

**Bajaj College of Science, Wardha**  
(An Autonomous College)  
**Department of Zoology**  
**Syllabus for M.Sc. Zoology (Semester Pattern)**  
**Semester – I**  
**Choice Based Credit System**  
**With effect from Academic Year (2023-24)**  
As per NEP (BOS dated 08/07/23)

## **Semester-I**

### **DSC-I , Structure and Function of Invertebrates**

#### **Unit-I**

- 1.1 Classical and molecular taxonomic parameters, species concept, systematic gradation of animals, nomenclature, modern scheme of animal classification into sub-kingdom, division, section, phyla and minor phyla.
- 1.2 Ultrastructure of protozoan locomotory organs (pseudopodia-cytoplasmic organelles, flagella, cilia and pellicular myonemes) and mechanism of various modes of locomotion.
- 1.3 Dermal cells and skeletal organization in calcareous sponges, Hexactinilida and Demospongiae (Porifera).
- 1.4 Polymorphism and metagenesis in coelenterate. Types of polyps, medusa and metamorphosis.

#### **Unit-II**

- 2.1 Origin of metazoan-colonial, syncytial and molecular theories.
- 2.2 Reproductive system-structure and mechanism of reproduction in *Dugesia*, *Fasciola*, *Taenia* and *Ascaris*.
- 2.3 Formation, Evolution and significance of coelom, metamerism and symmetry in classification of animals, particularly coelomata.
- 2.4 Evolution of nephridia and mechanism of excretion (nitrogenous excretory products, transport of water and salts) in Polychaeta, Oligochaeta and Hirudinea of Annelida.

#### **Unit-III**

- 3.1 *Peripatus*(Onychophora) structure, affinities and taxonomic position.
- 3.2 Respiratory organs in Arthropoda. Mechanism of gaseous exchange in tracheal respiration in Insecta and gill respiration in Crustacea.
- 3.3 *Neopilina*( Monoplacophora): structure, affinities and taxonomic position.
- 3.4 Neuroanatomy in Gastropoda, Bivalvia and Cephalopoda.

#### **Unit-IV**

- 4.1 Water vascular system in Echinodermata: structure and functions.
- 4.2 Larval forms in Echinodermata: Metamorphosis and phylogenetic significance.
- 4.3 General account and affinities of Ctenophora and Rotifera.
- 4.4 General account and affinities of Entoprocta and Ectoprocta.

## **Semester I :**

### **DSC -II- Biochemistry-I**

PG- ZOO (07)- S1-T2

#### **Unit I: Biomolecules I: Carbohydrates and Lipids**

- 1.1 Properties of Water: With interactions in aqueous systems. Ionization of water, weak acids and weak base.
- 1.2 The pH scale, measurement of pH, acid base titration curves. Buffers, biological buffer systems.
- 1.3 Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, stereoisomerism, anomers and epimers. Biological significance.
- 1.4 Lipids: Classification, structure and function of major lipid subclasses-acylglycerols, circulating lipids, chylomicrons, LDL, HDL, and VLDL.

#### **Unit II: Biomolecules II: Proteins and Nucleic acids**

- 2.1 Amino acids: Classification, Properties, rare amino acids.
- 2.2 Protein Structure: alpha-helix beta- structure,  $\beta$ -helix, super secondary structure. Tertiary Structure, Quaternary structure – hemoglobin.
- 2.3 Peptide bond, Vander Walls, electrostatic, Hydrogen bonding, and hydrophobic interactions.
- 2.4 Nucleic acids: Structure of Pyrimidines and purines. DNA and RNA types and properties.

#### **UNIT III: Enzymology -I**

- 3.1 Enzymes and Catalysts, Classification and nomenclature of enzymes. Chemical nature and properties of enzymes.
- 3.2 Factors affecting enzyme activity: Concentration of enzymes, Concentration of substrate, effect of temperature, effect of pH.
- 3.3 Effect of product concentration, effect of activators, effect of time, effect of light and radiation.
- 3.4 Active site and salient features of active site. Specificity of enzyme action (Lock & key model & Induced fit model).

#### **UNIT IV: Enzymology -II**

- 4.1 Enzyme Inhibition: Competitive inhibition, Non-competitive inhibition, Uncompetitive inhibition, Irreversible inhibition, Suicide inhibition, Allosteric inhibition.
- 4.2 Mechanism of Enzyme action.
- 4.3 Regulation of enzyme activity in the living system: Allosteric regulation, Activation of latent enzyme,
- 4.4 Control of enzyme synthesis, Enzyme degradation, Isoenzymes.

## M.Sc. Semester I

### DSC-III-Practical Based ON Structure and Function of Invertebrates

#### 1. Study of museum specimens using already available specimens in the museum/ charts/ models/ photographs/ digital alternatives etc.

Classification upto order and comments on the specimens representing all phyla.

#### 2. Anatomical Observations

Anatomical observations, demonstration and detailed explanation of

- a) **Digestive system** of Earthworm, Leech, Cockroach, Silkworm and Honey bee
- b) **Nervous system** of Prawn, Cockroach, Silkworm and Honey bee and
- c) **Reproductive system** of Earthworm, Leech, Cockroach and Honey bee with the help of ICT tools/ Models/ Charts/ Photographs etc.

#### 3. Mounting

Whole mount preparation of plankton and/or study of permanent preparation of the following with the help of already available permanent slides/ ICT tools/ charts/ photographs etc.

- a. Earthworm – Nerve ring, ovary, spermatheca, nephridia.
- b. Leech – jaws, ciliated organ.
- c. Cockroach – Mouth parts, Salivary glands, trachea.
- d. Prawn – Appendages, Statocyst.
- e. Protozoans- rhizopods , flagellates , ciliates (fresh water forms).
- f. Porifera – Spicules and gemmules of fresh water sponges.
- g. Crustaceans and rotifers - Planktonic copepodes, cladoceran, ostracoderm and rotifers.
- h. Larval forms of the free living invertebrates.
- i. Larval forms of parasitic invertebrates.

#### 4. Study of permanent Invertebrate slides

- a. Porifera – T.S. and L.S. of *Sycon*, gemmules, spongian fibres, spicules
- b. ctenophora – T.S. of *Hydra* , T.S. of Sea anemone, Ephyra larva
- c. Helminths – T.S. of *Planaria*, T.S. of *Taenia* , scolex W.M., Mature , gravid proglotids , T.S. of male and female *Ascaris*, W.M of *Ankylostoma*, *Enterobius*, *Dracunculus*, *Wuchereria*
- d. Annelida -T.S. of *Nereis*, T.S. of Earthworm passing through various organs, T. S. of Leech.
- e. Arthropod larvae – Nauplius, Zoea, Metazoea, Megalopa, Mysis.
- f. Mollusca – T.S. of foot, Veliger and Glochidium larva.
- g. Echinodermata- Pedicellariae, T.S. of arm of star fish, Bipinnaria, Oricularia larva.
- h. Hemichordata – T.S. through collar, proboscis, trunk and branchio-genital regions. Tornaria larva.

## **DSC-IV- Practical based on Fundamentals of Biochemistry**

1. Preparation of standard buffers and determination of pH of a solution.
2. Determination of  $pK_a$  of weak acid by pH meter.
3. Determination of isoelectric pH of casein, egg albumin & BSA.
4. Titration of mixture of strong acid and weak acid.
5. Titration curves of amino acid/weak acids and determination of  $pK$  value.
6. Qualitative analysis of Carbohydrates, Proteins, Urea, Creatinine, Cholesterol.
7. Colorimetric estimation of proteins by biuret method.
8. Extraction of total lipids by Folch Method.
9. Determination of saponification value of fats.
10. Determination of Acid value of fats.
11. Preparation of starch from potato and its hydrolysis by salivary amylase.
12. Effect of pH on activity of enzyme
13. Isolation of Urease and demonstration of its activity

## **Semester-I**

### **DSE-1 Elective -1, Cell Biology and Genetics**

#### **Unit-I**

- 1.1 Membrane structure and function - structure of model membrane, lipid bilayer, membrane protein diffusion, osmosis, active transport, uniport, multiport, symport, antiport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
- 1.2 Structural organization and functions of cell organelles- nucleus, mitochondria, endoplasmic reticulum, Golgi complex, lysosomes and peroxisomes.
- 1.3 Structure and Functions of microfilaments, microtubules and their role.
- 1.4 Cell division and cell cycle - phases of cell cycle, checkpoints of cell cycle, regulation of cell cycle, mitosis, meiosis.

#### **Unit-II**

- 2.1 Cell signaling - hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, Receptor protein- tyrosin kinase and ion channel receptors.
- 2.2 Signal transduction pathways, primary and secondary messenger systems, regulation of signaling pathways.
- 2.3 Cellular communication - general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix and integrins.
- 2.4 Cancer - genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis.

#### **Unit-III**

- 3.1 Mendelian, non-Mendelian inheritance - mono / dihybrid inheritance, types of dominance, multiple allelism, probability, exercises for solving genetics problems.
- 3.2 Extensions of Mendelian principles - codominance, incomplete dominance, gene interactions, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- 3.3 Quantitative Genetics - polygenic traits and mode of inheritance, analysis of variation, genetic and environmental factors, heritability, inbreeding and consequences, coefficient of inbreeding and consanguinity.
- 3.4 Mutation - types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants.

#### **Unit-IV**

- 4.1 Structural and numerical alterations of chromosomes - deletion, duplication, inversion, transversion, translocation, ploidy and their genetic implications.
- 4.2 Extra chromosomal inheritance - cytoplasmic inheritance, inheritance of mitochondrial genes, maternal inheritance.
- 4.3 Microbial genetics - recombination in bacteria and gene mapping, transformation, conjugation, transduction (generalized and specialized), fine structure mapping of genes.
- 4.4 Human genetics- pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

## **Semester-I**

### **DSE-1 Elective -II: Economic Zoology**

#### **UNIT I: Apiculture –**

- 1.1 Introduction, History of Beekeeping, Honeybee species in India and morphology.
- 1.2 Life Cycle of *Apis indica*, Colony Organization, and Cast System.
- 1.3 Basic Beekeeping Practices- Acquiring and Installing Bees in the Hive, Hive Management Techniques, Langstroth frame hive, Comb Foundation mill.
- 1.4 Bees Management, Economic Importance- Honey, Royal Jelly, Beeswax, Propolis

#### **UNIT II: Sericulture and Lac culture**

- 2.1 Introduction, History of Sericulture, Silkworm species in India.
- 2.2 Silk moth Life Cycle and Silk Production- *Bombax mori* life cycle, Feeding, and Care of Silkworm, Cocoon Formation, and Harvesting.
- 2.3 Introduction, History of Lac and Lac Culture, Lac Insect Development and Life Cycle.
- 2.4 Equipment Needed for Lac Cultivation Economic Importance

#### **UNIT III: Aquaculture**

- 3.1 Introduction of aquaculture.
- 3.2 Aquaculture Species and Culture Systems: Major fish, shrimp, and shellfish species cultivated in aquaculture.
- 3.3 Basic Pisciculture Management Practices -
- 3.4 Economic Importance of Pisciculture

#### **UNIT IV: Prawn culture and pearl culture:**

- 4.1 Introduction of Prawn Culture, Management of culture.
- 4.2 Prawn harvesting techniques, economic importance
- 4.3 Introduction of pearl culture, pearl formation, the process of pearl culture
- 4.4 Pearl Harvesting, Processing, and Economic Importance

## **RM- Research methodology**

### **UNIT I: Research basics and perception of research**

- 1.1 Definition, General and specific characteristics of research, types of research (basic, applied and patent oriented).
- 1.2 Steps of Action (basic) research, objectives of basic research, characteristics of investigators.
- 1.3 Scientific thinking- characters, steps in process of scientific thinking, Steps in problem identification, criteria for selecting problem, and sources of scientific problems.
- 1.4 Review of literature- meaning, need, and objectives, structure of review of literature, sources of literature collection, Simple rules of structuring (writing) literature review.

### **UNIT II: Basics of hypothesis, research methods, Data collection, tables, and graphs**

- 2.1 Definition of hypothesis, assumption, and postulate, nature, function and importance of hypothesis, characteristics of good hypothesis
- 2.2 Definition and types of research methods, characteristics of survey methods, Types of survey methods and their advantages
- 2.3 Experimental method- definition, basic assumption, Types of variables (controls) in experiments, Steps of experimental methods, Case study method, Laboratory records and its importance, ethics and safety of laboratory work place.
- 2.4 Types of data (variables): Nominal variable, Ordinal or rank variable, interval and ratio variable, analysis of data: Descriptive and inferential, Meaning of parameters, sample, populations, Basic structure of Graph, Bar graph, pie chart, Line graph, Basic structure of table, Meaningful tables

### **UNIT III: Statistical analysis**

- 3.1 Concept of central tendency of data, Median, Mode, Mean (and types of means), Merits, and demerits of using different measures & their applicability
- 3.2 Concept of dispersion(variability): Range, Standard deviation, standard errors, merits, and demerits of measures, tables and graphs showing descriptive measures
- 3.3 Hypothesis, Procedure for hypothesis testing, Z test, one tailed and two tailed student's t test, one sample t test, two sample t test,
- 3.4 chi-square test, one way ANOVA, Structure of ANOVA table, Relation between regression coefficients and correlation coefficient

### **UNIT IV: Technical, and research reporting, research ethics and plagiarism**

- 4.1 Research report- need of research report, General format of research report, Essential steps for writing scientific manuscript/research papers
- 4.2 Types of reports: Structure of thesis, structure of research paper, structure of project report, structure of project proposal
- 4.3 Annotated bibliographies: Structure and organization, Critical thinking, Evaluating information
- 4.4 Academic integrity, skills (rules) for good academic practice, understanding plagiarism and academic malpractice

## **Assignments based on Research Methodology course**

### **Instructions:**

These assignments can enhance the professional skills needed to pursue a career in research/teaching. Therefore, each PG department should identify ten assignments from the list below. Continuous evaluation will occur throughout the semester. Performance on the assignment will be graded for 40 marks.

- 1. Navigate and use Google, Google Scholar, SciHub, PubMed, Web of Science, Elicit and ScienceDirect effectively to search for research papers, perform searches and retrieve relevant research papers.**

[Suggestion/Working hours:-Dedicate a few hours each week to practice searching on these databases to continually refine your skills.]

- 2. Write accurately references in APA format for various types of sources, including books, journal articles, websites, and conference papers and gain a comprehensive understanding of the Zotero platform, including its interface, features, and capabilities for managing bibliographic information.**

[Suggestion/Working hours-Invest time in exploring and understanding the features of Zotero(<https://www.zotero.org/>) through guided tutorials and hands-on experience and gain proficiency in using Zotero to input, organize, and format references, and effectively manage bibliographic data]

- 3. How to read research paper and develop a thorough understanding of the three-pass approach for effective note-taking from research readings.**

- 4. Review and analyse collected references systematically to identify at least three prospective research problems or gaps in your domain.**

[Suggestion/Working hours:-Review a minimum of 20 relevant references in your domain to gain a comprehensive understanding of current research trends and gaps. Dedicate focused time each week to systematically review references and refine your problem identification skill]

- 5. Write at least three research objectives and three hypotheses that are well-defined, focused, and aligned with the research problem.**

[Suggestion/Working hours:-Within one month, be able to formulate clear and relevant research objectives or hypotheses for the given research problem. Seek feedback from mentors or advisors to refine your research objectives or hypotheses and ensure their relevance and clarity.]

- 6. Identify and differentiate between independent, dependent, and controlled variables in both laboratory and field experiments and thoroughly explore experimental setups, techniques, and equipment required for conducting both laboratory-based and field-based experiments based on the given research objectives.**



- 7. Write logbook records accurately for laboratory activities, experiments, and observations. Familiarize yourself with the structure and components of a laboratory logbook, including sections for dates, experimental procedures, observations, results, and signatures.**  
[Suggestion/Working hours:-Dedicate time each week to review and improve your logbook records based on feedback and personal assessment.]
- 8. Prepare excel templates for curating data by converting raw data into final values or observation. Prepare final data sets for graphs and prepare descriptive statistics measures.**
- 9. Create a graph (line/bar/pie) using Microsoft Excel. Prepare publication ready graph and write legend for the graph and table.**
- 10. Conduct t-test/ANOVA and present results in table and in graph.**

## **List of Books for reference M.Sc. Zoology Semester – I**

### **DSC I :- Structure and function of Invertebrates**

1. Hyman L.H. -The Invertebrate Vol. I, Protozoa through Ctenophora. McGraw-Hill Co., New York.
2. Barrington E.J.W.- Invertebrate structure and function. Thomas Nelson and sons Ltd., London.
3. Jagerstein G. -Evolution of Metazoan life cycle . Academic press, New York and London.
4. Hyman L.H. -The invertebrate McGraw-Hill Co., New York.
5. Barnes R.D. -Invertebrate Zoology W.B. Saunders and Co., Philadelphia
6. Hyman L.H. -The Invertebrates, smaller coelomate groups. Vol. 5 McGraw-Hill Co. New York.
7. Marshall A.J. and Williams W.D. -(1972) J. B. Zoology of Invertebrates ,ElBs and McMillan,London.
8. Backlemiccher W.N. -Principles of comparative anatomy of Invertebrates Oliver and Boyed Edinberg.
9. Hadisi J. -The Evolution of Metazoa. Pergamon Press, Oxford.
10. Dales R.P.- Annelids, Hutchinson, London.
11. Green J. -Biology of Crustacea, Wither by, London.
12. Morton J. E. -Mollusca, Hutchinson, London.
13. Nichols D. -Echinodermata, Hutchincon, London.

### **DSC II :Biochemistry-I\***

1. Lehninger-Principles of biochemistry.
2. Donald Voet and Judith Voet- Biochemistry.
3. Harper -Biochemistry.
4. Jeremy M. Berg, John L. Tymovzko ,LubertStryer- Biochemistry.
5. U. Satyanarayana, U. Chakrapani -Biochemistry.

### **DSE I : Cell Biology and Genetics**

1. De Robertis- E. D. P., - Cell and Molecular Biology , I. S. E. publication.
2. Turner P. C. and Mc Lennan - Molecular Biology ; Viva Books Pvt. Ltd.
3. Benjamin Lewis - Gene VIII , Oxford press.
4. Watson J. D. - Molecular biology of Gene ., Benjamin publication.
5. Darnell J. - Molecular cell Biology ; Scientific American Books USA.
6. Alberts B., Bray D. Lewis J.- Molecular Biology of the Cell , garland publishing Inc.
7. Laodish H., Berk A., Zipursky S. L., Matsudaira P., Baltimore D. and Darnell J., - Molecular Cell Biology W. H. Freeman and Co.
8. Cooper G. M. - The Cell: Molecular Approach

## **DSE II: ECONOMIC ZOOLOGY**

1. "Economic Zoology" by G.S. Shukla and V.B. "Economic Entomology.
2. "Applied Zoology: Ethological, Parasitic, and Infectious Diseases" by M. R. James
3. Upadhyay "Applied Entomology: An Introductory Textbook of Insects in Their Relations to Man" by Edward L. and Anne R. Smith
4. For the Farmer and the Fruit-Grower, and for Use as a Text-Book in Agricultural Schools and Colleges by John B. Smith
5. "Economic Zoology: A General Consideration of Economic Entomology" by Adolphus Milton Rogers
6. "Economic Zoology: An Elementary Text-Book in Zoology, with Special Reference to its Applications in Agriculture, Commerce, and Medicine" by Orlando Park
7. "Applied Economic Entomology: Being Plain and Practical Suggestions for Solution of the
8. "Aquaculture: Farming Aquatic Animals and Plants" by John S. Lucas and Paul C. Southgate
9. "Silkworm Rearing and Cocoon Production" by R.R. Baliga
10. "Pearl Production and Assessment" by Joan Lumbreras and Amador Zamorano
11. "Lac Culture and Processing" by M.P. Singh, V.P. Singh, and S.K. Ghosh

### **RM- Research methodology**

1. "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
2. "Research Design: Qualitative, Quantitative, and Mixed Methods Approaches" by John W. Creswell and J. David Creswell
3. "Qualitative Inquiry and Research Design: Choosing Among Five Approaches" by John W. Creswell
4. "Qualitative Research: A Guide to Design and Implementation" by Sharan B. Merriam and Elizabeth J. Tisdell
5. "Designing and Conducting Mixed Methods Research" by John W. Creswell and Vicki L. Plano Clark