

SCHOOL OF STUDIES IN ZOOLOGY
JIWAJI UNIVERSITY
GWALIOR



MASTER OF SCIENCE
ZOOLOGY

SYLLABUS

(2011-2013)

JIWAJI UNIVERSITY, GWALIOR

MASTER OF SCIENCE

ZOOLOGY

2011 - 2013

The course for Master of Science (M.Sc.) in Zoology shall comprise of four semesters of six months duration each. Each semester shall include four theory papers and two practical (laboratory) courses each involving 70 marks. There shall be a related internal assessment for each theory and practical course, involving 30 marks. For this purpose three tests shall be conducted and marks of best of two shall be considered for final awards. The marks of internal assessment of theory and laboratory courses shall be displayed before university examination. In each semester, examination for four theory papers (three hours duration each) and two practical courses (six hours duration each) shall be conducted. The practical examinations may be held before or after theory examinations.

The students are required to participate in study excursions of short and/or long-term duration organized by the School as and when possible.

The students have to select one of the following specializations (electives) that shall be taught in third and fourth semesters:

- A. Aquatic Biology & Aquaculture**
- B. Cell Biology**
- C. Endocrinology**
- D. Entomology**
- E. Fish Biology and Fisheries**

M.Sc. in Zoology: Course codes and titles

<u>First semester</u>	<u>Second semester</u>
ZOOL. 101: Structure & Function of Invertebrates	ZOOL. 201: General & Comparative Animal Physiology
ZOOL. 102: Quantitative Biology & Bioinformatics	ZOOL. 202: Biomolecules & Structural Biology
ZOOL. 103: Molecular Cell Biology & Genetics	ZOOL. 203: Population Ecology & Environmental Physiology
ZOOL. 104: Tools & Techniques for Biology	ZOOL. 204: Biosystematics, Taxonomy & Evolution
ZOOL. 105: Invertebrates, Quantitative Biology & Bioinformatics (Practical)	ZOOL. 205: Physiology & Biochemistry (Practical)
ZOOL. 106: Molecular Cell Biology, Genetics & Tools & Techniques (Practical)	ZOOL. 206: Ecology, Environmental Physiology, Biosystematics, Taxonomy & Evolution (Practical)
<u>Third semester</u>	<u>Fourth semester</u>
ZOOL. 301: Comparative Anatomy of Vertebrates	ZOOL. 401: Animal Behaviour
ZOOL. 302: Genes, Development & Differentiation	ZOOL. 402: Biology of Parasitism & Vertebrate Immune System
ZOOL. 303 (A): Aquatic Ecology & Resources ZOOL. 303 (B): Methods in Cell & Molecular Biology ZOOL. 303 (C): Comparative Endocrinology ZOOL. 303 (D): General Entomology & Insect Morphology ZOOL. 303 (E): Fish Structure & Function	ZOOL. 403 (A): Fisheries & Pisciculture ZOOL. 403 (B): Neurobiology & Immunology ZOOL. 403 (C): Male Reproductive Endocrinology ZOOL. 403 (D): Insect Taxonomy, Ecology & Development ZOOL. 403 (E): Taxonomy, Systematics & Ecology of Fishes
ZOOL. 304 (A): Fish Biology & Physiology ZOOL. 304 (B): Cellular Structure & Molecular Organization ZOOL. 304 (C): Endocrine Physiology ZOOL. 304 (D): Insect Anatomy & Physiology ZOOL. 303 (E): Fish Morphology & Anatomy	ZOOL. 404 (A): Aquaculture ZOOL. 404 (B): Chromosomes, Genes & Genetic Engineering ZOOL. 404 (C): Female Reproductive Endocrinology ZOOL. 404 (D): Applied Entomology ZOOL. 404 (E): Pisciculture & Economic Importance of Fishes
ZOOL. 305: Vertebrates & Genes & Differentiation (Practical)	ZOOL. 405: Animal Behaviour, Biology of Parasitism & Vertebrate Immune System (Practical)
ZOOL. 306 (A): Aquatic Biology & Fish Biology (Practical) ZOOL. 306 (B): Cell Biology (Practical) ZOOL. 306 (C): General & Comparative Endocrinology & Endocrine Physiology (Practical) ZOOL. 306 (D): General Entomology (Practical) ZOOL. 306 (E): Fish Biology (Practical)	ZOOL. 406 (A): Fisheries, Pisciculture & Aquaculture (Practical) ZOOL. 406 (B): Cell Biology (Practical) ZOOL. 406 (C): Reproductive Endocrinology (Practical) ZOOL. 406 (D): Insect Taxonomy, Ecology & Development & Applied Entomology (Practical) ZOOL. 406 (E): Fish Biology & Fisheries (Practical)

DETAILED SYLLABUS

FIRST SEMESTER:

ZOOL. 101: STRUCTURE AND FUNCTION OF INVERTEBRATES

UNIT I

1. Organization of coelom: Acoelomates and Pseudocoelomates
2. Protostomia and Deuterostomia
3. Locomotion: Flagellar and ciliary movement in Protozoa
4. Hydrostatic movement in Coelenterata, Annelida and Echinodermata

UNIT II

5. Patterns of feeding and digestion in lower Metazoa
6. Filter feeding in Polychaeta, Mollusca and Echinodermata
7. Organs of respiration: Gills, lungs and trachea
8. Respiratory pigments
9. Mechanism of respiration

UNIT III

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

UNIT IV

14. Trends in neural evolution
15. Larval forms of free living invertebrates
16. Larval forms of invertebrate parasites
17. Strategies and evolutionary significance of larval forms

UNIT V

18. Organization and general characters of Rotifera
19. Organization and general characters of Acanthocephala
20. Organization and general characters of Ectoprocta
21. Organization and general characters of Endoprocta
22. Organization and general characters of Phoronida

Suggested Readings:

Hyman, L.H. **The Invertebrates. Vol - I Protozoa through Ctenophora.** McGraw Hill Co., New York.

Hyman, L.H. **The Invertebrates. Vol. - II.** McGraw Hill Co., New York.

Hyman, L.H. **The Invertebrates. Vol. - VIII.** McGraw Hill Co., New York and London.

Barnes, R.D. **Invertebrate Zoology, 3rd edition.** W.B. Saunders Co., Philadelphia.

Barrington, E.J.W. **Invertebrate Structure and Function.** Thomas Nelson and Sons Ltd., London.

Sedgwick, A.A. **Student Text Book of Zoology. Vol. I, II and III.** Central Book Depot, Allahabad.

Parker, T.J., Haswell, W.A. **Text Book of Zoology**. Macmillan Co., London.

ZOOL. 102: QUANTITATIVE BIOLOGY AND BIOINFORMATICS

UNIT I

1. Probability distribution and their properties
2. Hypothesis testing
3. Analysis of frequencies
4. Experimental design and sampling theory

UNIT II

5. Analysis of variance(one way and two way ANOVA)
6. Correlation
7. Regression
8. Computers and their applications in biology

UNIT III

9. Operating systems: DOS, WINDOWS
10. Application softwares: MS Word, MS Access
11. MS Excel, MS Power Point
12. Internet and its uses

UNIT IV

13. Bioinformatics: Definition, history and scope
14. Analysis of DNA and protein sequences; molecular and genomic databases (e.g., GENE BANK, SWISS-PROT and other databases)
15. Introductory ideas on use of databases for sequence retrieval, similarity search and sequence alignment; post-transcriptional modification prediction
16. Introductory ideas on virtual libraries: MEDLINE, science citation index, current awareness services, electronic (E) journals and retrieval of other information related to research and career
17. Bioinformatics in drug discovery

UNIT V

18. Types of models: Deterministic and statistical, empirical, mechanistic, simulation of biological problems.
19. Formation and properties of models - generality, precision, realism and validation
20. Building population models for biological species of different categories, wild life population models
21. Treatment of biological models, morphogenesis, cycling of nutrients in an ecosystem, eutrophication models

Suggested Readings:

Batschelet, E. **Introduction to Mathematics for Life Scientists**. Springer-Verlag, Berlin.

Jorgenson, S.E. **Fundamentals of Ecological Modelling**. Elsevier, New York.

Swartzman, G.L. and S.P.O. Kaluzny. **Ecological Simulation Primer**. Macmillan, New York.

Lendren, D. **Modelling in Behavioral Ecology**. Chapman and Hall, London, UK.

Sokal, R.R. and F.J. Rohlf. **Biometry**. Freeman, San Fransisco.

- Snedecor, G.W. and W.G. Cochran. **Statistical Methods**. Affiliated East-West Press, New Delhi (Indian Ed.)
- Green, R.H. **Sampling, Design and Statistical Methods for Environmental Biologists**. John Wiley & Sons, New York.
- Murray, J.D. **Mathematical Biology**. Springer-Verlag, Berlin.
- Pielou, E.C. **The Interpretation of Ecological Data: A Primer on Classification and Ordination**.
- De Sapio, **Calculus for Biologists**.
- Rubinov, S.I. **Introduction to Mathematical Biology**.
- Saxena, V.P. 'Jaiv Ganit Ek Parichaya' (M.P. Hindi Granth Academy).
- Brown, S.M. **Bioinformatics- A Biologists Guide to Biocomputing and Internet**. Eaton Publishing, New York, 2000.
- Lesk, A.M. **Introduction to Bioinformatics**. Oxford, 2002.
- Bioinformatics - **Methods and Protocols**. In: **Methods in Molecular Biology**. Vol.132, Humana press, 2001
- Higgins & Taylor. **Bioinformatics - Sequence, Structure and Databanks**. Oxford, 2000.
- Baxevanis and Ouellette. **Bioinformatics**. John Wiley & Sons, 1998.
- Swindell. **Internet for the Molecular Biologists III**. Horizon Scientific, 1996.
- Peruski & Peruski. **The Internet and New Biology**. ASM, 1997.
- Gibson, G. & S.V. Muse. **A Primer of Genome Science**. Sinauer Associates Inc. Publishers, 2002.
- Krane and Raymer. **Fundamental Concept of Bioinformatics**. Pearson Education, 2003.
- Awesthead, Parish and Twyman. **Instant Notes: Bioinformatics**. Viva Book Pvt. Ltd., 2003.
- Attwood and Parry-Smith. **Introduction to Bioinformatics**. Pearson Education, 2003.

ZOOL. 103: MOLECULAR CELL BIOLOGY AND GENETICS

UNIT I

1. Biomembranes: Molecular composition, arrangement and functional consequences
2. Transport across cell membrane, diffusion, active transport, and pumps, uniports, symports, antiports
3. Cytoskeleton: Microfilaments and microtubules, structure and dynamics
4. Cell movements, intracellular transport, role of kinesin and dynein, cilia & flagella

UNIT II

5. Cell - cell signaling:
 - Cell surface receptors
 - Second messenger system
 - Signaling from plasma membrane to nucleus
6. Cell - cell adhesion and communication:
 - Gap junctions and connexins & Integrins
 - Collagen and non-collagen components
7. Genome organization: Molecular organization of a gene
 - Chromosomal organization of gene and non-coding DNA

UNIT III

8. General organization of the neuron
9. Classification of neurons and glia
10. Structure of the synapse and functions of the nerve fibre
11. Synaptic transmission: synaptic vesicles and transmitter release
12. Excitation – contraction coupling and sarcoplasmic reticulum

UNIT IV

13. Organelle genome
 - Mitochondrial genome: Structure and function
 - Chloroplast genome: Structure and function
14. Gene mutation: Induced and spontaneous mutations
15. DNA repair mechanisms
16. Gene regulation in prokaryotes
 - Lac Operon
 - Tryptophan Operon

UNIT V

17. Conceptual knowledge of genomics: Structural & Functional genomics
18. Sex determination in *Drosophila*
19. Sex determination in mammals
20. Basic concepts of dosage compensation

Suggested Readings:

- Alberts et al. **Essential Cell Biology**. Garland Publishing Inc., New York, 1998.
- Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. **Molecular Biology of the Cell**. B. Garland Publishing Inc., New York, 2001.
- Boney. **Cell Biology Level II**. Macdonald & Evans, 1982.

- Darnell, J., H. Lodish and D. Baltimore. **Molecular Cell Biology**. Scientific American Book, Inc., USA
- De Robertis & De Robertis. **Cell and Molecular Biology**. Lea & Febiger
- Gilbert. **Developmental Biology**. Sinauer, 2000.
- Karp. **Cell and Molecular Biology**. John Willey & Sons, New York, 1996.
- Lodish et al. **Molecular Cell Biology**. Freeman & Co., 2000.
- Tobin and Morcel. **Asking about Cells**. Saunders, 1997.

ZOOL. 104: TOOLS AND TECHNIQUES FOR BIOLOGY

UNIT I

1. Microscopy, principle & applications of: Light microscope, phase contrast microscope and Fluorescence microscope
2. General principle and applications of: Electron microscope (comparison between TEM & SEM)
3. Principle and applications of Confocal microscopy
4. Cryotechniques:
Cryopreservation of cells, tissues, organs and organisms
Cryosurgery, Freeze fracture & freeze drying

UNIT II

5. Microbiological techniques:
Media preparation and sterilization
Inoculation and growth monitoring
Microbial assays
Microbial identification (cytological staining methods for bacterial and fungal strains)
6. Principles and applications of photometry: Beer & Lambert's law, Absorption spectrum & absorption maxima
7. Colorimeter & spectrophotometer
8. Flame photometer and Atomic absorption spectrophotometer

UNIT III

9. Separation techniques: Chromatography, principle, types and applications
10. Electrophoresis, principle, types & applications, PAGE and agarose gel electrophoresis
11. Radioisotopes in biology: Units of radioactivity, Radioactive counters
12. Autoradiography

UNIT IV

13. Immunological techniques: Immunodiffusion and Immunoelectrophoresis
14. Techniques in immunodetection: Immunocyto-/ histochemistry, Immunoblotting, immunodetection and immunofluorescence
15. Surgical techniques: Organ ablation (e.g., ovariectomy, adrenalectomy etc.)
Perfusion techniques and Stereotaxy
16. Histological techniques: Principles of tissue fixation, Microtomy, cryotomy, and Histochemical staining

UNIT V

17. Cell culture techniques:
 - Design and functioning of tissue culture laboratory
 - Culture media, essential components and preparation
 - Cell viability testing
18. Cytological techniques:
 - Mitotic & Meiotic chromosome preparations from insects and vertebrates
 - Chromosome banding techniques (G-, C-, Q-, R- banding etc.)
19. Molecular cytological techniques:
 - In situ hybridization (radiolabelled & non-radiolabelled methods),
 - FISH, and Restriction banding
20. Molecular biology techniques:
 - Southern hybridization
 - Northern hybridization
 - DNA sequencing
 - Polymerase chain reaction (PCR)

Suggested Readings:

- Clark & Switzer. **Experimental Biochemistry**. Freeman, 2000.
- Locquin and Langeron. **Handbook of Microscopy**. Butterworths, 1983.
- Boyer. **Modern Experimental Biochemistry**. Benjamin, 1993.
- Freifelder. **Physical Biochemistry**. Freeman, 1982.
- Wilson and Walker. **Practical Biochemistry**. Cambridge, 2000.
- Cooper. **The Cell -A Molecular Approach**. ASM, 1997.
- John R. W. Masters. **Animal Cell culture- A practical approach**. IRL Press.
- Robert Braun. **Introduction to instrumental analysis**. McGraw Hill Int. Ed.
- K. Wilson & K. H. Goulding**. A Biologist's Guide to Principles & Techniques of Practical Biochemistry. **ELBS Ed.**

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE**ZOOL. 105: INVERTEBRATES, QUANTITATIVE BIOLOGY & BIOINFORMATICS**

- Culture of different Protozoa, their study in living state and permanent mounting
- Collection, preservation, staining, mounting and identification of different larvae, protozoans, sponges, coelenterates, helminths, particularly the following:
Balantidium, Opalina, Nyctotherus, Monocystis, Euglena, Paramaecium, Plasmodium, Vorticella, Hydra, Rotifers, *Ascaris, Amphistoma*, liverfluke etc.
- Mounting and identification of whole mounts of invertebrates their structural parts like gills, radula, statocyst, sting apparatus of honey bee, nephridia and ovary of earthworm, etc.
- Study of museum specimens of invertebrate animals
- Dissection of the following animals for demonstration of various internal structures: Starfish, *Echinus, Holothuria*, leech, *Pheretima*, crab, *Squilla*, grasshopper, cockroach, scorpion, *Unio, Mytilus, Octopus, Loligo, Sepia, Aplysia*.
- Study of permanent slides of invertebrate animal materials
- Biostatistical problems: Preparation of charts, diagrams (bar, histograms, pie, graphs etc.), computation of mean, mode, median, standard deviation, standard error of simple and classified data, chi square, t-test and ANOVA
- Statistical analysis of field data
- Computer applications in statistical problems
- Constructing mathematical models for simple zoological activities
- Solution and analysis of models
- Case studies of biological populations

SCHEME OF PRACTICAL EXAMINATION

1. Major dissection of organ systems with display and diagram	10
2. Biostatistical problem	10
3. Computer application and bioinformatics	10
4. Preparation of stained permanent mount of nonchordate material with diagram and identification	06
5. Spotting (museum specimens – 02, slides – 02, mathematical models – 02, computer applications – 02)	24
6. <i>Viva voce</i>	05
7. Practical record	05
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TOTAL MARKS	70
DURATION (HOURS)	06

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE**ZOOL. 106: MOLECULAR CELL BIOLOGY, GENETICS AND TOOLS & TECHNIQUES**

- Preparations of bacteria: Yeast, *Lactobacillus* etc.
Microtomy of invertebrate or vertebrate materials
- Determination of pH using pH indicator and pH meter
- Preparation of buffer solutions of defined ionic concentration and pH
- Absorption spectrum of coloured and colourless solutions using spectrophotometer and colorimeter
- Separation and detection of dyes/amino acids/sugars using paper chromatography and/or TLC
- Study of permanent slides of cytology
- Experiments in cytology and genetics
- Study of mitosis from onion root tips by making temporary squash preparation (staining with acetocarmine / acetoorcein)
- Study of chromosomes (meiosis and mitosis) from testicular tissue of *Chrotogonus* (grasshopper) / gryllids / cockroach etc.
- Salivary gland squash preparation for the study of polytene chromosomes of *Chironomus /Anopheles / Drosophila*
- Mammalian blood smear preparation for the study of drumstick as sex chromatin test in rat / human
- Study of Mendelian ratios from the seed coat colour pattern of seeds (monohybrid and dihybrid ratio)
- Field collection of experimental animals like earthworms, cockroaches, *Drosophila*, grasshoppers, spiders, gryllids etc.
- Collection of *Drosophila* for the study of morphological characters of males and females
- Breeding of *Drosophila*
- Demonstration of cellular organelles including mitochondria, Golgi bodies etc.
- Study of cellular ultrastructure by means of electron micrographs
- Working and applications of tools: B-Counter, ELISA reader, autoanalyser and image analyzer
- Preparation of practical record and submission of materials related to above

SCHEME OF PRACTICAL EXAMINATION

1. Cytological / molecular biological / cytogenetic exercise	10
2. Microbiological/genetics exercise	08
3. Determination of pH, preparation of buffer, colorimetric or spectrophotometric exercise	10
4. Chromatographic separation (paper/thin layer) of biomolecules	10
5. Spotting (cytological slides – 3, immunological tools – 2, microbiological preparations –1, electron micrographs – 2)	16
6. Microtomy: (a) Sectioning & stretching (b) staining & mounting	06
7. <i>Viva voce</i>	05
8. Practical record	05
TOTAL MARKS	80
DURATION (HOURS)	06

SECOND SEMESTER:

ZOOL. 201: GENERAL AND COMPARATIVE ANIMAL PHYSIOLOGY

UNIT I

1. Respiratory pigments through different phylogenic groups
2. Transport of oxygen and carbon dioxide in blood and body fluids
3. Regulation of respiration
4. Physiology of impulse transmission through nerves and synapses

UNIT II

5. Patterns of nitrogen excretion in different animal groups
6. Comparative physiology of digestion
7. Osmoregulation in different animal groups
8. Thermoregulation in homeotherms, poikilotherms and hibernation

UNIT III

9. Comparative study of mechanoreception
10. Comparative study of photoreception
11. Comparative study of phonoreception
12. Comparative study of chemoreception
13. Comparative study of equilibrium reception

UNIT IV

14. Bioluminescence as means of communication among animals
15. Pheromones and other semiochemicals as means of communication among animals
16. Chromatophores and regulation of their function among animals
17. Autonomic nervous system, neurotransmitters and their physiological functions

UNIT-V

18. Hormones, their classification and chemical nature
19. Mechanisms of hormone action
20. Physiology of male reproduction
21. Physiology of female reproduction

Suggested Readings:

- Prosser, C.L. **Comparative animal physiology**. W.B. Saunders and Co.
Eckert, R. **Animal physiology - Mechanisms and adaptation**. W.H. Freeman and Co.
Hoar, W.S. **General and Comparative Animal Physiology**.
Schiemdt-Neilsen. **Animal Physiology : Adaptation and Environment**. Cambridge
Prosser, C.L. **Environmental and Metabolic Physiology**. Wiley-Liss, New York

ZOOL. 202: BIOMOLECULES AND STRUCTURAL BIOLOGY

UNIT I

1. Primary, secondary, tertiary and quaternary structures of proteins, protein folding and denaturation
2. DNA: Double helical structure of DNA.
3. RNA :Structure of RNA, role of RNA in gene expression
4. DNA replication, recombination and repair

UNIT II

5. Basic concept of metabolism: Coupled and interconnecting reactions of metabolism; cellular energy resources and ATP synthesis
6. Glycolysis and glyconeogenesis
7. Citric acid cycle
8. Oxidative phosphorylation
9. Pentose Phosphate Pathway and Glyconeogenesis.

UNIT-III

10. Functional importance of lipid storage & membrane lipids
11. Fatty acid metabolism: Synthesis and degradation of fatty acids
12. Protein Synthesis
13. Membrane channels and pumps

UNIT IV

14. RNA synthesis and splicing
15. Biosynthesis of amino acids
16. Biosynthesis of nucleotides
17. Biosynthesis of membrane lipids and steroids

UNIT V

18. Enzymes: Basic concepts and kinetics
19. Mechanism of enzyme catalysis
20. Regulation of enzyme action
21. Concept of free energy and thermodynamic principles in biology
22. Energy rich bonds, compounds and biological energy transducers

Suggested Readings:

- Voet, D. and J.G. Voet. **Biochemistry**. John Wiley & Sons.
Freifelder, D. **Physical Biochemistry**. W.H. Freeman & Co.
Segal, I.H. **Biochemical Calculations**. John Wiley and Sons
Creighton, T.E. **Protein Structure and Molecular Properties**. W.H. Freeman & Co.
Freifelder, D. **Essentials of Molecular Biology**.
Cooper, T.G. **Tools of Biochemistry**.
Hawk. **Practical Physiological Chemistry**.
Garret, R.H. and C.M.Grisham. **Biochemistry**. Saunders College Publishers.

ZOOL. 203: POPULATION ECOLOGY AND ENVIRONMENTAL PHYSIOLOGY

UNIT I

1. Populations and their characters
2. Demography: Life tables, generation time, reproductive value
3. Population growth: Growth of organisms with non-overlapping generations, stochastic and time lag models of population growth, stable age distribution
4. Population regulation: Extrinsic and intrinsic mechanisms

UNIT II

5. Case studies in population dynamics with two examples from areas such as fisheries, wildlife and biological control of agricultural pests
6. Adaptation: Levels of adaptation, mechanisms of adaptation, significance of body size
7. Aquatic environments: Freshwater, marine, shores and estuarine environments
8. Eco-physiological adaptations to fresh water environments

UNIT III

9. Eco-physiological adaptations to marine environments
10. Eco-physiological adaptations to terrestrial environments
11. Environmental limiting factors
12. Concept of homeostasis
13. Biodiversity: Significance and conservation

UNIT IV

14. Inter and intra specific relationship
15. Competition
16. Predatory-prey relationship, predator dynamics, optimal foraging theory (patch choice, diet choice, prey selectivity, foraging time)
17. Mutualism, evolution of plant-pollinator interaction

UNIT V

18. Environmental pollution and human health
19. Conservation management of natural resources
20. Environmental impact assessment
21. Sustainable development
22. Ecological modeling: Fundamentals of constructing models and testing them

Suggested Readings:

- Cherrett, J.M. **Ecological Concepts**. Blackwell Science Publication, Oxford, U.K.
- Elseth, B.D. and K.M. Baumgartner, **Population Biology**. Van Nostrand Co., New York.
- Jorgensen, S.E. **Fundamentals of Ecological Modeling**. Elsevier, New York.
- Krebs, C.J. **Ecology**. Harper & Row, New York.

- Krebs, C.J. **Ecological Methodology**. Harper & Row, New York.
- Eckert, R. **Animal Physiology : Mechanisms and Adaptation**. W.H. Freeman and Co., New York.
- Hochachka, P.W. and G.N. Somero. **Biochemical Adaptation**. Priceton, New Jersey.
- Schiemdt Nielsen. **Animal Physiology: Adaptation and Environment**. Cambridge.
- Willmer, P.G. Stone and Johnston. **Environmental Physiology**. Blackwell Science Publication, Oxford, U.K.
- Louw, G.N. **Physiological Animal Ecology**. Longman Harloss, UK.

ZOOL. 204: BIOSYSTEMATICS, TAXONOMY AND EVOLUTION

UNIT I

1. Definition and basic concepts of biosystematics and taxonomy
2. Trends in biosystematics: Chemotaxonomy, cytotaxonomy and molecular taxonomy
3. Dimensions of speciation and taxonomic characters
4. Species concept: Different species concepts

UNIT II

5. Species category, sub-species and other infra-specific categories
6. Theories of biological classification
7. Taxonomic categories & Hierarchy of categories
8. Taxonomic characters: Different kinds, origin of reproductive isolation, biological mechanism of genetic incompatibility

UNIT III

9. Taxonomic procedures: Taxonomic collections, preservation, curation, process of identification
10. Taxonomic keys: Different kinds of keys, their merits and demerits
11. International code of Zoological nomenclature (ICZN): Operative principles, interpretation and application of important rules, formation of scientific names of various taxa
12. Concepts of evolution and theories of organic evolution

UNIT IV

13. Neo-Darwinism and population genetics:
Hardy-Weinberg Law of genetic equilibrium
Destabilizing forces, natural selection, mutation, genetic drift, migration & meiotic drive
14. Molecular population genetics:
Pattern of changes in nucleotide and amino acid sequences
Ecological significance of molecular variations (genetic polymorphism)
15. Genetics of speciation
Patterns and mechanisms of reproductive isolation
Modes of speciation (allopatry & sympatry)
16. Zoo-geological time scale

UNIT V

17. Trends in evolution
18. Molecular evolution: Gene evolution & Evolution of gene families
19. Molecular phylogenetics:
 - Construction of phylogenetic trees
 - Amino acid sequences and phylogeny
20. Nucleic acid phylogeny, DNA-DNA hybridization, restriction enzyme sites, nucleotide sequence comparison and homologies

Suggested Readings:

- Kato, M. **The Biology of Biodiversity**. Springer.
- Avise, J.C. **Molecular Markers, Natural History and Evolution**. Chapman & Hall, New York.
- Wilson, E.O. **Biodiversity**. Academic Press, Washington.
- Simpson, G.G. **Principles of Animal Taxonomy**. Oxford IBH Publishing Company.
- Mayor, E. **Elements of Taxonomy**.
- Wilson, E.O. **The Diversity of Life** (College Edition). W.W. Northem & Co.
- Tikadar, B.K. **Threatened Animals of India**. ZSI Publication, Calcutta.
- Dobzhansky, Th. **Genetics and Origin of Species**. Columbia University, Press
- Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valetine. **Evolution**. Surjeet Publication, Delhi.
- Futuyama, D.J. **Evolutionary Biology**. Suinuaer Associates, INC Publishers, Dunderland.
- Jha, A.P. **Genes and Evolution**. John Publication, New Delhi
- Merrel, D.J. **Evolution and Genetics**. Holt, Rinchart and Winston, Inc.
- Strikberger, M.W. Jones and Bartett Publisher, Boston London

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE**ZOOL - 205: PHYSIOLOGY AND BIOCHEMISTRY**

- Detection of carbohydrates, proteins and lipids in the given sample
- Demonstration of salivary digestion
- Demonstration of gastric digestion
- Demonstration of pancreatic digestion
- Detection of urea, uric acid, ammonia in the given sample
- Counting of red blood corpuscles in the blood of rat or man
- Counting of white blood corpuscles in the blood of rat or man
- Determination of haemoglobin percentage in the blood of rat or man
- Detection of blood groups and Rh factor in rat or man
- Determination of rate of respiration in an insect, mammal or fish
- Determination of blood clotting time
- Preparation of haemin crystals
- Determination of Erythrocyte sedimentation rate (ESR)
- Separation of Serum and tissue protein with the help of electrophoresis
- Demonstration of reflex action
- Quantitative determination of biological parameters (protein, glycogen and blood sugar, RNA and DNA etc.) with the help of colorimeter

SCHEME OF PRACTICAL EXAMINATION

1. Experiment on hematological parameter	15
2. Experiment on biochemical parameter	15
3. Qualitative enzymatic assay	15
4. Quantitative assay of a biochemical parameter	15
5. <i>Viva voce</i>	05
6. Practical record	05
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TOTAL MARKS	70
DURATION (HOURS)	06

LIST OF PRACTICAL EXERCISES FOR LABORATORY COURSE**ZOOL-206: ECOLOGY, ENVIRONMENTAL PHYSIOLOGY, SYSTEMATICS, TAXONOMY AND EVOLUTION**

- Water analysis for dissolved oxygen, free carbon-dioxide, chloride, pH, hardness and alkalinity
- Determination of climatic factors
- Composition and classification of soil, gravel, coarse and fine sands, clay, sand, clay-loam, loam, chalky and peaty
- Ecological niche: A habitat study
- Animal association and communities
- Population dispersion
- Identification and classification of important invertebrate groups
- Techniques of collection and preservation, mounting & display, indexing
- Structural adaptations of ecological significance
- Study of evolutionary trends through models etc.
- Problem related to evolution, population genetics etc. (natural selection, adaptation, trends of evolution, genetic polymorphism etc.)
- Preparation of phylogenetic tree using molecular data
- Toxicity tests: LC₅₀/LD₅₀

SCHEME OF PRACTICAL EXAMINATION

1. Experiments of environmental biology/habitat study /community study(2)	16
2. Animal associations / Ecological adaptation (2)	08
3. Problems related to evolution (2)	16
4. Methods of collection, preservation and identification of invertebrate / vertebrate animals with comments (5 animals)	15
5. Mounting and display of two animals (invertebrates and vertebrates)	05
6. <i>Viva voce</i>	05
7. Practical record	05
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TOTAL MARKS	70
DURATION (HOURS)	06