kendall - Veterinary Protozoology
15. Sleight - Biology of Protozoa
16. Vickerman - The Protozoa
17. Ward & Whipple - Fresh water Biology
18. Wenyon - Protozoology Vol. I & II

REFERENCE BOOKS:

1. Calkins Protozoa in Biological Research
2. Thomas C. Cheng - Research in Protozoology I-IV
3. Florkin and Scheer - Chemical Zoology Vol.-I
4. Hammond and Long - The Coccidia
5. Hutner and Lwoff - Biochemistry and Physiology of Protozoa Vol. I, II & III
6. John & John - How to know the Protozoa
6. Tayler & Baker - Cultivation of Parasites in Vitro



Paper No. ZOO/DSE/529- Entomology I

Contact Hours: 45

credits- 3

Course Objective: -

1. To develop a strong foundation in entomology, including an understanding of the importance of insects to human society.
2. To familiarize the students with insects for their external and internal features,
3. To review important areas in insect biology such as morphology, physiology, ecology, behavior, genetics, phylogeny, ontogeny and population biology.
4. To develop a sufficient background for those students who wish to study more advanced entomological topics.

Learning Outcome:

1. The students will learn in depth the morphological and structure of Insects.
2. The students will gain knowledge of different physiological adaptation, physiological processes in different orders of insect.

Unit I:

1. Introduction to Entomology. Structure of typical insects, morphology, segmentation and tagmosis.
2. Head: Structure, Antennae and types, mouth parts.
3. Thorax: Segmentation, wings: structure, venation and modifications.
4. Legs: Structure of typical legs, types.
5. Abdomen: Appendages, segmentation.

Unit II:

Insect classification:

- ii) Subclass-I Apterygote (Habit, Habitat, Life cycle, Classification)
Collembola, Protura, Diplura, Thysanura.
- iii) Subclass-II Pterygote (Habit, Habitat, Life cycle, Classification)
Ephemeroptera, Odoneta, Pleoptera, Embioptera, Phasmida, Arthropoda

Unit III:

Dermaptera, Grylloblattodea, Zoraptera, Blattodea, Mantodea, Pscoptera, Mellophaga, Siphunculata, and Hemiptera.

Unit IV:

1. Endopterygota
Coleptera, Strepsiptera, Hymenoptera, Neuroptera, Plecoptera, Diptera, Siphonaptera, Trichoptera, Lepidoptera.

Unit V:

1. Apiculture:
Seasonal management of Honey bees.
Collection and storage of Bee-pollen, Honey, Royal-Jelly, Bee-venom, Propolly.
Management of Bee-pollination
Bee communication
2. Lac culture: Biology of lac insects, Biochemistry of Lac.

REFERENCES BOOKS: -

1. The insect structure and function, 4th Edition (2008). Chapman, R.F. Publisher- Cambridge University Press, London.
2. General Textbook Entomology, 10th Edn., (1977) Imms, A.D. Richard, O.W. & Davies, R.G. (Eds.) 1: Chapman & Hall, London
3. General Entomology, 2nd edition (1973) Mani M.S. Oxford & IBH Publishing Company, Delhi.
4. Modern Entomology First edition: (1997) D.B. Tembhare, Himalay Publishing House Delhi
5. Principles of Insect Morphology, (1973). Snodgrass, R.E. Publisher - Tata McGraw Hill, Bombay.

ADDITIONAL REFERENCE BOOKS:-

1. The Principles of Insect Physiology, 2nd edition (2007) Wigglesworth, V.B. Publisher English Language Book Society and Methuen and Co. Ltd.
2. The Insects: Structure, Function and Biodiversity, (2004). Ambrose D.P. Publisher- Kalyani Publishers, New Delhi.
3. Introduction to Insect Biology & Diversity" Daly, H.V., J.T. Doyen & P.R. Ehrlich (1981): International Student Edn. McGraw-Hill, Kogakusha, Japan.
4. Insects Physiology" Henning, W. (1981). Wiley-Interscience Publ., John Wiley & Sons, Chichester, England.
5. Journals and Internet resources.

Paper No. ZOO/DSE/530- Endocrinology I

Contact Hours: 45

credits- 3

Course objectives:

1. To learn the basic information about the various endocrine glands/ tissue, particularly in invertebrates.
2. To learn the neuroendocrine system and their hormones.
3. To learn the physiological interaction of endocrine hormones and their regulation by environmental factors in invertebrates.

Learning outcome

1. The student will understand the basic structure of endocrine glands in invertebrates.
2. The students will learn the structure of neuroendocrine gland and their hormones.

Unit-I Endocrine mechanisms in Annelida

1. Neuroendocrine system in Annelida.
2. Growth and regeneration in Polychaetas.
3. The control of epitoky and relationship between gametogenesis and epitoky.
4. Growth and reproduction in Oligochaetes.
5. Endocrine control of gametogenesis in Polychaetas.

Unit - II Endocrine mechanisms in Mollusca

1. Neurosecretion in Lamellibranches.
2. Hormones and reproduction in Gastropods.
3. Hormones and reproduction in Cephalopoda.
4. Role of hormones in osmotic and ionic regulation in Gastropods.

Unit - III Endocrine Mechanisms in Insecta

1. Neuroendocrine system in Insecta.
2. Role of hormones in growth and metamorphosis in insects.
3. Moulting in adult insects and mode of action of developmental hormones in insects.
4. Reproductive system and endocrine control of oocyte development in insects

Unit - IV Endocrine Mechanisms in Crustacea

1. Neuroendocrine system in Crustacea.
2. Moulting cycle and role of hormones in Moulting in crustaceans.
3. Sexual differentiation and role of hormones in gonadal activity in crustaceans.
4. Colour change and its hormonal control in crustaceans.

Unit - V Neuroendocrine Mechanisms in Echinodermata

1. Histomorphology of radial nerve neurosecretory system in starfish.
2. Neurosecretory hormones and control of reproduction in echinoderm.
3. Hormone types and their chemical nature in echinoderms.

BOOKS:

1. Highnam K. C. and Hill L: The Comparative Endocrinology of Invertebrates.
2. Adiyodi and Adiyodi: Reproductive Biology of Invertebrates Vol I&II
3. Laufer H. and Downer R.C.H. Endocrinology of selected Invertebrates Type
4. Journals and Internet resources
5. Boolootian R: Physiology of Echinodermata

REFERENCE BOOKS:

1. Patil Meena: Neurobiology and Electrophysiology of Decapod Crustaceans Lockwood, A.P.M: Aspects of Physiology of Crustacea.
2. Novak, U.J.A.: Insect Hormones
3. Rock Stein M.: The Physiology of Insect Vol. I.
4. Wilbur, K.M. and Young, C.M.: Physiology of Mollusca. Vol. I and II Mill, P.J. Physiology of Annelida

Practical Paper No. ZOO/DSC/523(Practical based on ZOO/DSC-520)
Biosystematics and Animal Diversity

1. Museum specimen study of different groups of Invertebrates and Vertebrates.
2. Terrestrial ecosystem (Vegetation studies) Abundance. Frequency, Density.
3. Diversity: Dominance, Rankers biological spectrum Index of Dominance, etc.
4. Method of plankton collection, plankton identification, and quantification from river or stream or lake water.
5. Methods of collection, preservation, and identification of zooplankton.
6. Composition assessment of taxonomical diversity or biodiversity in habitat from local Grassland, Terrestrial, and Wetland.
7. Composition assessment of taxonomic diversity/Biodiversity from different ecosystems-
 - a. Species diversity indices.
8. Composition assessment of taxonomic diversity/Biodiversity from different ecosystems-
9. Relative density, Relative frequency, and relative abundance of species
10. Methods of collection, preservation, and identification with keys from different groups of organisms like Parasites, hosts, insects, birds, fishes, etc.
11. Construction of taxonomic Key from the characters in an animal group.
12. Visit any biodiversity center /spots and submission of the report
13. Study of lower deuterostomes.
14. Study of upper deuterostomes.
15. Study of lower protostomes.
16. Study of upper protostomes.
17. Study of adaptive radiations based on the basic hand key structure.

Practical Paper No. ZOO/DSC/524(Practical based on ZOO/DSC/521)
Biochemistry

1. Preparation of Acid and Alkali solutions and acid-base titration
2. Preparation of Buffers of known pH, and buffering capacity.
3. Identification of Carbohydrates by Chemical tests
4. Estimation of Amino acid (Tyrosine)
5. Estimation of Protein by Lowry's method.
6. Estimation of Carbohydrates by Anthrone reagent method. (Glycogen)
7. Estimation of DNA by DPA method.
8. Separation of amino acids by Paper chromatography.
9. Study of factors affecting enzyme activity (Substrate concentration, pH, Temperature, and inhibitors)
10. Isolation of Casein protein from the milk.
11. Determination of isoelectric pH of Casein.
12. Estimation of Blood glucose by Glucometer.
13. Estimation of Chitin.
14. Estimation of urea by Nessler's reagent.
15. Estimation of starch by iodine test.

Practical Paper No. ZOO/DSC/525(Practical based on ZOO/DSC/522)
Ecology (Principles and Practices)

1. Study of ecosystem biodiversity of the local area.
2. Estimation of Dissolved oxygen,
3. Estimation of hardness of water sample. (Total Sodium and Potassium hardness)
4. Estimation of Salinity /Nitrates and phosphates from a given water sample.
5. Biomass analysis in a given ecosystem.
6. Species diversity in the community and its measurement- Alpha diversity- Simpsons diversity index. Shannon index. Fisher alpha. Beta diversity- Sorensen's similarity index. Whittaker's index, Evenness, Gamma diversity. Guild and its functioning in the community
7. Productivity estimation in a given ecosystem (Primary and Secondary)
8. Study of the efficiency of a sampling method.
9. Study of air quality and aerobiology in a given area.
10. Toxicology-Principles, toxicants- types, dose and effects, toxicity of heavy metals.
11. Measuring ecotoxicity using a lettuce seed assay.
12. Estimation of various physical parameters of water (SSP, Turbidity, TDS, etc.)
13. Visit any biodiversity center/National Park/Sanctuary and submission of a report.
14. Study of GPS and Identification of spots in an ecosystem.
15. Identification of Vegetation, and crops based on remote sensing.

Practical Paper No. ZOO/DSE/531(Practical based on ZOO/DSE/527)
Helminthology I

1. Collection of trematodes from various hosts.
2. Collection of cestodes from various hosts.
3. Preservation, staining, and identification of collected trematodes and preparation of their permanent slides (at least 10).
4. Preservation, staining, and identification of collected cestodes and preparation of their permanent slides (at least 10).
5. Study of different trematodes from permanent slides (at least 10).
6. Study of different cestodes from permanent slides (at least 10).
7. Examination of fecal samples for ova.
8. Collection and examination of molluscan hosts for larvae of trematodes.
9. Study the effect of helminth parasites (histopathology) on their host's tissue by micro-technique.
10. Study of identification of cestodes by using keys.
11. Study of identification of trematodes by using keys.
12. Study of trematodes of economic importance
13. Study of cestodes of economic importance.
14. Estimation of Protein/ glycogen content in Trematodes.
15. Estimation of Protein /glycogen content in cestodes.
16. **Submission:** At least five permanent slides are to be submitted at the time of the practical examination

Practical Paper No. ZOO/DSE/532(Practical based on ZOO/DSE/528)
Protozoology-I

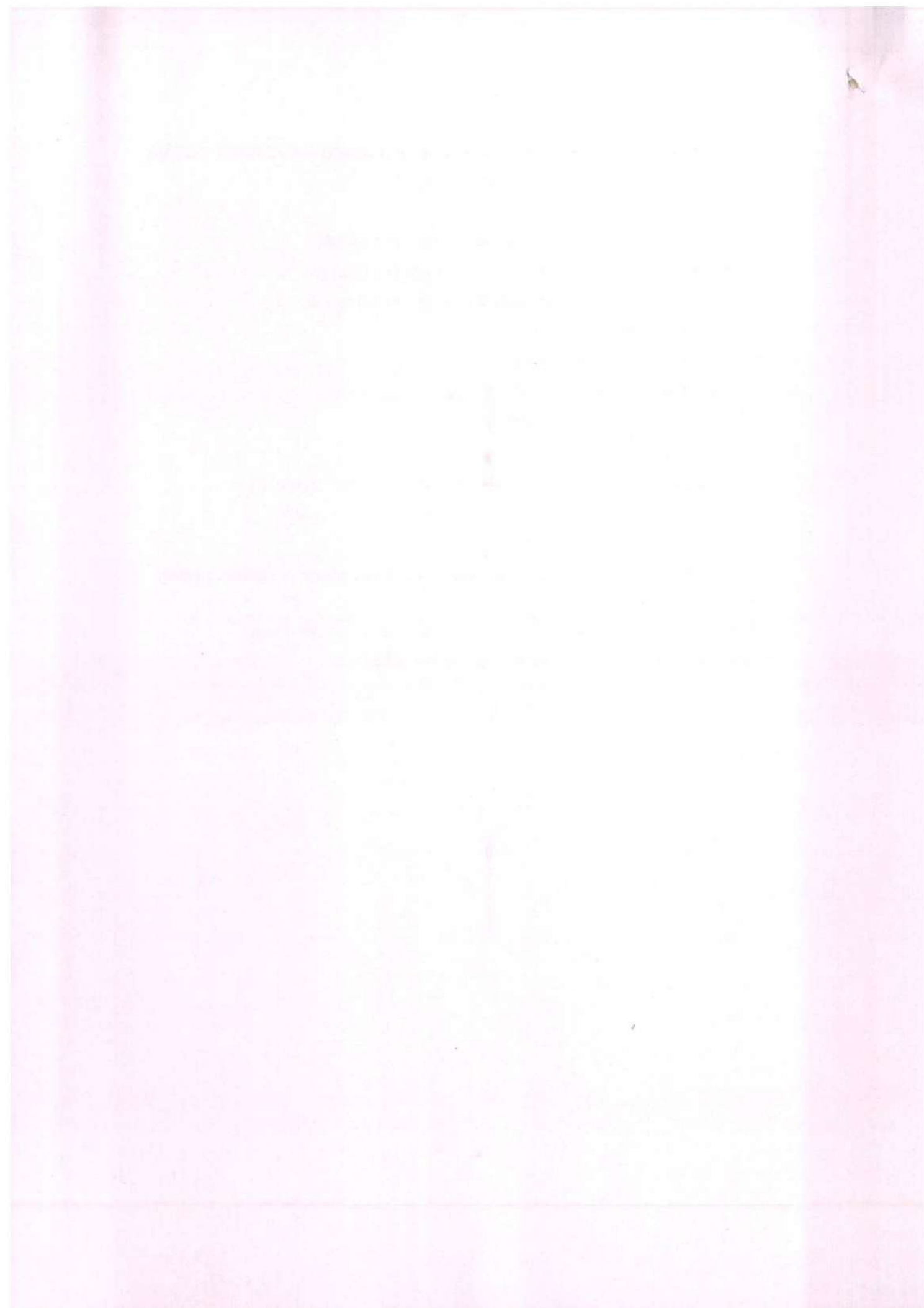
1. Collection, observation of Marine protozoa in living condition-fixation, staining, and identification of protozoa.
2. Collection, observation of Planktonic protozoa in living condition-fixation, staining, and identification of protozoa.
3. Collection, observation of soilprotozoa in living condition-fixation, staining, and identification of protozoa.
4. Study of population density of ciliates in freshwater.
5. Study of oxygenin freshwater ciliates.
6. Study of carbon dioxidein freshwater ciliates.
7. Study of pH in freshwater ciliates.
8. Study of oxidized organic matterin freshwater ciliates.
9. Study of cyclosis in Paramecium.
10. Study of contractile vacuole to observe excretion.
11. Study of contractile vacuole to observe osmoregulation.
12. To study the slides of protozoans of medical importance.
13. To study the slides of protozoans of veterinary importance.
14. To make a permanent slides of any free living /any protozoan parasites from the soil.

Practical Paper No. ZOO/DSE/533(Practical based on ZOO/DSE/529)
Entomology I

1. Study and mount various types of mouth parts, antennae, wings, legs, and genitalia of various insects. (2 in two insects).
 2. Study of the morphology of Thysanura.
 3. Study of the morphology of Pterygota.
 4. Study of the morphology of Odonata.
 5. Study of the morphology of Phasmida.
 6. Study of the morphology of Grylloblattodea.
 7. Study of the morphology of Blattodea.
 8. Study of the morphology of Siphonaptera.
 9. Study of the morphology of Coleoptera.
 10. Study of the morphology of Hymenoptera.
 11. Study of the morphology of Diptera.
 12. Study of the morphology of Lepidoptera.
 13. Study of the morphology of Siphunculata.
 14. Study of the morphology of Neuroptera.
 15. Study of the morphology of Mantodea.
 16. Study of Bee management.
 17. Study of mounting of Bee sting.
- The in the study of morphology of insect orders the example of insect, the emphasize must be made to study the insects of economic importance or insects of special adaptation or modification or pests can be studied as an example.

Practical Paper No. ZOO/DSE/534 (Practical based on ZOO/DSE/530)
Endocrinology I

1. Histomorphological study of neuroendocrine system in Annelida.
2. Histomorphological study of neuroendocrine system in Mollusca.
3. Histomorphological study of neuroendocrine system in Arthropoda
4. Dissection of nervous systems in Leech.
5. Dissection of nervous systems in crab.
6. Dissection of nervous systems in Cockroach.
7. Dissection of nervous systems in Slug.
8. Dissection of nervous systems in Snail.
9. Histopathological preparation of slides of neuroendocrine centers (at least 5).
10. Effect of optic – tentaclectomy on weight changes in the slug, *Laevicaulis*.
11. Effect of brain removal on oxygen consumption in Leech.
12. Effect of eyestalk (bilateral) removal on integument chromatophores of freshwater prawn, *Caridina/Macrobrachium*.
13. Effect of eyestalk removal on oxygen consumption of freshwater crab/prawn.
14. Effect of eyestalk removal on blood glucose level in crab/prawn.



Paper No. ZOO/RM/535 - RESEARCH METHODOLOGY

Contact hours: 60

Credit 4

Learning Objectives:

- To understand some basic concepts of research and its methodologies
- Identify appropriate research problem and parameters
- Prepare a project proposal
- To organize and conduct research in a more appropriate manner
- Write a research report/ proposal and thesis.

Learning Outcome

- The students will learn about the concepts of research with reference to life science.
- The students will learn about the research problems and parameters involved.
- The students will learn to prepare a research project proposal.
- The students will learn to write a research report, dissertation and thesis.

UNIT I

I. Science / Life Sciences and concept of Research

15hrs.

Basic concepts-Knowledge, Information and Data-Science, Pseudoscience. Life Science-Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements. Basic concepts of research -Meaning, Objectives, Motivation and Approaches. Types of Research (Descriptive /Analytical, Applied/ Fundamental, Quantitative/Qualitative, Conceptual/ Empirical. Research methods versus Methodology, Research and scientific method. Research Process.

II. Research Formulation and design

15hrs.

Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating there search problem, Selecting the problem and necessity of defining the problem. Literature review-Importance of literature reviewing in defining a problem, Critical literature review, Identifying gap areas from literature review.

Hypothesis -Null and alternate hypothesis and testing of hypothesis -Theory, Principle, Law and Canon. Research Design-Basic principles, Meaning, Need and features of good design, Important concepts. Types of research designs. Development of are search plan-Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs. Data collection techniques.

III. Scientific Documentation and Communication

15hrs.

Scientific writing begins with a question. Scientific writing in computer age, Communication channels – informal and formal, compilations, Use of internet, Difference between subject directories and search engines, emails, Use of word processing to write more effectively, Revising with word processors. Writing of the first draft- Content, matters dealing with authorship, copy right. Standard structure- Introduction, Materials and Methods, result, Discussion and conclusion. The title, references, Abstract and summary. Title page, key

words, and acknowledgement. Project proposal writing, Research report writing (Thesis and dissertations, Research articles, Oral communications). Presentation techniques - Assignment, Seminar, Debate, Workshop, Colloquium, Conference.

VI. Information Science, Extension, Ethics and Text , Tables and English language 15hrs

Sources of Information -Primary and secondary sources. Library-books, journals, periodicals, reference sources, abstracting and indexing sources, Reviews, Treatise, Monographs, Patents. Internet-Search engines and software, Online libraries, e-Books, e-Encyclopedia, TEDTalk, Institutional Websites.

Intellectual Property Rights - Copy right, Designs, Patents, Trademarks, Geographical indications. Safety and precaution-ISO standards for safety, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards.

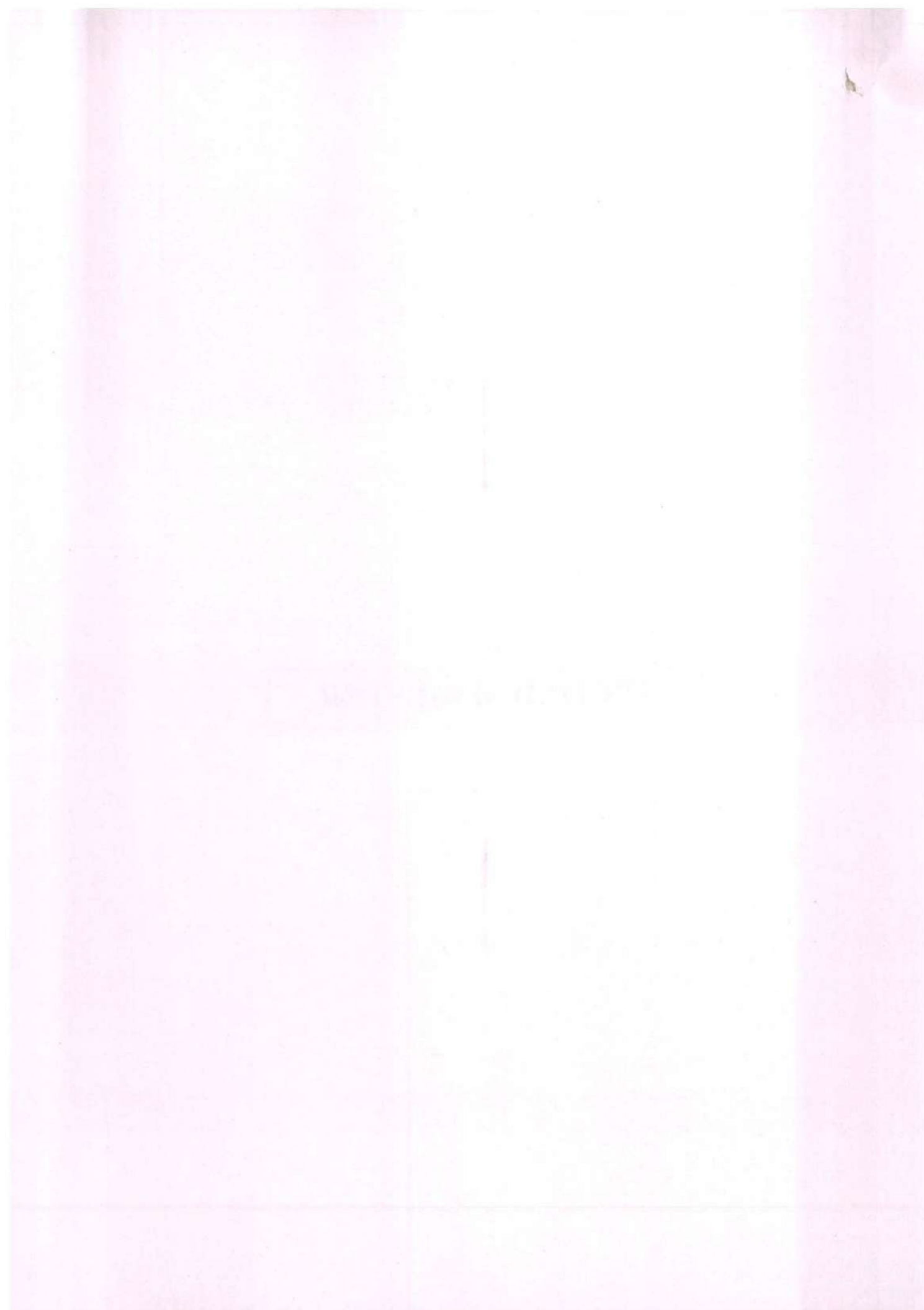
Extension: Lab to Field, Extension communication, Extension tools. Bioethics: Laws in India, Working with man and animals, Consent, Animal Ethical Committees and Constitution.

References

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SECOND SEMESTER



Paper No. ZOO/DSC/570- Genetics and Bioinformatics

Contact Hours: 45

credits- 3

Learning Objectives:

- To understand basic unit cell and the molecular biology of the cellular function.
- To understand the protein secretion and sorting within the cell and laws of cell division and their regulation.
- To understand the central dogma of molecular biology.

Learning Outcome:

- The student will learn about the cell and cellular function at molecular level.
- The student will learn about the protein secretion, sorting and arranging the protein to different cell organelle.
- The student will learn in detail the central dogma of molecular biology in Prokaryotes and Eukaryotes.

GENETICS

UNIT 1: Principle of genetic transmission and molecular organization of chromosomes.

Extension of Mendellian principles; allelic variations and gene function- incomplete dominance, and co- dominance. Gene action, - penetrance and expressivity, gene interactions- epistasis, pleiotrophy, genomic imprinting, phenocopy.

Genome size, and C -value paradox, structure of eukaryotic chromosomes, nucleosome model, chromosome condensation, -euchromatin and heterochromatin, Repetitive nucleotide sequences in eukaryotic genomes. Kinetics of renaturation, Cot and Cot curve repetitive sequences. Mini and micro satellites, Molecular structure of centromere, and telomere. Polytene chromosome and lampbrush chromosome. Chromosome banding techniques.

UNIT II: Gene Fine structure

Evolution and concept of gene function and structure. The definition of gene. The standard genetic code, redundancy and wobble. DNA structure- alternate forms of Double Helix, Gene Synthesis (in vitro synthesis) – works of Khorana and Kornberg, Modern finding on the nature of gene. Interrupted genes in eukaryotes, Exons and Introns -R loops, significance of introns. Genes within genes (overlapping genes) Bacteriophage phi X174.

Transposable elements in Bacteria-IS elements, Composite transposons, Tn3 elements, medical significance. Transposable elements in Eukaryotes - P elements, Retro-transposons, Significance of transposons.

UNIT III: Genetic linkages, Recombination and Chromosome Mapping

Chromosome theory of heredity, Linkage and recombination of genes in a chromosomes, crossing over as the physical basis of recombination, Stern's Experiments; molecular mechanisms of recombination (Holliday model), Gene conversion, Recombination mapping with two point and three point test cross in Drosophila. Coincidence and interference.

Genetic mapping, by tetrad analysis in *Neurospora*, Mitotic recombination, Genetic recombination in Phage λ locus, Complementation test. Deletion mapping, Conjugation mapping, Mapping by interrupted mating, Mapping with molecular markers, and mapping using somatic cells.

BIOINFORMATICS

Unit IV: Scope and Data bases

Bioinformatics, scope and applications. Biological data bases- Primary data bases- Nucleotide sequence data bases; Gen Bank , EMBL, DDBI ; DDBJ; Protein sequence data base, SWISSPROT, PIR,; Structure data bases; PDB,NDB; secondary data bases,; PPROSITE,PFAM,CATH; composite databases, OWL; Literature data base; Pub Med; Data base searching – Entrez; Database sequence submission-BankIt.

Unit V Sequence analysis

Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees. Structural genomics, functional genomics, comparative genomics, data mining in proteomics, Microarray, significance of proteomics and drug design.

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and Bartlett Publishers Inc.
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Strickberger,M.W.1968.*Genetics*.MacmillanPublishingCo.
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Bioinformatics

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2. Attwood T. K. and Parry Smith, D. 2006. *Introduction to Bioinformatics*. Pearson Education. Bourne P. E. and Weissig H. 2003. *Structural Bioinformatics*. Wiley-Liss. USA
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6. Tisdall J. D. 2001. *Beginning Perl for Bioinformatics*. O'Reilly Media Inc. CA, USA
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Paper No. ZOO/DSC/571- Cell and Molecular Biology

Contact Hours: 45

credits- 3

Learning Objectives:

- To understand basic unit cell and the molecular biology of the cellular function.
- To understand the protein secretion and sorting within the cell and laws of cell division and their regulation.
- To understand the central dogma of molecular biology.

Learning Out come

- The student will learn about the cell and cellular function at molecular level.
- The student will learn about the protein secretion, sorting and arranging the protein to different cell organelle.
- The student will learn in detail the central dogma of molecular biology in prokaryotes and Eukaryotes.

Unit 1 Introduction of cell:

Evolution of cell- From molecules to first cell, From prokaryotes to eukaryotes, Prokaryotes and eukaryotic genomes, single cell to multicellular organism.

Plasma membrane structure and function, Nature of cytoskeleton, microfilament, intermediate filaments, Microtubules, Actin filaments, cilia and centrioles, Organization of cytoskeleton. Cell- cell communication. Cell junctions and extracellular matrix, cell – cell adhesion and communications, cell matrix adhesion, collagen -the fibrous protein of the matrix, non collagen components of the extra cellular matrix.

UNIT II: Cell growth and Division

Overview of the cell cycle and its control, The molecular mechanism for regulating mitotic and meiotic events, Amitosis, cell cycle control, Checkpoints in cell cycle regulation. Cell to cell signaling, overview of the extracellular signaling, Identification of cell surface receptors, G-protein coupled receptors, and their effectors, second messengers, enzyme linked cell surface receptors, interactions and regulation of signaling pathways.

Unit III: Protein secretion and sorting :

Organelle biogenesis and protein secretion, synthesis and targeting of- mitochondria, chloroplast, peroxisomal proteins, translational modifications in the ER, intracellular traffic, vesicular traffic, in secretary pathways, protein sorting in the Golgi bodies, traffic in the endocytic pathways, exocytosis.

UNIT IV : DNA Model and chromatin structure

Types of DNA and RNAs, Chromosome structure, chromatin and Nucleosomes; Genome sequence, and chromosome diversity, Chromosome duplication and segregation, The nucleosome, chromatin structure, euchromatin, heterochromatin, constitutive and facultative heterochromatin, regulation of chromatin structure, and, nucleosome assembly, Nucleolus. Gene and genome organization- Split genes, Gene clusters, Histones, Non histones, Nucleosomes,

Chromatin, chromosomes structure, in prokaryotes and eukaryotes, Basic processes, Replication of DNA- Prokaryotes and eukaryotic DNA replication. Mechanism of DNA replication, Enzymes and accessory proteins, involved in DNA replication, Replication errors, DNA, Damages, and their repairs.

UNIT V : Transcription and mRNA processing

Prokaryotic and Eukaryotic transcription, General and specific transcription factors, Regulatory elements, and mechanism of transcription regulation(Lac operon), Transcriptional and post transcriptional gene silencing: Initiation, elongation, and termination of transcription, capping, polyadenylation, Splicing, editing, mRNA stability, RNA interference, Microarray. Translation: Genetic code, prokaryotes and eukaryotic translation and ribosome structures, the translation machinery, mechanisms of chain initiation, elongation, and termination, regulation of translation , co and post translation modifications of proteins, epigenetic.

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Paper No. ZOO/DSC/572- Biophysics

Contact Hours: 45

credits- 3

Learning Objectives:

- To understand universal law as applied to biological system.
- Better understanding to f the concept from physical laws and application
- To understand the various physical mechanisms happening in a biological system.

Learning Outcome.

- The student will learn the application and concept of the physics in biological processes.

UNIT 1: Diffusion and Osmosis

Diffusion – Kinetics of diffusion, Fick's law of diffusion and diffusion coefficient, Biological significance in animals and plants. Electrochemical gradients, capacity and resistance, Stokes-Einstein Equation and Graham's Law, Facilitated diffusion, Gibbs- Donnan Equilibrium.

Plasma membrane:-Internal composition, cell penetration, permeability of cell membrane, permeability coefficient.

Osmosis –Osmotic concentration and osmotic pressure, Van't Hoff's Laws.

Biological significance of osmosis and animal and plants.

UNIT II: Biophysics cell Membrane

Physicochemical properties of cell membrane, conformational properties of cell membranes, Membrane transport, - endocytosis, exocytosis, nutrient transport across membranes, porins, facilitated diffusion, porter molecules, Facilitated transport:- Symport, antiport, uniport, anion porter, glucose porter, Active transport: Proton pumps, Na^+ K^+ pumps and Ca^{++} pumps, ionic channels . Functions of cell membrane, Artificial membranes.

UNIT III: Bioenergetics

Thermodynamics -Laws of thermodynamics, Entropy, Enthalpy, Free energy, Reversible thermodynamics, and irreversible thermodynamics; System – open, closed, and isolated Photo-bioenergetics. Photosynthesis– light and dark reactions, redox couple and redox potential. Chemo-bioenergetics; electron transport and oxidative phosphorylation, Chemiosmotic theory and binding changes mechanism of ATP synthesis.

UNIT IV: Biomechanics and Neurophysics

Striated muscle- contractile proteins, Mechanical properties of muscle, contraction mechanisms, role of calcium ions, Biomechanics of the cardiovascular system – Blood pressure, electrical activity of during the heart beat, Electrocardiography.

Nervous system–synapse, Physics of membrane potential bioelectric potential: Diffusion potential, membrane potential- muscle and nerve, voltage clamp, Sensory mechanism- The eye-visual receptor, electrical activity and visual generator potentials, Neural aspects of vision, Visual communication and bioluminance.

Hearing : Physical aspects, - the ear,, elementary acoustic, theories of hearing, Signal transduction- mode of transport, signal transduction in the cells.

UNIT V: Radiation Biophysics

Ionizing radiations , units of radioactivity, exposure and dose.

Interaction of radiation with matter: Photoelectric effect, ion pair production, absorption and scattering of electrons.

Biological effects of radiations; effect on nucleic acids, proteins, enzymes, and carbohydrates, cellular effects, of radiations, somatic and genetics,

Nuclear medicine; Internally administered radioisotopes, radioiodine in thyroid function analysis, Renal , liver, and lung function analysis.

Applications of radioactive tracers, Radiations protection and therapy.

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Paper No. ZOO/DSE/577- Helminthology II

Contact Hours: 45

credits- 3

Learning Objectives:

- To understand the phylogeny, the biology and applied aspects of helminthes parasites in disease and plant parasites.
- The role of helminthes parasites in burden of disease.
- Genomics of helminthes

Learning Outcome

- The student will learn about the phylogeny, and importance of the helminthic parasites in control of disease.
- The student will learn about genomics and understand how helminthes survive in human body by manipulating the surface coat.
- The student will learn about the challenges in vaccine and drug resistance.
- The student will learn the skill to identify the plant nematodes and control measures in agricultural productivity.

Unit I

Phylogeny of the nematodes and related groups. Economic importance. Burden of helminthes disease worldwide and in India. Parasitic(plants and animal) and free or non pathogenic nematodes. *C. elegans* as model animal for genetic studies.

Unit II

Nematode ultra structure – complex system and processes

Body wall of nematodes: cuticle, Epicuticle (Hypodermis), muscle layer, Hydrostatic skeleton, Nervous system. Cephalic sense organs : Amphids, labial and cephalic papillae. Caudal sense organs– caudal papillae, plasmids. Spicules, inner body tube or digestive system – the stomadeum (foregut), The intestine (midgut), the Proctodeum (hind gut), Secretary / excretory system, Feeding and nutrition's in Nematodes. Essential foods, blood feeding by Hookworms and other nematodes. Male reproductive system, Female reproductive system. Fertilization, development and hatching of eggs. Moulting and Development in nematodes. Implications of nematodes ultra structural studies.

Unit III Nematodes as plant parasite,

Introduction and general life cycle, feeding types, symptoms of damages caused by nematodes, population dynamics, the threshold levels, nematode survival, Ecology, control of nematode disease- resistance/tolerance, crop rotation, chemical control, Biological control, organic amendments, physical control. Interaction with other organisms, classification of plant parasitic nematodes. Life cycle studies of followings -a. Root knot Nematodes (*meloidogyne*) b. Citrus Nematodes (*Tylenchulus*)c. Bud and leaf Nematodes (*Aphelenchoides*) d. Seed gall Nematodes (*Anguina*)

Unit IV: Genomic epidemiology

Genomic epidemiology of filarial nematodes- Transforming the basis of the elimination, progress decisions- Introduction, parasitic transmission, morbidity and control/elimination strategies- *Onchocerciasis volvulus*, and *Wucheria bancrofti*, Lymphatic filariasis, Parasitic population and genetics, and transmission zones, conceptual approach, understanding

geographic and temporal variability in drug response, genomics tools to inform elimination program decisions.

Epidemiological biology, clinical pathology, immune response, diagnosis, treatment, pharmacotherapy, immunotherapy of *Trichenella spiralis*, *Trichuris trichura*, *Strongyloides stercoralis*.

Unit V: Chemotherapy

Drug used against helminthic infection in man, Drug resistance in human helminthes, cryopreservation of helminthes, Immunity to helminthes, trends in vaccines against helminthes and challenges.

References

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Paper No. ZOO/DSE/578- Protozoology II

Contact Hours: 45

credits- 3

Learning Objectives:

1. To understand the genetics, nutritional and parasitic adaptation in human or in other vertebrates.
2. The students will also study the geomedical, aspects of protozoan's .

Learning outcome :

1. The student will understand the genetics , and the nutritional requirements and general organization of protozoan's.
2. The students will understand the genetics of the common parasites like trypanosomes and plasmodium.
3. The student will learn about the metabolic adaptation.

UNIT I Genetics of protozoa

Trypanosome- diploidy and sexual stages , chromosome number, survival in blood stream by coat changing, (Shedding). Molecular structure of the surface coat , Mechanism of variable surface glycoprotein e(VSG) gene expression in telomeres, control of VSG gene activity during "Fly" stage . Discontinuous transcription of VSG genes.

Plasmodium : Chromosome size, diploid and haploid stages, and meiosis, chromosome size polymorphism, Evolutionary relatedness of plasmodium sp by comparative DNA analyses, Importance of cloning genes for surface proteins , Cloning of genes, encoding the circum sporozoite protein. Gene encoding the S- antigens of merozoites, - merozoites and sporozoites share a common epitopes, Diversity surface antigens.

UNIT II Geo medical aspect of parasites

1. Factors influencing the distribution of protozoa.
Climatic and Atmospheric factors, - temperature , humidity , precipitation, and irradiation , and edaphic
Other factors - Oxygen, Carbon dioxide, pH , Light, Food , Nutrition
2. Immunity to protozoan parasite - Host reaction, Innate and acquired defense mechanism;
Antigen of zooparasites, Special manifestation of Antigen – Antibody reaction as related to protozoan parasites.

UNIT – III General organization

1. General organization and morphology of the parasitic flagellates occurring in digestive tract of man. i. *Retartomonas intestinalis*, ii. *Chilomastix mesnili*, iii. *Giardia lamblia* iv. *Trichomonas tenax*
2. General organization of the Microspora - Structure of the spore, life cycle of *Nosema*, Diseases caused by microspora in fishes and Arthropods.
3. General organization of the Myxosporea – structure and development of the spore, Life cycle of *Myxobolus*, disease caused by Myxosporea in fishes.
- 4 General morphology, life cycle, transmission and pathology of parasitic Amoebae of man and domestic animals. i. *Entamoeba histolytica* ii. *E. gingivalis*

UNIT –IV

1. Structure and life cycle pattern of acephaline and cephaline Gregarines.
2. Coccidia of poultry with special reference to the structure, treatment and control.

3. Parasitism in ciliophora – structure, Life cycle, Pathogenesis and control of i. *Balantidium coli*
ii. *Ichthiophtherius multifilis*

UNIT V Nutrition in Protoza

Nutrition in Protoza

Preferred substrate glucose, acquisition of amino acids, Metabolism in parasitic protozoans.
Bioenergetics and the role of oxygen, energy metabolism in kinetoplastid flagellates,
Aerotolerant, Anaerobic protozoans, Malarial parasites.

Text Books:

1. Mehlhorn H (2008) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
2. Mehlhorn H (2016) Encyclopedia of parasitology, vol 3. Kluwer Academic Publishers, Great Britain
3. Mehlhorn H (1988) Parasitology in Focus . Springer –Verlag , Berlin.

Paper No. ZOO/DSE/579- Entomology II

Contact Hours: 45

credits- 3

Learning Objectives

1. To understand the role of insects especially the economic importance.
2. To Learn about the insect pests that damage our crops and to learn about their control.
3. To learn about the insect /vectors of importance in medical and veterinary science.
4. To learn the molecular tools used in entomological research and their applications.

Learning Outcome

1. The student will understand the necessity of insect in economic, of crop.
2. The students will be able to identify the pests and will be able to control the pest with appropriate control mechanism.
3. The students will learn about the molecular tools in entomological studies.

Unit I:

1. Structure of egg, sperm, Oogenesis, Spermatogenesis.
2. Developmental stages of insects: Hemimetabolous, Holometabolous insects.
3. Larvae types, pupae, Male and female reproductive structure.

Physiology of systems: Integument: Structure, Molting, Sclerotization; Digestive system: Physiology of digestion. Respiratory system: Structures, mechanisms of respiration, structure of trachea and respiration in terrestrial and aquatic insects.

Unit II:

1. Circulatory system: Structure, Haemocoel, Dorsal vessel, accessory pulsatile organs, Hemolymph – chemical composition, Hemocyte: Structure and types, mechanisms of circulation.
2. Excretory system: Structure and Malpighian tubules, Physiology of excretion and osmoregulation.
3. Nervous system: Central nervous system, Action potential.
4. Sense organs: Eyes, Chemoreceptors, Mechanoreceptors. Effector organs: Sound producing organs, light producing organs.
5. Endocrine system: Typical endocrine glands in insects, mechanism of hormone action, Moulting and development. Ectohormones: Pheromones, types and defensive secretors.

Unit III Principles of insect pest control

Chemical control: mode of action of insecticide, merits and demerits of chemical control. Modern trends in pest control. Biological control: Principles, procedure, Biological agents; success and limitations. Autocidal control – sterile male technique, genetic technique, the pheromone technique. Integrated pest management (IPM) Principles and application. The local dispersal and migration of insect pest and their importance in IPM strategies- example Aphids, and white flies.

Unit IV: Molecular tools use in Medical and Veterinary Entomology

Cloning genes, and genomics, cloning genes, Recombinant DNA technologies. Genomics: cataloguing an organisms complete genetic sequence, Library construction and genome assembly, Bioinformatics and data base, Genome and vector and vector borne pathogens, PCR and its applications. Diagnostic techniques: Rapid detection and quantification of pathogens in hosts and vectors, Visualization of pathogens in host and vectors. Immune based diagnosis of host infection.

Unit V: Insect plant interactions:

Events during herbivory, -plant volatile perception and recognition, Insect as microbial host, salivary production and secretions. Insect Endosymbionts in plant signaling, Digestion and nutrition. Endosymbionts- mediated insect defense, Plant metabolite detoxification and Endosymbionts. Herbivory- site of damages, activation of phyto- hormonal pathways, and role of microbes. Microbial priming, below ground changes (Rhizospheres), changes in above ground, - below ground interactions.

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2. Tembhare, D.B (2009) Modern Entomology , Himalaya Publishing House Delhi.
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15. Wardle, D. A. 2002. Communities and ecosystems: linking the aboveground and belowground components, Princeton, New Jersey, Princeton University Press.

Paper No. ZOO/DSE/580- Endocrinology II

Contact Hours: 45

credits- 3

Learning Objectives:

- The students will learn about vertebrate hormones and their actions in vertebrates.
- The student will learn about hypothalamic pituitary axis and the various hormones released, their role in sex determination.
- The student will learn about the male and female reproductive endocrinology
- The students will learn about other hormones secreted by other organs- like stomach, intestines, pancreases, etc.

Learning Out come

- The students will understand about the various hormones in vertebrate and their origin and roles.
- The students will understand the role of male and female reproductive hormones.
- The students will understand the hormonal actions and other hormones involved in metabolism and homeostasis.

Unit - I The vertebrate endocrine system

Classes of hormones. Hormone synthesis and control – a general concept. General mechanisms of hormone action. Termination of hormone action. Hormone circulation and metabolism. Plasma membrane hormone receptors, second messengers of hormone action, receptor signal transduction, Multiple membrane messengers, Eicosanoids and hormone action, Cytosolic hormone receptors. Sex determination, differentiation of male and female gonads. Development and differentiation of genital ducts. Gonadal hormone synthesis. Gonadal steroids and brain differentiation.

Unit -II Hypothalamus and Pituitary gland

Structure of Hypothalamus and hypophysiotropins and their functions in brief. Control of Hypothalamo-hypophysial hormone secretion. Histomorphology of pituitary gland, hormones and their functions. Neurohypophysial hormones and their functions. Pars intermedia and role melanotropic hormones.

Hormones of pituitary, - families of pituitary hormones, Growth hormones, and prolactin, The glycoprotein hormones, Pro-Opiomelanocortin and melanocortins, Neurophysical hormones, Hypophysiotropic hormones, - thyrotropins releasing hormones, - thyrotropin – releasing hormones, Gonadotropins releasing hormones, (GnRH), corticotropin releasing hormones (CRH) Prolactin release inhibiting Factor (PIF), prolactin releasing factor (PRF), MSH – release inhibiting Factor (MIF).

Neurophysical hormones - oxytocin, vasopressin, vasotocin, mode of action, Melanotropic hormones. Control of MSH secretion, - dopaminergic control, Physiological roles.

Unit - III Reproductive Endocrinology

Female Reproductive endocrinology. Pregnancy, Parturition and Lactation mechanisms

Anatomy of female reproductive system and histology of ovary, ovarian cycle and its hormonal control. Ovarian steroid hormones and their physiological functions. Menstrual cycle in primates and its hormonal basis. Estrus cycle in rat and its hormonal basis. Role of hypothalamic, pituitary and ovarian hormones in pregnancy in mammals. 3. Hormonal mechanism in parturition in mammals. Hormonal mechanism in lactation mammals. Menopause.

Male Reproductive Endocrinology ;

Anatomy of male reproductive system, histology of testis, spermatogenesis; hormones of testis and their functions. Endocrine control of testicular function, GnRH and Pituitary gonadotropins- inhibin, prolactin, Role of androgens, Spermatogenesis. Estrogen – physiological roles, fertility, male behavior, Epiphyseal fusion, cardiovascular functions.

Unit V : Hormones in homeostasis, Gastro intestinal tract, thyroid and adrenal glands.

Hormonal control of – calcium homeostasis. Parathormone, calcitonin, vitamin D.

Gastro intestinal Hormones- Gastrin, Secretin , cholecystokinin(CCK), Gastric inhibiting peptides, Vasoactive Intestinal Peptide (VIP), Substance P , Somatostatin , motilin. Pancreatic hormones – Insulin and glucagon – physiological action. Thyroid hormone and control of thyroid hormone secretion. Adrenal steroid hormones- Glucocorticoids, Mineralocorticoids, Aldosterone, Renin – Angiotensin system. Neurohormones- Endorphins.

Books Recommended

1. Hadley , M. E (2004) Endocrinology. Pearson education (Singapore)
2. Norman ,AW, Litwerck, G .(1987) Hormones. Orlando ,FL ; Academic press,
3. Larsen PR, Kronenberg ,HM, Melmed ,S and Polonsky , KS (Ed)(2003) Willams Text Book of Endocrinology , 10th . Ed. Philadelphia, Saunders,

Practical Paper No. ZOO/DSC/573 (Practical based on ZOO/DSC/570)
Genetics and Bioinformatics

1. Determination of blood groups and suggestions on Medico-legal problems regarding parentage disputes using blood groups.
2. To study the culture of *Drosophila melanogaster* in laboratory. The sexual dimorphism
3. Study of life cycle stages of *Drosophila melanogaster* and maintaining the culture.
4. To study the different mutants in *Drosophila*.
5. Identification of blood group, a case study of multiple alleles.
6. Preparation and mounting of *Chironomus* larva - Giant Chromosomes
7. To Study of gene frequency using PTC tests (taster and non-tasters)
8. Database search and data retrieval using NCBI and SWISS-PROT
9. Database search and data retrieval using PDB and Expasy.
10. Methods of sequence alignment-BLAST and Clustal W.
11. Phylogenetic tree using PHYLIP.
12. Gene Prediction using GENSCAN/GRAI
13. Protein structure visualization using RASMOL.
14. Study of human karyotype.
15. Studies on recombination mapping using *Drosophila* crossing or problems from theoretical data.

Practical Paper No. ZOO/DSC/574 (Practical based on ZOO/DSC/571)
Cell and Molecular Biology

1. Orientation to good laboratory practices.
2. Study of different stages of Mitosis and Meiosis by using permanent slides.
3. Squash preparation of grasshopper testis to study meiotic stages.
4. Determination of mitotic index in the squash preparation of onion root tip. Effect of drugs on cell division (Colchicine or any other inhibitor)
5. Study of mitochondria by vital staining technique.
6. Genotoxicity by Micronuclei test.
7. Induction of puff and study of puffing pattern in polytene chromosomes.
8. Preparation of different cell types as hepatocytes/ parenchymal cells
9. Study of tumor and cancerous cells (Use permanent slides)
10. Preparation of Microtome section, spreading.
11. Histochemical staining of carbohydrates (PAS).
12. Histochemical staining of Protein (Bromophenol blue).
13. Histochemical staining of lipids (Sudan Black).
14. Histochemical staining of DNA (Feulgen stain).
15. Case study associated with the cytoskeleton.
16. Separation of proteins by SDS-PAGE.

Practical Paper No. ZOO/DSC/575 (Practical based on ZOO/DSC/572)
Biophysics

1. To study the ECG cycle for signals and the corresponding cardiac functions.
2. To study the measurement of blood pressure.
3. To study the phenomenon of cyclosis by ingestion of dye in Paramecium.
4. To study the osmotic relation in animals.
5. To study the osmotic hemolysis of erythrocytes in different concentrations of salt solutions.
6. To study the muscle excitation by using the Kymograph apparatus.
7. To study the effect of calcium ions on the heartbeat of a rat/ crab by using a kymograph.
8. Demonstration of background count of radiation by Geiger Muller counter.
9. Cell fractionation and Differential Centrifugation to isolate mitochondria and nuclei
10. Study of membrane fluidity.
11. Study of diffusion of biomolecules/ions (Flick's law).
12. To study membrane potential using fluorescence spectroscopy.
13. Passage of molecule through dialysis membrane and demonstration of Donnan membrane equilibrium.
14. Preparation of liposome
15. To analyze erythrocyte membrane lipid/proteins by TLC/SDS-PAGE
16. To study spectrophotometric assay of Hill reaction and estimation of Chlorophyll.

Practical Paper No. ZOO/DSC/576
Practical Skill/advanced technique

(This course will be carried out with in collaboration with Health center of University)

1. Function of components of chemical laboratories – Basic needs of a chemical laboratory.
2. Safety regulations: First aids and chemical laboratory records.
3. Laboratory equipments and basic laboratory operations.
4. Specimen collection.
5. Units of measurement, Preparations of reagent solutions and laboratory calculations.
6. Quality controls of laboratory findings.
7. Hematology; Introduction to Hematology.
8. Specimen collection and laboratory preparations in hematology.
9. Routine hematological tests.
10. Special hematological tests.
11. Hemostasis and coagulation.
12. Bleeding disorders.
13. Immuno-hematology or blood banking
14. Blood banking.

Practical Paper No. ZOO/DSE/581 (Practical based on ZOO/DSE/577)
Helminthology II

1. Collections and handling of Nematodes from locally available animals
2. Identification of collected Nematodes using standard methods.
3. Basic techniques of preservation Nematodes.
4. Basic techniques of mounting Nematodes
5. Fecal sample analysis for collection and identification of ova.
6. Study of permanent slides (At least 8).
7. Collection and identification of Phytonema.
8. Techniques of collection, fixation, mounting, and preparation of permanent slides.
9. Studies of nematodes of medical importance with permanent slides.
10. Submission of permanent slides at the time of examinations.
11. Study of life cycle of citrus nematodes.
12. Study of life cycle of root knot nematodes
13. Study of life cycle of bud and leaf nematodes
14. Immunological techniques in helminthology

Practical Paper No. ZOO/DSE/582 (Practical based on ZOO/DSE/578)
Protozoology II

1. Classification of parasitic protozoa.
2. Study of ciliates in the alimentary canal of vertebrates.
3. Study of ciliates in the alimentary canal of invertebrates.
4. Impregnation of ciliates with dry silver nitrate for the study of kinetic structure.
5. Study of hemoflagellates from vertebrate blood.
6. Preparation of blood smear, staining, and identification of staining of hemosporina.
7. Histopathology of host tissue caused by Apicomplexan parasites.
8. Examination of a fecal sample of vertebrate host for oocyst of coccidia.
9. Collection of coccidian oocysts by centrifugation method.
10. Observation of oocysts for sporulation.
11. Study of different mosquito vectors of protozoan parasites.
12. Collection of Myxozoa from fishes.
13. Study of binary fission and conjugation in ciliates.

Practical Paper No. ZOO/DSE/583 (Practical based on ZOO/DSE/579)
Entomology- II

1. To study the types and total count of hemocytes in the hemolymph of cockroach / grasshopper/ any insect.
2. Study and mounting of Head, and mouth parts of typical insect and their modifications.
3. To study and mounting of Abdominal Spiracle in cockroach or grasshopper.
4. Study and mounting of thoracic spiracles in cockroach or grasshopper.
5. Dissection of central nervous system of cockroach.
6. To dissect and study the retro-cerebral complex in cockroach. Identification of corpora allata and corpora cardiaca or dissection of ring gland in Lepidoptera.
7. To study the plant insect interaction - Using ants and plant extract or flower extracts
8. To study of attraction or repulsion of ants / insects different feeds.
9. Study and mounting of sense organ- Eyes/ Antenna
10. Study and mounting of sound producing organs.
11. Effect of hormones on molting in insects by ligation techniques.
12. Determination of LD50.
13. Amplification of insect DNA by using PCR and its importance in entomology.
14. Study of insect phylogeny using bioinformatics tools.
15. Study bacteria in insect gut.
16. Estimation of uric acid in Malpighian tubules.
17. Insect pheromones with reference to honey bee.
18. Biochemical studies of royal jelly in Honey bee.
19. Field visit for demonstration of pest damage/ to the entomology Department of Agricultural University farm.

Practical Paper No. ZOO/DSE/584 (Practical based on ZOO/DSE/580)
Endocrinology II

1. *In situ* demonstration of endocrine glands in rats or by demonstration using visual aids.
2. Histological study of endocrine glands in different vertebrate representatives.
3. Anatomical studies of the reproductive system in rat.
4. Study of the estrous cycle in rat.
5. Endocrine gland removal in rats- Orchidectomy
6. Endocrine gland removal in rats- vasectomy
7. Endocrine gland removal in rats- Adrenalectomy
8. Endocrine gland removal in rats- Thyroidectomy
9. Effect of thyroxin on oxygen consumption in fish
10. Chromatophores and color changes in fish (a) Effect of background and (b) Effect of MSH injection.
11. Determination of cholesterol in the adrenal gland of rats.
12. Effect of insulin on blood glucose levels in fish/rat
13. Histological techniques: preparation of permanent slides for the histological structure of endocrine glands of rats (at least 5 be submitted).