

Anekant Education Society's
**TULJARAM CHATURCHAND COLLEGE OF ARTS,
SCIENCE & COMMERCE, BARAMATI, DIST – PUNE.
AUTONOMOUS**



POST GRADUATE DEPARTMENT OF ZOOLOGY

SYLLABUS

M.Sc. Zoology Part-I, SEMESTER-I

Anekant Education Society's
TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE,
BARAMATI.
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Scheme of Course Structure (CBCS) Faculty of Science
Post Graduate Department of Zoology
SEMESTER I

Class: M.Sc. I

Pattern: 40 (IA) + 60 (EA)

Sr. No.	Code	Paper	Paper Title	Credit	Exam	Marks
1	ZOO:4101	Theory	Biochemistry & Bioenergetics	4	I / E	40 + 60
2	ZOO:4102	Theory	Cell Biology & Genetics	4	I / E	40 + 60
3	ZOO:4103	Theory	Fresh Water Zoology & Ichthyology	4	I / E	40 + 60
4	ZOO:4104	Theory	Skills in Scientific Communication and Writing & Biostatistics	4	I / E	40 + 60
5	ZOO:4105	Zoology Practical-I	Practicals Corresponding to ZOO:4101, ZOO:4102	4	I / E	40 + 60
6	ZOO:4106	Zoology Practical-II	Practicals Corresponding to ZOO:4103, ZOO:4104	4	I / E	40 + 60
7			Skill Development	2	-	
8			Certificate Course	2	-	

IA* - Internal Assessment
EA*- External Assessment

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)

Class: M.Sc. I (Semester– I)

Paper Code: ZOO:4101

Paper: I **Title of Paper:** Biochemistry and Bioenergetics

Credit: 4 **No. of Lectures:** 60

Learning Objectives:-

- To understand structures and functions of biomolecules.
- To understand the role in metabolic pathways of carbohydrates, proteins, lipids and nucleic acids.
- To understand the kinetics of Enzymes.
- The energetics of biomolecules.

Learning Outcomes:-

- Understand structures and functions of biomolecules Such as carbohydrates, proteins, lipids and nucleic acids.
- Understand the role of biomolecules in metabolic pathways.
- Understand the Enzymes, kinetics and energetics.
- Get well prepared for research in life sciences.
- Students will gain proficiency in basic laboratory techniques and be able to apply the scientific method in the processes of experimentation and hypothesis testing.

TOPICS / CONTENTS:

1. Biomolecules: - Classification, Structure and Function.	20 L
1.1 Stabilizing Interactions in Biomolecules.	1 L
1.2 Water: Structure and Function, pH and Buffers, Biological Buffer System	2 L
1.3 Carbohydrates: Classification, basic Chemical Structures, General Reactions and properties, Biological Significance.	3 L
1.4 Lipids: Classification, structure and function of major lipid subclasses. Formation of micelles, monolayers, bilayer	3 L
1.5 Vitamins and Coenzymes: Classification, water-soluble and fat-soluble vitamins, coenzyme forms and their significance	3 L
1.6 Proteins:	8 L
A. Amino acids: Classification, properties and reactions, ninhydrin reaction	
B. Peptide bond, formation, End group analysis and sequencing, Ramachandran plot.	
C. Denaturation of Protein	
D. Protein structure:	
i. Primary structure and its importance	
ii. Secondary structure- X ray diffraction, alpha-helix, beta-helix	
iii. Tertiary structure: Myoglobin, Forces stabilizing, unfolding and refolding.	
iv. Quaternary structure- haemoglobin.	
E. Biological Roles of Proteins	
2. Bioenergetics: - Metabolic Pathways and its energetics	32 L
2.1 Basic law of thermodynamics: internal energy, enthalpy, entropy, concept of free energy, redox potentials, high energy compounds, structure and function of ATP.	3 L

- 2.2 Concepts of metabolism:** Metabolic Pathways-Catabolic and anabolic, regulation of metabolic pathways. **2 L**
- 2.3. Glycogen Biosynthesis and its regulation:** Role of enzymes in synthesis & degradation of glycogen, role of cAMP, gluconeogenesis. **4 L**
- 2.4. Carbohydrate metabolisms:** Glycolysis- Detailed study, energetic and its regulation, PFK, Citric acid cycle- Detailed study, energetics, regulation and significance, Role of PDH, HMP pathway, Electron transport chain and oxidative phosphorylation. **8 L**
- 2.5. Oxidative degradation of amino acids:** transamination, oxidative deamination, urea cycle, Ammonia excretion. **4 L**
- 2.6. Purine and Pyrimidine** degradation, biosynthesis of purine and pyrimidine nucleotides **5 L**
- 2.7. Lipid metabolism:** Introduction, Biosynthesis of palmitic acid, Beta oxidation of fatty acid, Lipogenesis and lipolysis, Ketogenesis, Transport of Fatty Acids. **6 L**
- 3. Enzymology: - Classification and Kinetics** **8 L**
- 3.1 Classification: Types, Nomenclature and Properties
- 3.2 Enzyme Kinetics -One Substrate Reaction (Michaelis-Menten Equation)
- 3.3 Specific Activity
- 3.4 Factors affecting enzyme activity
- 3.5 Enzyme inhibition
- 3.6 Allosteric Enzymes
- 3.7 Isozymes (LDH)

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 2. *Biochemistry* 6th Ed, (2007) Berg Jeremy, Tymoczko John, Stryer Lubert, Publisher: W. H. Freeman, New York.
 3. *Biochemical Calculations*, 2nd Ed., (1997) Segel Irvin H., Publisher: John Wiley and Sons, New York.
 4. *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, (2001) Palmer Trevor, Publisher: Horword Pub. Co., England.
 5. Harper's Illustrated Biochemistry 26th Ed. (2003) Robert Murray et. Al.
 6. *Lehninger's Principles of Biochemistry*, 4th edition, (2005) Nelson D. L. and Cox M. M., W. H. Freeman and Co. NY.
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Class: M.Sc. I (Semester– I)

Paper Code: ZOO: 4102

Paper: II Title of Paper: Cell Biology and Genetics

Credit: 4

No. of Lectures: 60

Learning Objectives:-

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
- Students will understand how these cellular components are used to generate and utilize energy in cells
- Students will understand the cellular components underlying mitotic cell division.
- Students will apply their knowledge of cell biology to selected examples of changes or losses in cell function. These can include responses to environmental or physiological changes, or alterations of cell function brought about by mutation.
- To apply the principles of genetics to produce a family pedigree from a family history and to distinguish patterns of inheritance for single gene disorders linked to autosomes, sex chromosomes and mitochondrial genes.
- To describe methods used to determine the relative contribution of genes and environment to common disorders with complex inheritance and to provide genetic counseling based on empirically derived risk tables.
- Perform a literature search on a specific genetic disease and inform other students of the findings in a written abstract and an oral presentation.

Learning Outcomes:-

- Comprehensive, detailed understanding of the chemical basis of heredity.
- Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
- Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
- Understanding the role of genetic mechanisms in evolution.
- The knowledge required to design, execute, and analyse the results of genetic experimentation in animal and plant model systems.
- Students will understand the structures, biochemical composition and Functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Various Techniques of cell Study
- Students will understand the cellular components for mitotic cell division.
- Students will apply their knowledge of cell biology responses to environmental or physiological changes, or alterations of cell function brought about by mutation or Cancer
- Student understands cell apoptosis, necrosis and senescence
- Students will come to know about the intrinsic and extrinsic factors for causes of cancer.
- Understand types of cancer, biological entities responsible for it.
- How cells are newly form and the chromosome number is maintain for formation of gametes

TOPICS / CONTENTS:

Section -A Cell Biology

- 1. Overview of Chemical Nature of the Cell:** 2 L
 - 1.1 Carbon as backbone of biologically important molecules.
 - 1.2 Macromolecules and their role in form and function of living systems.
- 2. Plasma Membrane:** 4 L
 - 2.1 Models of plasma membrane structure.
 - 2.2 Transport across membrane and Active and passive transport; Voltage and transmitter gated ion channels; energetics of transport.
 - 2.3 Membrane potential and synaptic transmission.
- 3. The Endomembrane System and Peroxisomes:** 3 L
 - 3.1 Endoplasmic reticulum, protein folding, processing and secretion; lipid synthesis.
 - 3.2 Golgi complex: Protein glycosylation and proteolytic processing
 - 3.3 Lysosomes and intracellular digestion.
 - 3.4 Structure and functions of Peroxisomes and glyoxysomes.
 - 3.5 Intracellular Transport and protein trafficking.
- 4. Nucleus** 4 L
 - 4.1 Ultrastructure, Nuclear pore complex, Nucleo - Cytoplasmic Interactions
 - 4.2 Nucleolus, Nuclear lamina and its role in Cell Division
- 5. Mitochondria and Chloroplast** 2 L
 - 5.1 Structure, Genetic system, Functions, Protein Import
- 6. Extracellular Matrix, Cell-Cell Junction and Adhesion** 3 L
 - 6.1 Polarity proteins
 - 6.2 Adhesion junctions
 - 6.3 Tight junctions (Desmosomes)
 - 6.4 Claudins
 - 6.5 Gap junctions
 - 6.6 Extracellular matrix of animal and plant cell surface
 - 6.7 Plasmodesmata
- 7. Cell Signaling and Transduction** 3 L
 - 7.1 Chemical Signals and Cellular Receptors, Role of Sec. messengers.
 - 7.2 G Protein-Linked Receptors
 - 7.3 Protein Kinase-Associated Receptor
 - 7.4 Hormonal Signaling
- 8. Cell Cycle and its regulation** 3 L
 - 8.1 Check points of cell cycle.
 - 8.2 Regulation of Cyclin and Cyclin dependent kinases, p53
 - 8.3 Inhibitors of cell cycle.
- 9. Cytoskeleton and Motor Proteins** 3 L
 - 9.1 Microtubules: Structure, MTOC's and functions of microtubules
 - 9.2 Intermediate filaments: Structure and functions of intermediate filaments.
 - 9.3 Microfilaments: Actin polymerization, role in cell movement.
 - 9.4 Dynein, Kinesin and Myosin
 - 9.5 Inhibitors of cytoskeleton organization

10. Cancer Biology	3 L
10.1 Characteristics of Cancer Cell	
10.2 Metastasis	
10.3 Types and classification of Cancer	
10.4 Causes of cancer: Physical, Chemical and biological agents;	
10.5 Tumor viruses -Hepatitis B viruses, Adenoviruses, SV40, Polyoma virus, Herpes viruses, Papillomaviruses and Retroviruses, Oncogenes and Tumor suppressor genes	
10.6 Diagnosis, Screening and treatment of cancer	
Section -B Genetics	
1. Recapitulation of Mendelian Principles:	2 L
Practical applications of genetics in brief.	
2. Gene Interactions	4 L
Incomplete and co-dominance, Dominant Epistasis, Recessive Epistasis, Duplicate Dominant Epistasis, Duplicate recessive epistasis, Polymeric gene interaction.	
3. Multiple alleles:	2 L
Blood groups and its significance, coat colour in mice	
4. Linkage and crossing over:	4 L
Linkage, linkage groups, types of crossing over, Models of molecular basis of recombination, maps in diploids for 3-point test cross (determination of gene order and distance with suitable examples)	
5. Inheritance of qualitative and quantitative traits:	4 L
QTL Mapping, heritability, genetic basis and influence of environment on quantitative inheritance.	
6. Principles of Population Genetics:	4 L
Hardy-Weinberg law and its application.	
7. Somatic Cell Genetics:	2 L
Its applications, Gene Therapy, Gene transfer technology	
8. Human genetics:	4 L
Dominant and recessive disorders, Pedigree Analysis, physical and physiological traits.	
9. Gene Mutation:	3 L
Types, Causes and Detection	
10. Introduction to epigenetics.	1 L

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 14. Genetics by Sarin, C., Tata McGraw Hill, New Delhi
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 16. Genetics-A Molecular Approach: Peter J. Russell; Pearson Inc. publishing as Benjamin Cummings; 2006.
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Class: M.Sc. I (Semester– I)

Paper Code: ZOO: 4103

Paper: III

Title of Paper: Fresh Water Zoology and Ichthyology

Credit: 4

No. of Lectures: 60

Learning Objectives:-

- To understand the animal kingdom.
- To understand the taxonomic position of protozoa to helminthes.
- To understand the general characteristics of animals belonging to protozoa to helminthes.
- To understand the body organization of phylum from protozoa to helminthes.
- To understand the origin and evolutionary relationship of different phylum from protozoa to helminthes.
- To provide students with an interactive learning environment whereby critical thinking is developed and knowledge is acquired on various aspects of fish anatomy, function, biology and academic writing.
- The overall goals of this course are to: introduce students to fish diversity. appreciate the means through which fishes adapt to suit their challenging environments. provide an overview of fish anatomy, ecological environment, and behaviour.

Learning Outcomes:-

- Students learn about the aquatic ecosystem, lentic and lotic habitat as well the ephemeral water bodies.
- Students learn about the different parameters of physical conditions of water.
- Students learn about the different parameters of chemical conditions of water and its importance to the aquatic life.
- Students learn the different physiological and protective adaptations.
- Students understand the relation of Amphibia and water with the life cycle of frog and the tadpole as important herbivores.
- Students learn different adaptations in turtles and crocodiles with economic importance.
- They can also understand the taxonomic and phylogenetic relationships of fish and fish-like vertebrates within the context of all vertebrate groups.

Topic and Content

Section A: Fresh Water Zoology

- 1. Types of Aquatic Environment. 4 L**
 - 1.1 Lotic Habitat: Major river systems in India / rapid and slow-moving rivers.
 - 1.2 Lentic Habitat: Lakes, Ponds and Swamps, Bogs lakes and succession of lakes.
 - 1.3 Ephemeral water bodies (Temporary habitat).
- 2. Physical Conditions of Water: 4 L**
 - 2.1 Movement of water, depth, viscosity, density, buoyancy, temperature, light, transparency and turbidity.
- 3. Chemical Conditions of Water: 4 L**
 - 3.1 Dissolved oxygen and carbon di-oxide, phosphates, sulphate content, nitrates
 - 3.2 Nitrate-nitrite ratio, acidity, alkalinity, Mg-hardness, Ca-hardness, dissolved solids
 - 3.3 Organic matter, primary productivity
 - 3.4 Importance of chemical conditions to aquatic life.

4. **Physiological and protective adaptations of the following.** 2 L
4.1 Protozoa, Rotifera, Crustaceans, Fishes.
5. **Diagnostic features and life cycle of temporary rainwater pool animals:** 3 L
5.1 Fairy shrimps
5.2 Tadpole shrimps.
5.3 Clam shrimps.
6. **Respiratory and locomotory adaptations:** 3 L
3.1 Adaptations in freshwater insects and their larvae.
7. **Amphibia and water:** 2 L
7.1 General life cycle of frog.
7.2 Tadpole as important herbivore of freshwater habitat.
8. **Adaptations in fresh water reptiles:** 3 L
8.1 Turtles and crocodiles, economic importance of reptiles.
9. **Economic importance:** 2 L
9.1 Economic importance of freshwater molluscs (snails and bivalves) as a food and medicine:
10. Biological changes in freshwater due to sewage pollution (with reference to rivers) and its effect on freshwater animals. 3 L

SECTION B: Ichthyology

1. **Classification and Diagnostic Characters (up to orders):** 4 L
Extant Cyclostomata, Chondrichthyes and Osteichthyes (9 major orders of fishes)
2. **Phylogeny of Fishes** 1 L
3. **External morphology:** 2 L
Body form, appendages, pigmentation, skin and scales, principles of morphometry and locomotion
4. **Endoskeleton:** 2 L
Skull, axial and appendicular skeleton.
5. **Digestion:** 3 L
Food and feeding habits, digestive system and its anatomical modifications.
6. **Respiration:** 2 L
Structure and functions of gills; adaptations for air breathing; role of air bladder.
Respiratory functions of food.
7. **Buoyancy Mechanisms:** 2 L
Role of fat and swim bladder.
8. **Excretion and Osmoregulation:** 3 L
Glomerular and aglomerular kidneys; Nitrogen (Ammonia, Urea and TMAO) excretions; water and salt and balance in steno and euryhaline fishes. Role of skin and gills
9. **Catadromous and Anadromous fishes** 1 L
10. **Reproduction:** 4 L
Structure of gonads, gametogenic cycles; spawning and parental care.
11. **Nervous System and Sense Organs:** 3 L
Organization of the central and peripheral nervous systems. Eye, lateral line organs and chemoreceptors
12. **Endocrine Organs:** 3 L
Functions of the pituitary, thyroid, inter-renal and chromaffin tissues, ultimobranchial and

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Class : M.Sc. I (Semester I)
Paper Code : ZOO-4104
Paper : IV Title of paper: Skills in Scientific Communication & Writing and Biostatistics
Credit : 4 No. of Lecture: 60

Learning Objectives:-

- To learn the importance of English in research communication.
- To study the organization of grammatically correct sentences in English
- To learn how we can prepare a research project for funding.
- To learn how to prepare a scientifically correct well organized research paper and review articles.
- To learn about numerical data analysis.
- To study the tabular, diagrammatic and graphical representation of data.
- To study correlation between variables for making conclusions.
- To study parametric and non-parametric tests for comparison of numerical data.
- To study importance of statistical tests for scientific communications like research papers.

Learning Outcomes:-

- Students will learn the importance English language in scientific communication.
- Students will learn the organization of research papers and review articles.
- Students will understand about the project proposal for obtaining research grants.
- Students will study how to analyze and represent the numerical data.
- Students will learn to compare the variables and to predict unknown from known data.
- Students will understand the parametric and non-parametric tests and distributions of data.
- Students will study the tests of comparison of data by various statistical tests.

Topic and Content

Section A: Skills in Scientific Communication and Writing

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|---|---|
| <p>1. Language as a Communication Tool:
Relationship among reading, writing, hearing and speaking, synonyms and antonyms</p> <p>2. Organization of English Language:
Sentence structure, basic grammar, Syntax, paragraphs, paraphrases and précis-recognizing important statements and key words</p> <p>3. Common Error in Written and Spoken Presentation:
Tautology, double negative, doubles positive superfluous words, sequence and tenses.</p> <p>4. Oral presentation:
How to prepare presentation, power point slides use of communication and it, voice, speed of delivery, obstacles in effective communication.</p> <p>5. Hypothesis, Theory and Concept</p> <p>6. Concept of IPR and patent:
General introduction to IP and IPR; Introduction, History and role of international conventions.</p> <p>7. Research project preparation and funding</p> <p>8. Outline of a Scientific Paper:
8.1 Introduction: Survey of Literature, defining the problem and justification
8.2 Materials and Methods: Contents, importance of measurements, reproducibility etc.
8.3 Observations and Results: Text and data presentation, tables, graphs, histograms, diagrams, photographic plates, legends and captions.</p> | <p>3 L</p> <p>4 L</p> <p>3 L</p> <p>4 L</p> <p>2 L</p> <p>3 L</p> <p>3 L</p> <p>8 L</p> |
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Section B: Biostatistics

- 1. Introduction:** **2 L**
 - 1.1 Applications and Uses of Statistics
 - 1.2 Population and sample, Different types of Sample
 - 1.3 Exercise and Problems.
- 2. Data Classification:** **3 L**
 - 2.1 Some important terms (Class frequency, class- limits, Class-width, class –mark)
 - 2.2 Frequency distribution, Cumulative frequency, Graphical representation of data (Histogram, Pie-Diagram, Ogive-Curve.)
 - 2.3 Exercise and Problems.
- 3. Measures of central tendency:** **4 L**
 - 3.1 Concept of central tendency, Types of central tendency (Arithmetic mean, Median and mode) combined mean.
 - 3.2 Partition values (Quartiles, Deciles, and Percentiles)
 - 3.3 Exercise and Problems.
- 4. Measures of dispersion:** **3 L**
 - 4.1 Concept of dispersion, absolute and relative measure of dispersion.
 - 4.2 Different measures of dispersion (Range, Quartile- Deviation, Variance and standard deviation, Coefficient of Variation) combined variance
 - 4.3 Exercise and Problems.
- 5. Correlation and Regression:** **5 L**
 - 5.1 Bivariate data, concept of correlation, Types of Correlation, Scatter diagram,
 - 5.2 Karl Pearson's coefficient of correlation and its properties.
 - 5.3 Concept of regression, linear regression, regression coefficients and its properties.
 - 5.4 Exercise and problems.
- 6. Probability and probability distribution:** **5 L**
 - 6.1 Some important terms (types of experiment, sample space and types of sample space, events and types of events.)
 - 6.2 Definition of probability (mathematical and classical) conditional probability.
 - 6.3 Concept of random variable, univariate probability distribution and its mathematical expectation.
 - 6.4 Some standard probability distributions (binomial, Poisson and normal) their probability distribution, mean, variance and properties of these distribution.
 - 6.5 Exercise and Problems.
- 7. Test of hypothesis:** **8 L**
 - 7.1 Some important terms (hypothesis, types of hypothesis, Test, Critical region, acceptance region, type I error, type II error, level of significance, p-value)
 - 7.2 Test for mean and equality of two population means, Test for proportion and equality of two population proportions.
 - 7.3 Chi-square test for goodness of fit, Unpaired and paired 't' test,
 - 7.4 F test for equality of two population variances.
 - 7.5 Exercise and Problems.

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 7. Statistical Methods: Snedecor G.W. and Cochran W.G.
 8. Statistical Methods : Dixon W.S. and Massey
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Class	: M.Sc. I (Semester I)	
Paper Code	: ZOO-4105	
Paper	: V	Title of paper: Zoology Practical-I
		(Practicals Corresponding to ZOO: 4101, ZOO: 4102)
Credit	: 4	No. of Practical: 20

Section I – ZOO 4101: Biochemistry and Bioenergetics (Any 10)

- 1 Preparation of standard Acid and Alkali solutions and acid-base titration.
- 2 Preparation of Buffers of known pH and molarity and measurement of pH of Various samples, Buffering capacity
- 3 Estimation of Inorganic Phosphate.
- 4 Estimation of Sugar (Glucose) by O-toludine method.
- 5 Estimation of Tyrosine by FCR.
- 6 Estimation of vitamin 'C' by iodine method.
- 7 Isolation of amylase/ invertase, to find specific activity and progress curve
- 8 Estimation of protein by Lowry et.al method.
- 9 Units and specific activity of enzymes.
- 10 Effect of substrate concentration pH temperature inhibitor and activator on enzyme activity
- 11 Estimation of cholesterol
- 12 Estimation of Starch

Section II- ZOO 4102: Cell Biology and Genetics (Any 10)

- 1 Measurements of cell size using light microscope.
- 2 Study of meiosis in Grasshopper testes / Onion flower buds / Aloe vera with emphasis on all stages of prophase.
- 4 Cell fractionation- Nuclei, mitochondria observation, nuclear count.
- 5 Study of metaphase spreads chromosomes from any suitable material.
- 6 Effect of Colchicine treatment on Mitosis from any suitable material.
- 7 Demonstration of collagen by Van Gueson's Stain in Liver/Tissue Sections.
- 8 Study of sex linked inheritance in Drosophila sp.
- 9 Determination of gene distances and gene order for a given three point test cross
- 10 Polytene chromosomes of Drosophila/ Chironomous-examination of puff and bands
- 11 Study of Banding Pattern in Chromosome (G- Banding and/or C- Banding)
- 12 Estimation of allelic frequencies, heterozygote frequencies in human populations
- 13 Effect of toxicant on Hydra regeneration.

Class	: M.Sc. I (Semester I)	
Paper Code	: ZOO-4106	
Paper	: VI	Title of paper: Zoology Practical-II
		(Practicals Corresponding to ZOO: 4103, ZOO: 4104)
Credit	: 4	No. of Practical: 20

Section I -ZOO 4103: Fresh Water Zoology (Any 05)

- 1 A qualitative and quantitative analysis of Zooplankton from a given sample of water using Sedgwick rafter counting cell.
- 2 To prepare and maintain a culture of Paramecium, Daphnia and Hydra.
- 3 Study of locomotory and respiratory adaptations in aquatic insects and their larvae. (Ranatra, Notonecta, Gerris, Bellostoma, Dytiscus).
- 4 Estimation of Chlorides in given sample of water.
- 5 Study of Bioindicators of pollution by insects, rotifers, algae, diatoms.
- 6 Determinations of LC₅₀ using fish/insect larvae for known pollutant like Heavy metal/any Pesticide/industrial effluent.
- 7 Water analysis with regards to hardness (Total and Calcium).
- 8 Compulsory Visit to ZSI and freshwater body for the study of aquatic ecosystem and water purification plant and submission of tour report.

Section II - ZOO 4103: Ichthyology (Any 05)

- 1 General external characters, fins and scales (permanent slides and temporary preparations); morphometric measurements Length-weight relationship, conditions factors, gonosomatic and hepatosomatic indices
- 2 Classification of fishes (12-18 representatives of different orders); use of diagnostic keys
- 3 Adaptations of fishes (adhesive organs, accessory respiratory organs, stomachless fishes, spiral valve, electric organs etc.
- 4 Digestive system, Cranial nerves (V, VII, IX and X) and eye ball musculature, innervations and reproductive systems of carp/catfish/Tilapia
- 5 Histology of digestive, respiratory, excretory, reproductive and endocrine organs.
- 6 Satiation index (e.g. Gambusia-mosquito larvae system)
- 7 Visit to fish farm/fish market or any aquarium to study breeding behavior of gourami, Siamese fighter, swordtail/tilapia

Section III - ZOO 4104: Skills in Scientific Communication (Any 05)

- 1 Syntax, paraphrasing and précis writing, synonyms, antonyms, abbreviations.
- 2 Outline of a scientific paper; preparation of a project and writing Introduction
- 3 Writing abstracts, conclusion/ summary and acknowledgements, key words and to suggest a title to the given abstract/paper
- 4 Assigning legends to given graphs, figures and captions to given tables, Deciphering the given pictorals.
- 5 Study of proof correction symbols; proof- reading the given text and correcting the Proofs
- 6 How to write materials and methods, observation and discussion section for the given research paper.

Section IV - ZOO 4104: Biostatistics (Any 05)

- 1 Construction of frequency distribution and its graphical representation.
- 2 Measures of Central Tendency and Dispersion.
- 3 Correlation and Regression.
- 4 Computation and application of normal, binomial and Poisson probabilities.
- 5 Test for means and proportions.
- 6 Chi-square test of goodness of fit, Paired and unpaired t- test, F-test
- 7 Statistical analysis with Computer software packages.

Anekant Education Society's
**TULJARAM CHATURCHAND COLLEGE OF ARTS,
SCIENCE & COMMERCE, BARAMATI, DIST – PUNE.
AUTONOMOUS**



POST GRADUATE DEPARTMENT OF ZOOLOGY

SYLLABUS

M.Sc. Zoology Part-I, SEMESTER-II

Anekant Education Society's
TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE,
BARAMATI.
AUTONOMOUS

Scheme of Course Structure (CBCS) Faculty of Science
Post Graduate Department of Zoology
SEMESTER II

Class: M.Sc. I

Pattern: 50 (IA) + 50 (EA)

Sr. No.	Code	Paper	Paper Title	Credit	Exam	Marks
1	ZOO:4201	Theory	Molecular Biology	4	E/I	60 + 40
2	ZOO:4202	Theory	Developmental Biology	4	E/I	60 + 40
3	ZOO:4203	Theory	Comparative Animal Physiology and Endocrinology	4	E/I	60 + 40
4	ZOO:4204	Theory	Biological Techniques	4	E/I	60 + 40
5	ZOO:4205	Zoology Practical-III	Practicals Corresponding to ZOO:4201 and ZOO:4202	4	E/I	60 + 40
6	ZOO:4206	Zoology Practical-IV	Practicals Corresponding to ZOO:4203 and ZOO:4204	4	E/I	60 + 40
7		Skill Development		2		
8		Introduction to Cyber Security – I		2		

IA* - Internal Assessment
EA* - External Assessment

SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)

Class: M.Sc. I (Semester– II)

Paper Code: ZOO:4201

Paper: I **Title of Paper:** Molecular Biology

Credit: 4

No. of Lectures: 60

Learning Objective:

1. To understand structure and physical chemical properties of genetic materials.
2. To understand the mechanism behind the replication of genetic material.
3. To learn about transcription and translation processes.
4. To study the causes and repair mechanism of DNA damage.
5. To be aware of transposable elements or jumping genes.

Learning outcomes:

1. Students will understand the central dogma of molecular biology.
2. Candidates will know about the process like replication, transcription and translation.
3. Student will know the regulation of gene and its expressions.
4. Students will understand the basic principle, advanced techniques in molecular biology.

TOPICS / CONTENTS:

1. DNA Structure and Topology:

5 L

Structure of chromatin, nucleosome, chromatin organization and re-modelling, higher order organization –Coiling, Supercoiling, chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin, types of DNA

2. Physical properties of DNA:

2 L

T_m, hypo and hyper chromicity, solubility, mutarotation and buoyancy

3. Genome organization:

4 L

C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and, kinetic and sequence complexity, satellite DNA. Types of RNA and their significance

4. DNA Replication:

10 L

DNA replication in E. coli, Origin of replication, types of E. coli DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA, replication features of single stranded phages. Eukaryotic DNA replication, multiple replicons, structure of eukaryotic DNA polymerases, ARS in yeast, Origin Recognition Complex (ORC), regulation of replication.

5. DNA Damage and Repair:

6 L

Different types in DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair, Nick Translation, SOS Repair

6. Transcriptional Unit in Prokaryotes and Eukaryotes:

12 L

Role and significance of promoter, enhancer, intron, exon, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, structure of RNA polymerase, post transcriptional processing: Capping, polyadenylation and splicing in eukaryotes. Ribonucleoproteins (Sn RNPs & Sc RNPs)

7. Genetic Code:

2 L

in prokaryotes and eukaryotes

8. Protein synthesis in Prokaryotes and Eukaryotes:

7 L

Ribosome structure, RNA Transport Mechanism, activation of amino acids,

peptide bond formation and translocation of peptides, post-translational modifications, inhibitors of protein synthesis

9. Gene Regulation **6 L**

Lac Operon, Trp Operon, Arabinose Operon, pre and post transcriptional regulation, Post Translational Regulation

10. Mobile DNA elements: **4 L**

Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transposition, Controlling elements in TnA and Tn10 transposition, SINES and LINES. Retroviruses and retro-transposon

11. Recombination :- **2 L**

Types of Recombination and Proteins involved in recombination

REFERENCES

1. Genes IX, X, XI edition, Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
 2. Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker,
 3. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher -
 4. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
 5. Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGraw Hill Science.
 6. Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian
 7. Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
 8. Essential Cell Biology, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin,
 9. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
 10. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.
 11. Lohar Prakash S. (2016) : Cell and Molecular Biology, MJP Publishers, Chennai MJP Publishers, Chennai ISBN 81-8094-027-6
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Class: M.Sc. I (Semester– II)

Paper Code: ZOO:4202

Paper: II **Title of Paper:** Developmental Biology

Credit: 4

No. of Lectures: 60

Learning objectives:

- To understand the basic steps of development of embryo
- To make the students aware about the mechanisms related to pre-embryonic and post embryonic developments
- To understand cellular regulation and pattern formation in development
- To assist and co-operate with advanced, sophisticated and updated research in the field of Biology

Learning outcomes:

- Student will learn the molecular mechanism of development.
- Student will come to know the differentiation pre and post embryonic developments.
- They will get to know various types of pattern formation
- They will get in touch with new horizons and discoveries in the field of embryology

TOPICS / CONTENTS:

1. Evolution of Developmental Patterns:

4 L

The Evolution of developmental patterns in unicellular protists, multicellularity and developmental patterns among the metazoan

2. Basic concepts of Developmental Biology:

3 L

Model systems: *C. elegans*, *Drosophila*, Zebra Fish, Frog(*Xenopus laevis*), Chick, Mouse

3. Gametogenesis:

3 L

Spermatogenesis, regulation of sperm motility (tail fibre complex and role of dynein ATPase), role of pH and divalent cation.

4. Oogenesis:

5 L

Structure and Types of eggs and synthesis and storage of maternal transcripts, proteins and cell organelles, r-DNA amplification, transcription lampbrush chromosomes, vitellogenesis and its regulation

5. Fertilization:

7 L

Types, Pre- fertilization events - Capacitation, Species specific sperm attraction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to ensure monospermic and species-specificity in fertilization, Significance of Fertilization

6. Post- Fertilization Events :

6 L

Cleavage patterns, Blastulation and types of Blastulae, Gastrulation gradients, Origin and Specification of germ layers Concepts in Pattern formation, animal vegetal axis.

7. Egg activation:

2 L

Regulation of cell cycle and utilization of maternal macromolecules and organelles during early development.

8. Organizers:

5 L

Role of Spemann's organizers in *X. laevis*, Zebra fish, Chick and Mammal

9. Mesoderm Induction in *Xenopus*:

3 L

Role of signals in dorsal, intermediate and ventral mesoderm induction.

10. Pattern formation in *Drosophila*:

3 L

Bicoid, Nanos and Torso, Morphogen gradients and regulation of Hunchback

- 11. Neural competence and molecular signaling during neural induction:** 3 L
- 12. Eye Lens Induction and Limb Development and regeneration in Vertebrates:** 7 L
- 13. Cell Growth and Aging :** 2 L
Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death.
- 14. Growth and post embryonic development:** 4 L
Apoptosis and Necrosis, aging and senescence Hayflick's Experiment
- 15. Cloning and Ethics:** 3 L

REFERENCES

1. Developmental Biology, 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.
 2. Principles of Development, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
 3. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd.
 4. Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.
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Class: M.Sc. I (Semester– II)

Paper Code: ZOO: 4203

Paper: III Title of Paper: Comparative Animal Physiology & Endocrinology

Credit: 4 No. of Lectures: 60

Learning objectives:

- To create interest and enthusiasm amongst the students in learning the body functions of animal groups ranging from Pisces, Amphibia, Aves and Mammals.
- To make the students aware about the differentiation between poikilothermic and homoeothermic animals with their compensatory mechanisms for thermoregulation
- To get them ready to apply the principle and working of various body mechanisms in their daily routine life to live standard life.
- To motivate the student to work in the field of physiology and medicine for their future research work.
- To Make them aware about the significance of hormones in our day to day life
- To introduce them with different exocrine and endocrine glands.

Learning outcomes:

- Student will learn all body systems among different kind of animals with their comparison to trace similarities and differences between them.
- Student will come to know about difference between thermo-biological and osmo-regulatory mechanisms among different animal groups.
- Students will understand neuroendocrinology amongst different animal groups ranges in amphibians, cephalopod molluscs, mammals and human beings.
- Student will get motivated to take up the subject of physiology for their research .

Section I - Comparative Animal Physiology

TOPICS / CONTENTS:

1.Digestion: 4L

Physiology of digestion, absorption and their regulation.

2.Respiration: 4L

Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. Blood pigment, role in Oxygen transport. O₂ dissociation curves- physiological and ecological significance, CO₂ transport

3.Muscle Contraction: 4L

Structure (light & electron microscopic) of the skeletal muscle, proteins of the myo-filaments, events at Neuro- Muscular Junction ,nature of actinmyosin interaction., sarcoplasmic reticulum and role of Ca⁺⁺ in contraction

4.Osmotic Regulation: 4L

Concepts of Osmole, Osmolality and tonicity, Ionic Regulation, Hyper and hypo-osmotic regulators, ureosmotic animals

5.Excretion:	4L
Processes& Detail mechanism of urine formation, renal function in animals specially the mammalian kidney, Renal pressure system, Comparative biochemistry of nitrogen excretion.	
6.Temperature:	4L
Biokinetic Zones, tolerance and resistance. Thermobiological terminology. Compensatory patterns in poikilotherms, Critical temp, and zone of thermal neutrality. Mechanism of thermoregulation in homeotherms.	
7. Nervous System :	3L
Anatomy of Brain, Comparative Physiology of Nervous system, Origin and Conduction Nerve Impulse, Nerve Excitation	
8.Sense Organs:	3L
Classification & functions (details of photoreception as a model).Reflexes, Principles of neural integration.	

Section II – ENDOCRINOLOGY

TOPICS / CONTENTS:

1. Chemical Communication:	3 L
Hormones as chemical messenger, structure of hormones Neurosecretion, neurohemal and endocrine organs. Chemistry of Invertebrate and vertebrate hormones.	
2.Hormone Receptors:	3 L
Receptors on the plasma membrane, cytoplasm & nucleus and Mechanism of hormone action- signal transduction cascade	
3.Hypothalamic Hypophysiotropins	2L
4.Adenohypophysial Hormones:	2L
FSH, LH, ACTH, PRL, STH and TSH	
5.Control of Chromatophores:	2L
Pituitary and Pineal	
6.Hormonal Regulation of Carbohydrates, Protein &Lipid metabolism:	3L
Pancreatic Hormones and Glucocorticoids	
7.Osmoregulatory Hormones:	2L
ADH, mineralocorticoids, renin-angiotensin	
8.Gastrointestinal Hormones	2L
9.Control of calcium and Phosphate Metabolism	2L
10.Endocrine Mechanism in Crustacean:	3 L
X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction,	

colour change, moulting

11. Hormonal Control in Oogenesis of Amphibia: 2L

Yolk Synthesis, Secretion & Uptake

12. Hormonal Regulation of in Cephalopod Molluscs and Echinoderms: 2L

Reproductive System and Their Regulation

13. Hormones Regulation in Insect and Frog: 2L

Larval Development and Metamorphosis

REFERENCES

1. Comparative Animal Physiology, Clifford Ladd Prosser, John Wiley & Sons
 2. Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row
 3. Comparative animal physiology, Philip Carew Withers, Saunders College Pub., 1992
 4. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.
 5. Bollander, F. (1994). Molecular endocrinology, edn.2, Acad. Press, San Diego.
 6. Hadely, M.E. (1996). Endocrinology. Edn.4, Prentice Hall, Upper Saddle Park.
 7. Thomdyke, M.C. and Goldsworthy, G.J. (1988). Neurohormones in Invertebrates. Cambridge University Press.
 8. Hoar, W.S. and Hickman, C.P., Jr. (1983). A laboratory companion for general and comparative physiology. Edn.3, Prentice - Hall, Englewood Cliffs, N.J., USA.
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 10. Zarrow, M.X., Yachim, J.M. and McCarthy, J.L. (1964). Experimental endocrinology: a sourcebook of basic techniques. Academic Press, New York
 11. Lohar Prakash S. (2012) : Endocrinology : Hormones and Human Health, MJP Publishers, Chennai ISBN 81-8094-011-X
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Class: M.Sc. I (Semester– II)

Paper Code: ZOO: 4204

Paper: IV **Title of Paper:** Biological Techniques

Credit: 4

No. of Lectures: 60

Learning objectives:

- To understand the advanced techniques in life sciences
- To study the principles behind the working of various instruments.
- To understand the techniques used in research and applicability.
- To make the students aware of cell culture technology.

Learning outcomes:

- Student will learn the working of instruments.
- Student will come to know the basic and advance techniques in life sciences.
- They will get to know about separation and isolation of biomolecules.
- They will understand the application of computer and biological databases in research.

TOPICS / CONTENTS:

1. Microscopy:	7 L
Principles and Applications of Phase Contrast Microscopy, Fluorescence Microscopy, Confocal Microscopy, Transmission And Scanning Electron Microscopy, Atomic Force Microscopy and Live Cell Imaging, FACS Analysis	
2. Spectroscopy:	8 L
UV-Visible Spectroscopy, Atomic Absorption Spectroscopy, Molecular Spectroscopy, IR Spectroscopy, NMR And X-Ray Crystallography, Circular Dichroism, MALDI-TOF	
3. Electrophoresis:	6 L
Moving Boundary Electrophoresis, Zone Electrophoresis, Different Supports Used for Electrophoresis, Native And SDS-PAGE, 2D- Gel Electrophoresis	
4. Centrifugation:	6 L
Principle, Basic Theory of Ultracentrifuge, Differential and Density Gradient Centrifugation, Molecular Weight Determination and Its Applications	
5. Chromatography:	7 L
Principles and Applications of: Paper and Thin Layer Chromatography, Adsorption Chromatography Partition Chromatography, Ion-Exchange Chromatography, Affinity Chromatography, Molecular Exclusion Chromatography, Thin Layer Chromatography, GC-MS, HPLC, HPTLC.	
6. Histological Techniques:	5 L
Types of Fixatives, Sectioning of Tissues, Histochemical Staining, Immunohistochemistry, Immunofluorescence	
7. New Generation Techniques:	6 L
Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarray, protein sequencing, FRET analysis	
8. Computer Application:	5 L

Introduction, The cell culture laboratory and equipment, Aseptic techniques and good cell culture practice, Types of animal cell, characteristics and maintenance in culture, Stem cell culture and Potential use of cell cultures

REFERENCES

1. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press.
 2. Light Microscopy in Biology: A Practical Approach, 2nd edition (1999), Alan J. Lacey, Publisher–Oxford University Press.
 3. Electron Microscopy: Principles and Techniques for Biologists, (1992), Lonnie D. Russell, Publisher-Jones & Bartlett
 1. O’conner, M. and Woodford, F.P. Writing scientific papers in English. Elsevier – Ecerpta Medica- North Holland Publ., Amsterdam.
 2. Trelease, S.F. How to write Scientific and Technical papers. Williams & Willikins Co., Baltimore, USA.
 3. Day, R.A.How to write and publish a Scientific Paper. Cambridge University Press
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 5. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker J.M., Cambridge University Press
 6. Biophysical& Biochemical Techniques, Wilson K and Walker J.M.,
 7. Laboratory Exercises and techniques in Cellular Biology, Anthony Contanto, Wiley Publ.2012
 8. Histological and Histochemical methods: Theory and Practice, Kiernan J.A. Scion Publ.
 9. Lohar Prakash S.(2014) : Bioinformatics, MJP Publishers, Chennai ISBN 978-81-8094-066-8
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SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)

Academic Year 2019 – 2020

Class: M.Sc. I (Semester– II)

Paper Code: ZOO: 4205

**Title of paper: Zoology Practical-III
(Practicals Corresponding to ZOO: 4201, ZOO: 4202)**

Credit : 4

No. of Practical: 20

Section I ZOO: 4201 – Molecular Biology

1. Estimation of DNA by diphenyl amine reagent.
2. Estimation of RNA by orcinol reagent.
3. Isolation of bacterial DNA and estimation by UV spectrophotometry.
4. Isolation of DNA from sheep/chicken liver.
5. Quantification of isolated DNA by agarose gel electrophoresis.
6. Isolation of RNA from biological sample.
7. Isolation of plasmid from bacteria.
8. Study of UV light/mutagen induced DNA damage through comet assay.
9. Detection of protein by Western blotting technique.

Section II ZOO 4202 – Developmental Biology

1. Mounting of chick embryos and preparation of permanent mounts.
 2. Filter paper ring method for in vitro culturing of chick Embryo & observations.
 3. Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development.
 4. Drosophila development on live material: egg structure, egg laying and early development in culture by phase contrast
 5. Study of embryonic and post-embryonic development using frog egg as a model system.
 6. Study of effect of ligature in Drosophila / House fly larva
 7. Study the imaginal disc in Drosophila larva
 8. Chick limb bud staining with neutral red for morphogenetic cell death
 9. Study of grafting of Hensen's node.
 10. Regeneration of Hydra/Planaria.
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Class: M.Sc. I (Semester– II)

Paper Code: ZOO: 4206

**Title of paper: Zoology Practical-IV
(Practicals Corresponding to ZOO: 4203, ZOO: 4204)**

Credit : 4

No. of Practical: 20

Section –I: ZOO: 4203 Comparative Animal Physiology (Any 5)

1. Study of nitrogenous waste products of animals from different habitats.
2. Body size and oxygen consumption in aquatic animals (crab/fish).
3. Estimation of sugar and chloride content in rat/crab/human blood.
4. Effect of insulin on the blood sugar of rat.
5. Estimation of lactate content of rat/crab/human blood.
6. Determination of the heart beat in the crab-effect of temperature & ions.
7. Effect of eye stalk ablation on chloride & glucose in the haemolymph of the crab.

Section –II: ZOO: 4203 Endocrinology (Any 5)

1. Histology of invertebrate and vertebrate neurosecretory and endocrine structures.
2. Staging of fish chromatophores and effect of adrenaline in vivo and Acetylcholine in vivo.
3. Study of retrocerebral complex of the cockroach.
4. Gonadectomy, Pancreatectomy, Adrenalectomy, Thyroidectomy in rat/mouse
5. Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human.
6. Estimation of thyroxine from human blood.
7. Determination of Acetylcholine esterase.

Section –III: ZOO 4204 Biological Techniques(Any 10)

1. Determination of λ -max for tyrosine and hemoglobin using UV/Visible spectrophotometer.
2. Separation of amino acids by TLC.
3. Separation of proteins by SDS-PAGE and analysis by gel documentation system.
4. Study isozymes by in-gel assays (zymogram).
5. Enzyme purification by Ion- Exchange Chromatography.
6. Perform primary animal cell culture and viable cell count.
7. Immobilization of amylase by enzyme immobilization technique.
8. Quantification of a protein Enzyme Linked Immunosorbent Assay.
9. Detection of protein by Western Blotting.
10. DNA amplification by Polymerase Chain Reaction.
11. Localization of proteins by immuno-histochemistry.
12. Introduction to databases and sequence alignment by BLASTA and FASTA.
13. Phase Contrast and Fluorescence Microscopy.
14. In situ detection of different enzymes