

ALLAHABAD STATE UNIVERSITY

Department of Zoology

Postgraduate Syllabus

M.SC. (PREVIOUS) SEMESTER –I

The examination shall comprise four theory papers and a practical test

Theory

Paper –I: Non-Chordata 100 Marks

Paper –II: Biostatistics, Evolution and Principles of Taxonomy 100 Marks

Paper-III: Biological Chemistry 100 Marks

Paper-IV: Cytogenetics : Classical and Molecular 100 Marks

Practical 100 Marks

Total : 500 Marks

Candidate must obtain minimum pass marks in theory and practical examination separately.

Paper I: Non-Chordata

Unit-I: Protoza : Nutrition; Reproduction; Locomotory organs and locomotion

Unit-II: Porifera : Organization and affinities of Porifera; Canal System, Skeletal system

Unit-III: Cnidaria : Metagenesis in Obelia, Polymorphism: Polypoid and medusoid form

Unit-IV: Platyhelminthes : Evolution of Parasitism, Life cycle patterns in helminthes parasites; Tegument and tegumental organs

Unit-V: Annelida: Adaptive radiation in Polychaeta; Segmental organs in Annelida; Metameric segmentation, Trochophore larva Structure and significance

Unit-VI: Parasitism in Crustacea; Crustacean larvae; Mouth parts of insects and mode of feeding; Insect Metamorphosis and its hormonal control; Basic concept of insect pest management; Biology and control of Lepisma; Pediculus, Cimex

Unit-VII: Archimollusca (Ancestral Mollusca), Torsion in gastropods;

Unit-VIII: Affinities of Echinodermata; Symmetry, Larval form and its significance

Unit-IX: Brief outlines of the structure and affinities of minor phyla with special reference to Ctenophora, Rotifera, Acanthocephala, Sipunculoidea and Echiuroidea

Suggested Books:

1. Anderson, Donald Thomas. Invertebrate Zoology. Oxford Univ. Press.
2. Ashok Verma: Invertebrate: Protozoa to Echinodermata, Narosa Publishing Co.
3. Barnes, Robert D. Invertebrate Zoology. Saunders College Publ.
4. Barnes, Richard, Barnes, R.S.K. & Calow, P. P. The Invertebrates: A Synthesis. Wiley-Blackwell.
5. Brown, Frank A. Invertebrates. Daya Publishing House.
6. Brusca, R.C. & Brusca, G.J.. Invertebrates. Sinauer Associates, Inc.
7. Buchsbaum, R., Buchsbaum, M., Pearse, J. & Pearse, V. Animals without backbones: An Introduction to the Invertebrates. University of Chicago Press.
8. Hyman, L.H. Invertebrate Zoology volumes of different phyla.
9. Meglitsch Paul A. & Schram, Frederick R.. Invertebrate Zoology. Oxford Univ. Press.
10. Miller, Stephen A. & Harley, John P. Zoology, 7th Edition. McGraw Hill International.
11. Moore, Janet. An Introduction to the Invertebrates. Cambridge University Press.
12. Pechenik, Jan A. Biology of the Invertebrates. Tata McGraw Hill Publ.
13. Ruppert, E.E. & Barnes, R.D., Invertebrate Zoology. Harcourt Asia Pvt. Ltd.
14. Pechenik, Jan A. Biology of the Invertebrates. Tata McGraw Hill Publ.

Paper –II: Biostatistics, Evolution and Principles of Taxonomy

Unit-I: Sampling techniques: methods of sampling, choice of sampling methods, sampling and non-sampling errors; Diagrammatic and graphic representation of data and their significance and limitations; Measures of dispersion : variance and standard deviation; measures of skewness and kurtosis

Unit-II: Probability : theory and application; Probability distribution : normal, binomial and Poisson; Probit analysis; Correlation and linear and non-linear regression

Unit-III: Tests of significance: t-test, analysis of variance – one way and two way of classification, f-test, null hypothesis and chi-square test

Unit-IV: Experimental design: basic concepts and principles, completely randomized design (SRD) and randomized complete block design (RCD), Latin square design (LSD) and confounding; Interferential biostatistics: statistical estimation, confidence intervals and fiducial limit

Unit-V: Heredity and evolution, ecology and evolution, isolation and speciation (allopatric, peripatric, parapatric, and sympatric), genetic drift. Genes in population: Hardy Weinberg Law and Sewell Wright effect, Evolution in action,

Unit-VI: Definition and basic concepts of systematics and taxonomy: Historical resume of systematics and its importance and application in biology. Trends in biosystematics : Concepts of different conventional and newer aspects – chemotaxonomy, cytotaxonomy, ethotaxonomy, molecular taxonomy and numerical taxonomy

Unit-VII: Species concepts: species category, different species concepts, subspecies and infra-specific categories, theories of biological classification hierarchy of categories, taxonomic and non-taxonomic characters; Procedure in Taxonomy: Collection,

preservation, identification, taxonomic keys – different kinds of taxonomic keys, their merits and demerits, systematic publications, different kinds of publications

Unit-VIII: Type concept: different zoological types; international code of zoological nomenclature (ICZN): its operative principles, interpretation and application of important rules, zoological nomenclature, formation of scientific names of various taxa.

Suggested Books -

- 1- George W. Snedecor, William G. Cochran. Statistical Methods. Wiley-Blackwell.
- 2-Frederick Emory Croxton, Dudley J. Cowden. Applied General Statistics. Prentice-Hall,
- 3- Karmel, P.H. & Polasek, M. Applied statistics for economists. Publisher, Pitman.
- 4- Spiegel, M.R.: Theory & Problems of Statistics, Schaum's outline series, McGraw Hill Pub, Co., New York: Schaum's Outline Series (McGrawHill),
- 5- Spiegel, M.R.: Probability and Statistics.
- 6- Marylees Miller, Irwin MillerFreund, John, E.'s Mathematical Statistics with Applications.
- 1- Stricberger, M.W. Evolution.
- 7- Verma A.: Principles of Animal taxonomy
8. Futuyama, D.J. Evolution.
- 9- Lull, R.S. Organic Evolution.
- 10- Organic evolution by Veer Bala Rastogi
- 11-Organic evolution by Bendre and Kumar
- 12-Organic evolution by A.K Berry
13. Richard E. Blackwelder: Taxonomy: a Text and Reference Book

Paper-III: Biological Chemistry

Unit-1: Chemical equilibrium- Law of Mass action; Elementary thermodynamic system; calculation of free energy change during biological redox reactions, acid, base, amphoteric, Zwitter ions;

Unit-2: Kinetics of enzyme reaction- Kinetics of enzyme- catalyzed reactions, order of enzyme reactions, rate equations, two substrate reactions; Temperature Coefficient, Activation energy; Enzyme inhibition- Competitive and non- Competitive inhibitors; Application of enzyme inhibition techniques in pest control, Allosteric enzymes;

Unit-3: Structure and function of Vitamins and coenzymes; Aerobic and anaerobic energy - β production from carbohydrates, lipids and amino acids, Glycolysis, HMP shunt, oxidation of fatty acids, deamination & transamination of amino acids, Phenylalanine, tryptophan, aspartate, proline and threonine,

Unit-4: Biosynthesis of amino acids (Phenylalanine, tryptophan, aspartate, proline and threonine), nucleotides, glycogen and urea; Immobilized enzymes and their applications.

Suggested Books:

1. David L. Nelson and Michael Cox: Lehninger Principles of Biochemistry: International Edition
2. H. Stephen Stoker: General, Organic, and Biological Chemistry
3. John E. McMurry, Carl A. Hoeger, Virginia E. Peterson, David S. Ballantine: Fundamentals of General Organic & Biological Chemistry,

4. Denise R. Ferrier: Biochemistry
- 5., Tymoczko JL, and Stryer L, Biochemistry, published by W.H. Freeman and Company
6. Donald Voet: Biochemistry, Vol. 1: Biomolecules, Mechanisms of Enzyme Action, and Metabolism
7. Jeremy M. Berg: Biochemistry
8. Robert K. Murray: Harper's Illustrated Biochemistry
9. Donald Voet: Fundamentals of Biochemistry: Life at the Molecular Level
10. Reginald H. Garrett: Biochemistry

Paper-IV: Cytogenetics : Classical and Molecular

Unit-1: Environment and heredity; Lethal genes; Sex-linked inheritance; chromosome mapping; Sex chromosome, Sex determination; Multiple allelism;

Unit-2: DNA replication, Transposable elements in prokaryotes and eukaryotes, Role of transposable elements in genetic regulation;

Unit-3: Microbial genetics: Bacterial transformation, transduction, conjugation, Bacterial chromosome, Bacteriophages; Molecular cytogenetic techniques (FISH, GISH, DNA finger printing, Flow cytometry and chromosome painting),

Unit-4: Elements of Eugenics, Imprinting of genes, chromosomes and genes, Gene therapy.

Suggested Books:

1. Frederick Hecht: Textbook of cytogenetics
2. H C MacGregor: Introduction to Animal Cytogenetics
3. Barbara Hamkalo: Molecular Cytogenetics
4. Yao-Shan Fan: Molecular Cytogenetics: Protocols and Applications
5. J E Celis: Cell Biology: A Laboratory Handbook
6. Rudi Appels: Chromosome Biology
7. John Morrow: Eukaryotic Cell Genetics
8. Gunter Ed Obe: Cytogenetics: Basic & Applied Aspects
9. Klaus Goerttler: New Frontiers in Cytology: Modern Aspects of Research and Practice

M.Sc. (Previous) Semester –I

Practical Syllabus

Distribution of Marks: Time : 6 Hours

Exercise	Marks
Dissection	20
Preparation	10
Biochemistry exercise	14
Cytogenetics exercise	12

Spotting (12 Spots)	24
Viva-voce	10
Class Records	10
Total Marks:	100

General survey and classification of the non-chordate phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.

Protozoa : Vital staining and iodine preparation of *Euglena*, *Paramecium* and *Vorticella*- Study of cyclosis and trichocysts in *Paramecium*; differential counts of the various stages of *Monosystis*; Permanent preparation of *Ceratium*, *Noctiluca*, *Paramecium*, *Vorticella*, Rectal ciliates of frog and *Monocystis*.

Porifera : Permanent preparation of gemmules, spongin fibers and different kinds of spicules.

Coelenterata: Dissection (General anatomy) of Sea Anemone, study of Nematocysts of *Hydra*, Permanent preparation of *Hydra*, *Obelia* and other hydrozoan colonies and *Obelia Medusa*.

Helminths : Study of feeding mechanism and regeneration in *Planaria*, Permanent preparation of selected soil and plant Nematodes, *Planaria*, selected Helminths parasites of cattle and poultry and different larval stages of liver fluke.

Annelida: Dissection (General Anatomy) of *Nereis*, dissection of circulatory system and reproductive system of earthworm, Dissection of general anatomy , digestive system, excretory system, hemoceolomic system, reproductive system and nervous system of *Leech*, Permanent preparation of Head region, Jaws and Parapodia of *Nereis*, Ovaries, Nephridia, Blood glands and spermathecae of earthworm and Jaws, salivary and Nephridia of *Leech*.

Dissections and preparations of the principal animal types of phyla (Arthropoda to Echinodermata)

Biochemistry: Isolation and colorimetric determination of the glycogen content of rat liver; Demonstration of the effect of epinephrine on the glycogen yield from the liver; Estimation of nucleic acids in testis of rat; Comparative estimation of protein content of the fat body of cockroach and the liver of fish, frog and rat; Quantitative estimation of the total free amino acids in the tissues of cockroach and paper chromatographic separation of these amino acids; Kinetic assay of the salivary amylase, and study of the effects of time, temperature and pH; Study of the effect of substrate concentration on urease activity; Inhibition of cholinesterase activity in rat brain by organophosphate; Estimation of total lipid in fat body of cockroach and liver of fish, frog and rat.

Cytogenetics : Study of mitosis and meiosis in onion root tip, *Sarcophaga* and testis of grasshopper or any other insect with the acétocarmine squash method; Study of the salivary gland chromosomes of *Drosophila* and *Chironomus*; Study of the life cycle of *Drosophila*.

M.SC. (PREVIOUS) SEMESTER -II

The examination shall comprise four theory papers and a practical test

Theory

Paper -I: Ecology and Environmental Biology	100 Marks
Paper-II: Comparative Animal Physiology	100 Marks
Paper-III: Animal Behaviour	100 Marks
Paper-IV: Techniques and Tools in Biology	100 Marks
Practical	100 Marks
Total :	500 Marks

Candidate must obtain minimum pass marks in theory and practical examination separately.

Paper-I: Ecology and Environmental Biology

Unit-I: Concept of Ecosystem and their types; Marine shores and estuaries; Freshwater; terrestrial; Grassland; Forest, desert and parasitic habitat; Ecological adaptations, levels, mechanism and significance of body size; Concepts of homeostasis, Environmental stress and strain, acclimation and acclimatization;

Unit-II: Conservation of natural resources; wetlands. Demography, life tables, generation time, net reproductive rate and reproductive volume; Life history strategies, evolutions of sex and mating systems, optimal size r and k selection population, dynamics and its regulation;

Unit-III: Pollution monitoring schemes with special reference to bio-indicators and prediction of ecological effects; Environmental diseases with special reference to carcinogenesis and radiation injuries; Management of Industrial and Biomedical Waste, Socio-economic aspects of environmental policies and practices

Unit-IV: Ozone depletion, Global warming, Summits for control of green house gases (Earth summit, Kyoto Protocol (UNFCCC), Copenhagen summit), Challenges of climate change, Nuclear winter, Environmental laws with special reference to air, water and sound.

Suggested Books:

1. Clarke: Elements of Ecology.
2. Eugene P. Odum: Ecology.
3. S. Charles Kendeigh: Ecology with Special reference to Animal and Man
4. Allee, Emerson, Park and Schmidt: Principles of Animal Ecology
5. C.J. Krebs: Ecology..
6. Edmond Hillary: Ecology
7. P.S. Verma and V K Agarwal: Environmental Biology (Principles of Ecology)
8. Allan Frewin Jones: Environmental Biology

Apurva Kumar Sarda

Paper-II: Comparative Animal Physiology

Unit-I: Mechanism of conduction and transmission of nerve impulse: Nernst equation, ionic basis of resting and spike potential, synaptic transmission and neurotransmitters; Patterns of nutrition and digestion: origin of nutritive types, digestion and absorption of food

Unit-II: Osmotic conformity and regulation : Stenohaline, Euryhaline animals, Hypo and hyper environment and terrestrial life; General characteristics of stimulus and response reaction: Chemoreceptors, photoreceptors, phonoreceptors, mechnoreceptors, equilibrium reception;

Unit-III: Respiration: Respiratory pigments, oxygen and carbon dioxide transport, Respiratory adaptation to low oxygen tension, Poikilothermy; Circulation: Types of circulation, physiological categories of heart; Pattern of nitrogen excretion in different animals: Excretory products,

Unit-IV: Biosynthesis of urea and uric acid; Comparative study of endocrines organs and their secretion in non chordates and chordates.

Suggested Books:

1. Knut Schmidt-Nielsen: Animal physiology
2. Philip C. Withers: Comparative Animal Physiology
3. Christopher D. Moyes and Patricia M. Schulte: Principles of Animal Physiology
4. Clifford L. Prosser and Frank A. Brown, Jr.: Comparative animal physiology
5. Ian Kay: Introduction to Animal Physiology
6. Thomas Mills: A text-book of animal physiology

Paper-III: Animal Behaviour

Unit-I: Evolutionary and neurological basis of behaviour, Innate behavior, Stereotyped and acquired behaviour, Neural and hormonal control of behaviour,

Unit-II: Orientation with special reference to insects, birds & bats; Instinct, Biological rhythms (Circadian & circannual rythms), Learning & memory (conditioning, habituation, insight learning, association learning reasoning cognitive skill),

Unit-III: Patterns of communication (Chemical, visual, light, audio, Species specificity of songs, evolution of language with respect to primates), Social behaviour with reference to insects and primates;

Unit-IV: Sexual behaviour: Courtship, sexual selection, mating patterns, parental care, migratory behaviour of fishes and birds; Territorial behaviour, Behavioural genetics;

Ap. Kumar S.A.

Suggested Books:

1. Janice Moore and Michael D Breed: Animal Behavior
2. Marian Dawkins: Observing Animal Behaviour
3. Manning, A.: An Introduction of Animal Behaviour.
4. P. J. B. Slater: Essentials of animal behavior
5. Russell, E.S.: The behaviour of Animals.
6. David McFarland: Animal Behaviour
7. Alcock, J. Animal Behaviour : An evolutionary approach.
8. Dugatkin, Lee: Principles and Animal Behaviour.
9. Silverman, P.: Animals Behaviour in the laboratory.
10. Nikolaas Tinbergen: The Study of Instinct
11. Chris Barnard: Animal Behaviour: Mechanism, Development, Function and Evolution

Paper-IV: Techniques and Tools in Biology

Unit-1: Principles and uses of analytical instruments:- Balances, Flame Photometry, Spectrophotometer, Spectrofluorophotometer, Atomic Absorption Spectrophotometry.

Hydrobiological techniques for determination of inorganic ions in water (Na⁺, K⁺, Ca⁺⁺, Li⁺, SO₄⁻, PO₄⁻, and Cl⁻)

Unit-2: Microbial techniques: Media preparation and sterilization, inoculation and growth monitoring, use of fermentations, microbial assays.

Unit-3: Separation and identification of biomolecules by Chromatography: Paper and thin layer chromatography (TLC), Gas Liquid Chromatography (GLC), Column chromatography, Ion exchange chromatography, Gel exclusion chromatography, High Performance Liquid Chromatography (HPLC), Affinity chromatography

Unit-4: Separation of biomolecules by electrophoresis, Principles of differential and density centrifugation.

Suggested Books:

1. Aysha Divan and Janice Royds: Tools and Techniques in Biomolecular Science
2. John Addis and Erica Larkcom: Tools, Techniques & Assessment in Biology: Nelson Advanced
3. P.K. Bajpal: Biological Instrumentation and Methodology: (Tools and Techniques of Biology)
4. Geoffrey Harper : Tools and Techniques (Selected topics in biology)
5. Carson, Susan: Molecular Biology Techniques
6. Keith Wilson: Principles and Techniques of Biochemistry and Molecular Biology

Ajay Kumar Sarda

M.Sc. (Previous) Semester –II

Practical Syllabus

Distribution of Marks: Time : 6 Hours

Exercise	Marks
Physiology exercise (2 exercises)	16
Technique/Instrumentation	10
Ecology exercise	10
Behaviour exercise	10
Spotting (12 Spots)	24
Viva-voce	20
Class Records	10
Total Marks-	100

Ecology: Study of different structural adaptations to ecological conditions. Study of the micro and macro fauna of soil by froth floatation method. Comparative estimate of physico-chemical ecofactor in different localities: Temperature, pH, carbonate, sulphate, nitrate and turbidity in freshwater sample on; Moisture content in soil sample. Study of seasonal variation in plankton population.

Toxicology: Estimation of threshold and/or LC_{50} and/or other mortality measurement of selected toxicant for selected organisms. Study of TDS, COD, BOD caused by the effects of pollutants in water bodies.

Physiology: Comparative study of total count of the erythrocytes and leucocytes of fish, frog, bird and rat. Comparative study of the differential leucocyte counts of fish, frog, bird and rat. Colorimetric estimation of the haemoglobin content of blood, colour-index and mean corpuscular hemoglobin in fish, frog, bird and rat. Determination of haematocrit in fish, frog, bird and rat. Determination of respiratory rate of rat (in relation to size and sex), Fish (at different temperatures), Cockroach. Study of the functional properties of the cardiac muscles of frog by pharmacological methods, using acetylcholine and adrenaline. Studies on skeletal muscles of frog: Simple twitch; Threshold strength; Curation; to tetanus. Determination of the passage of food with the help of marker.

Behaviour: Study of Taxis; Kinesis; Habituation; Trial and error learning; Visual discrimination; Feeding behavior; Pheromonal communication with reference to sexual/special behaviour.

A. K. Sharma

Techniques and Tools: Basic principles and functioning of Microtomy, Spectrophotometry, Flame Photometry, Atomic absorption spectrophotometry, Paper and thin layer chromatography, Centrifugation.

M.Sc. (Final) Semester - III

The examination shall comprise four theory papers and a practical test

Theory

Paper –I: Chordata 100 Marks

Paper-II: Animal Development and Morphogenesis 100 Marks

Paper-III: Biotechnology and Molecular Biology 100 Marks

Paper-IV (Special paper--student may choose anyone from following):

(a) Fishery Biology- Morphology, Physiology and Development of Fishes 100 Marks

(b): Entomology - Insect morphology, physiology & development 100 Marks

(c): Cell Biology- Cytological Techniques 100 Marks

Practical 100 Marks

Total : 500 Marks

Candidate must obtain minimum pass marks in theory and practical examination separately.

Paper I: Chordata

Unit-I: Origin of Chordates; Interrelationship of Ostracoderms and Placoderms

Unit-II: General organization and affinities of Holocephali, Crossopterygii and Dipnoi; origin of paired fins in teleosts

Unit-III: Origin of tetrapoda; neoteny in Amphibia; origin and evolution of reptiles, birds and mammals; Rhynchocephalia

Unit-IV: Aerodynamics in birds; birds are glorified reptiles, adaptive radiation in Eutheria, origin and evolution of man

Suggested Books:

1. H. H. Newman: The Phylum Chordata
2. Orr, R.T.: Morphology and biology of Reptiles.

Ajay Kumar Sarda

- 3- De Beer, G.R.: Vertebrate Zoology.
- 4- Romer, A.S.: Vertebrate Body.
- 5- Majumuria, T.S.: Introduction to Chordates.
- 6- A.K.Verma : A Hand Book of Zoology
7. Noriyuki Satoh: Chordate Origins and Evolution: The Molecular Evolutionary Road to Vertebrates
8. Kotpal : Modern Textbook Of Zoology Vertebrates
9. Colbert, E.H.: Evolution of the Vertebrates.
10. Parker, J and W.A. Haswell. Text book of Zoology Vol.II (Chordata)

Paper II: Animal Development and Morphogenesis

Unit-I: Gametes, structure and formation; fertilization (pre- and post-fertilization events, biochemistry of fertilization), nature of eggs and their cleavage; gastrulation; organogenesis of vertebrate brain, eye and heart

Unit-II: Evolution of viviparity in mammals; cellular and biochemical events in metamorphosis of insects and amphibians, causes of fetal deformities.

Unit-III: Determination of polarity and symmetry; pattern regulation in insect imaginal discs; induction and organizer concept; differentiation at the level of chromosomes;

Unit-IV: Regeneration and gradients in developing systems, ageing and cellular death; transgenic animals and knock outs, Unique properties of stem cells – embryonic stem cells - adult stem cells – umbilical cord stem cells – similarities and differences between embryonic and adult stem cells. Properties of stem cells – pluripotency – totipotency

Suggested Books:

1. Alfonso Martinez Arias, Alison Stewart: Molecular Principles of Animal Development
2. Gilbert SF.: Developmental Biology.
3. Adam S Wilkins: Genetic Analysis of Animal Development
4. Alfonso M.A.: Molecular Principles of Animal Development
5. Michael J. Barry: Molecular Embryology: How Molecules Give Birth to Animals
6. Boris Ivan Balinsky : Introduction to Embryology
7. Gerald Edelman: Topobiology: An Introduction To Molecular Embryology
8. Richard M. Eakin: Vertebrate Embryology: A Laboratory Manual
9. Alan Feduccia and Edward McCrady: Torrey's Morphogenesis of the Vertebrates
10. Emil S Szebenyi: Atlas of Developmental Embryology
11. Paul Sharpe and Ivor Mason: Molecular Embryology: Methods and Protocols (Methods in Molecular Biology)
12. Theodore W. Torrey and Alan Feduccia: Morphogenesis of the Vertebrates
13. Alfred Francis Huettnner: Fundamentals of comparative embryology of the vertebrates
14. Kursad and Turksen: Embryonic Stem cells

Asif Hussain S.A.

Paper III: Biotechnology and Molecular Biology

Unit-I: Recombinant DNA technology: Introduction, Restriction endonucleases and applications, other useful enzymes for molecular cloning, steps in gene cloning, identification and isolation of desired gene, cloning vectors, screening and selection of recombinant DNA clones, gene probes as Diagnostic tools, biosynthesis of insulin, Somatostatin and growth hormone

Unit-II: Tissue culture, hybridoma technology and monoclonal antibodies: Cell culture, organ cultures, culture media, embryonic stem cell transfer, targeted gene transfer, in vitro fertilization in humans, embryo transfer in cattle applications of embryo transfer technology, animal cloning Environmental biotechnology:

Unit-III: Bioconversions, Pollution control, microbial enhancement of oil recovery, microbial mining and metal recovery, sewage treatment, Health care biotechnology: gene replacement therapy

Unit-IV: Miscellaneous: An introductory knowledge of biosensors, biosensore, biochips, DNA fingerprinting, immobilized Enzymes, bioenergy, genomic DNA libraries

Unit-V: Molecular analysis of eukaryotic DNA- overall composition, reassociation kinetics, kinetic analysis of eukaryotic DNA.

Unit-VI: Nucleotide polymerases, DNA replication, repair and mispair mechanisms; The basic transcription apparatus, promoters, enhancers, termination and anti termination

Unit-VII: Organisation of eukaryotic genes- globin gene, IgG, rDNA, histone gene, Genetic code, protein synthesis, translation, m-RNA processing and organization of interrupted genes, ribonucleoproteins, organelle genomes, Structure and life cycles of bacteriophage T2 or T4 virulent and temperate phages, Phage mutants and their importance

Unit-VIII: RNA phages, tumour viruses and their life cycles, retroviruses, Topoisomerases, gyrases, methylases, nucleases, Molecular biology of cancer: Oncogenes, chemical carcinogenesis; Genetic and metabolic disorders, Principles and methods of gene targeting, gene silencing.

Suggested Books:

1. Colin Ratledge, and Bjorn Kristiansen: Basic Biotechnology
2. Bernard R. Glick, Jack J. Pasternak: Molecular Biotechnology: Principles and Applications of Recombinant DNA
3. Reinhard Renneberg: Biotechnology for beginners
4. Cheryl L. Patten and Jack J. Pasternak: Molecular Biotechnology: Principles and Applications of Recombinant DNA
5. William Wu and Helen H. Zhang: Gene Biotechnology
6. Saif Hameed: Biotechnology: Progress and Applications
7. Dara S.S.: A Text Book of Environmental Chemistry and pollution control
8. Jeyalakshmi.R.: Principles of Environmental Science
9. Kamaraj.P & Arthanareeswari.M: Environmental Science – Challenges and Changes,

Apurva Sarda

10. Arivalagan.K, Ramar.P & Kamatchi.P: Principles of Environmental Science
11. R.I. Freshney: Animal cell culture
12. P.Ramadas: Animal Biotechnology
13. Scragg.A.H: Bioreactors in Biotechnology- A Practical approach
14. Bailey and Ollis: Biochemical Engineering Fundamentals
15. J.D.Watson : Molecular biology of gene
16. Benjamin Lewin: Gene
17. David Freifelder : Essentials of Molecular biology,
18. Stefan Wolfe: Molecular and Cellular Biology
19. Keith Wilson and John Walker: Principles and Techniques of Biochemistry and Molecular Biology
20. Tim Hunt: Molecular Biology of the Cell
21. Robert F. Schleif: Genetics and molecular biology
22. Elizabeth Ann Allison: Fundamental molecular biology
23. Robert Weaver: Molecular Biology
24. Daphne C. Elliott and William H. Elliott: Biochemistry and Molecular Biology

Paper IV: (a) Fishery Biology- Morphology, Physiology and Development of Fishes

Unit 1: Morphology : Structure and Functions of – Ear-Air Bladder connection and Weberian Apparatus; Endocrine glands: (Hypophysis, Thyroid, Adrenal, Ultimobranchial body, Corpuscles of Stannius and urophysis);

Unit 2: Different types of caudal fins; Specialized organs in fishes; (Electric organs, Sound producing organs; Light producing organs, Poison glands, Nervous system and sense organs);

Unit 3: Physiology : Physiology of digestion, Respiration, Osmoregulation, Excretion and Reproduction

Unit 4: Development : Gastrulation, Neurulation, Organ formation, Larval development, Metamorphosis

Suggested Books:

1. Datta Munshi, J.S. and M.P. Srivastava: Natural History of Fishes and Systematic of Fresh water Fishes of India.
2. Gupta, S.K. and Gupta, P.C.: General and Applied Ichthyology.
3. Srivastava, C.B.L.: A textbook of Fishery Science and Indian Fisheries.
4. Lagler et.al. Ichthyology
5. Norman, J.R.: A History of Fishes.
6. Kyle, H.M. A: Biology of Fishes
7. Khanna, S.S.: An Introduction to Fishes.

Ajit Kumar Saha

8. Srivastava, C.B.L.: Fish biology
9. Quentin Bone and Richard H. Moore: Biology of fishes
10. Paul J. B. Hart and John D. Reynolds: Volume 1-Handbook of Fish Biology and Fisheries
11. Lagler Karl F. : Freshwater Fishery Biology

Paper IV (b): Entomology - Insect morphology, physiology & development

Unit-I: The integumentary system: histology of the integument, physical property and chemical composition of cuticle, sclerotization, colouration and moulting. Morphology of the head - tentorium, antenna and mouth parts and their modification; thorax - tergites, legs and their modifications, wing structure and venation, their modifications coupling mechanism and abdomen - pre-genital abdominal appendages, external genitalia

Unit-II: Nervous system : the neurons, central visceral and peripheral nervous system; Sensory mechanisms - mechanoreceptors (tango reception, proprioception, sound perception), chemoreception, thermoreception, hygromoreception and photoreception (compound eyes, image formation, stemmata, ocelli); Bioluminescence and sound production.

Unit-III: Alimentary system : nutrition, feeding behaviour, morphology of the gut and physiology of digestion and absorption; Circulatory system : dorsal vessel, accessory pulsating structures, sinuses and diaphragms, mechanism of circulation, composition and function of haemolymph; Respiratory system : structure of tracheae, tracheoles, air-sacs, spiracles, physiology of respiration, respiratory adaptations of aquatic and parasitic insects;

Unit-IV: Excretory system : Malpighian tubules and its arrangements, physiology of excretion (nitrogenous excretion, salt and water balance); Reproductive system : male and female reproductive system; Development: post-embryonic development, metamorphosis, types of larvae and pupae, Exocrine Glands : structure and function, pheromones; Endocrine glands : structure and function of non-neural, neural and peptide hormones, regulation of general body function and metabolic activities, moulting, polymorphism and diapause.

Suggested Books:

1. Robert Evans Snodgrass: Principles of Insect Morphology
2. Frank Friedrich, Rolf G. Beutel, Si-Qin Ge, and Xing-Ke Yang: Insect Morphology and Phylogeny: A Textbook for Students of Entomology
3. Ernest Melville DuPorte: Manual of Insect Morphology
4. Herbert Ross: A textbook of entomology
5. Howard Ensign Evans: Insect biology
6. Augustus Daniel Imms: Imms' General textbook of entomology
7. Richard J. Elzinga: Fundamentals of entomology
8. Christian Oseto: General And Applied Entomology
9. John Henry Comstock: An Introduction to Entomology
10. Reginald Frederick Chapman: The Insects: Structure and Function
11. Vincent Wigglesworth: The principles of insect physiology
12. James L. Nation: Insect Physiology and Biochemistry
13. Morris Rockstein: The physiology of Insecta

Arjun Kumar Saha

Paper IV (c): Cell Biology- Cytological Techniques

Unit-I: Elementary principles of phase, interference, polarization, fluorescence and electron microscope (transmission electron microscope, scanning electron and atomic force microscopy)

Unit-II: Theory and application of freeze-drying, x-ray diffraction, radioautographs, Methods of cell tissue culture

Unit-III: Chemical basis of fixation and cytochemical localization of proteins, lipids, glycogen, RNA, DNA, phosphatase, esterases and oxidases

Unit-IV: Purification and fractionation of nucleic acids, Nucleic acid hybridization, Enzymatic application of DNA by PCR.

Suggested Books:

1. Marie Exbrayat: Histochemical and Cytochemical Methods of Visualization
2. Kim S Suvarna, Christopher Layton, John D. Bancroft: Bancroft's Theory and Practice of Histological Techniques
3. J F Danielli: General Cytochemical Methods
4. Henry Troyer. Boston: Principles and Techniques of Histochemistry
5. David Glick: Techniques of Histo- and Cytochemistry

M.Sc. (Final) Semester –III

Practical Syllabus

Distribution of Marks:	Time : 6 ours
Exercise	Marks
Dissection	15
Preparation	8
Microtomy	8
Embryology exercise	10
Biotechnology/Molecular Biology exercise	10
Spotting (12 spots)	24
Viva-voce	15
Class Records	10
Total Marks-	100

General classification and survey of the structure or organization of the Chordate phyla.

Dissections and Preparations of the principal Chordate type.

Experiments on artificial ovulation insemination in study of the life history stages of frog and insects.

Mounting of egg's and embryos of snail.

Study of hormonal control of amphibian metamorphosis.

Incubation and mounting of chick embryo.

Study of prepared slides of the embryology of frog, chick and mammals and mammalian placentation.

Arjun Kumar S. A.

Microtomy of embryonic stages.

Application of window techniques *in situ* study of chick embryo with special reference to morphogenetic moments.

Determination of the effect of temperature on the embryonic development of chick.

Study of the development of selective organs through preserved specimen and prepared slides.

Experiment on regeneration in *Planaria*; regeneration of tail and limb in amphibian larva and lizards.

Estimation of DNA by diphenylamine reaction, Determination of RNA by orcinol method; Preparation of normal, molar and molal solutions; Preparation of buffers (acids, basic and neutral); Separation of amino acids by paper chromatography; Isolation of DNA from plant/animal/bacterial cells; Analysis of DNA by agarose gel electrophoresis; Animal cell culture media preparation, sterilization, washing, packing.

Washing & Sterilization, Preparatory steps for tissue culture, basic procedures for Aseptic tissue transfer, incubation of culture. DNA Fingerprinting (Using RAPD techniques)

Postgraduate Syllabus

M.Sc. (Final) Semester –IV

The examination shall comprise four theory papers and a practical test

Paper I: Comparative Anatomy and Molecular Endocrinology 100 Marks

Paper-II Economic Zoology & Wildlife 100 Marks

Paper-III (Special paper--student may choose anyone from following which he/she has opted in Semester III):

- (a): Fishery Biology- Taxonomy and ecology of Pisces 100 Marks
- (b): Entomology- Ecology, Evolution and Taxonomy 100 Marks
- (c): Cell Biology-- Cellular organization and fundamental processes: Cell structure 100 Marks

Paper-IV (Special paper--student may choose anyone from following which he/she has opted in Semester III):

- (a): Fishery biology- Applied Ichthyology 100 Marks
- (b): Economic Entomology- Beneficial and Harmful 100 Marks

insects, Insect Pest Management

- (c) Cell Regulations- Cell communication and differentiation 100 Marks

Practical 100 Marks

Total : 500 Marks

Ap. Kumar Sankar

Candidate must obtain minimum pass marks in theory and practical examination separately.

Paper I: Comparative Anatomy of Vertebrates and Molecular Endocrinology

Unit I, II, III: Comparative anatomy of the following systems of vertebrates:

Integumentary system; Digestive system; Respiratory system; Skeletal system; Circulatory system; Excretory system; Reproductive system.

Unit IV: Definition and scope of Endocrinology- Historical and anatomical aspects of mammalian endocrine system. Definition of a hormone- chemical nature of mammalian hormones- types of hormone receptors-secondary messenger system-general mechanism of peptide and non- peptide hormones action.Feed-back regulation of Endocrine System.

Unit V: The Endocrines of Hypothalamus- Hypo-Physiotropic hormones- Neurovascular hypothesis. Pituitary gland hormones- chemistry and biochemical functions. Pineal gland hormones- chemistry- biochemical functions- mechanism of action. Thyroid gland hormones- chemistry- biochemical functions- mechanism of action. Parathyroid glands- biochemical functions.

Unit VI:Adrenal gland: Hormones of adrenal gland- chemistry- mechanism of action- biochemical functions. Pancreas- Insulin/glucagon: chemistry-biochemical functions- mechanism of action. Somatostatin. Hormones involved in calcium metabolism- chemistry- mechanism of action. Neuro-hormones- the brain-renin-angiotensin, Urotensin-neuropeptides.

Unit VII: Hormones of female and male reproductive system: Ovarian steroid hormones-chemistry- biosynthesis and transport; Synthesis, chemistry and metabolism of androgens- dynamics of steroid hormone production and metabolism- mechanisms of action of sex steroid hormones.Testicular and ovarian determining genes – Mullerian-inhibiting substance genes- molecular basis of male and female contraception.

Suggested Books:

1. Kenneth V. Kardong: Vertebrates: Comparative Anatomy, Function, Evolution
2. Edward J. Zalisko and Kenneth V. Kardong: Comparative Vertebrate Anatomy: A Laboratory Dissection Guide
3. R. K. Saxena: Comparative anatomy of vertebrates
4. John Sterling Kingsley: Comparative Anatomy of Vertebrates
5. Robert Wiedersheim: Elements of the comparative anatomy of vertebrates
6. Libbie Hyman: Hyman's Comparative Vertebrate Anatomy
- 7.. Henry M. Kronenberg, Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen:William Textbook of Endocrinology
8. Bolander, Franklyn.: Molecular Endocrinology
9. Park-Sarge, Ok-Kyong, Curry, Jr., Thomas E: Molecular Endocrinology
10. William T. Schrader, Bert W. O'Malley: Laboratory methods manual for hormone action and molecular endocrinology
11. D. Schulster, S. Burstein & B. A. Cooke: Molecular Endocrinology of the Steroid Hormones
12. Stephen R. Hammes: Molecular Endocrinology

As per University Scheme

Paper II : Economic Zoology & Wildlife

Unit 1: Prawn culture; Fish Culture, Pearl culture; Apiculture, Sericulture,

Unit 2: Poultry and Lac-culture; Leather industry; Pharmaceuticals from animals, white revolution.

Composting and Vermicomposting, Requirements of Vermicomposting and Vermiculture: Choice of species, composting species,

Unit 3: General study of wildlife; Endangered wild animal species; Wildlife conservation programmes, conservation of the Asiatic lion, 'Project Tiger; Project Crocodile, Project Hangul, Project Elephant,

Unit 4: Wildlife Sanctuaries; National parks and biosphere reserves; Major organizations concerned with wildlife conservation and their activities and programmes, Wild life ecotourism management.

Suggested Books:

1. Herbert Osborn: Economic Zoology: An Introductory Text-Book in Zoology, with Special Reference to Its Applications in Agriculture, Commerce and Medicine
2. Jawaid Ahsan & Subhas Prasad Sinha: A Hand Book on Economic Zoology
3. Ashok K. Rathoure, Nazneen Z. Deshmukh, Dinesh Kumar and Rachna Goswami: Applied and Economic Zoology
4. Arjya B. Majumdar and Debosmita Nandy: Environment and Wildlife Laws in India
5. S K Singh: Text Book of Wildlife Management
6. M.K. Ranjit Singh: Indian Wildlife
7. Mahesh Rangaraj: Indias Wildlife History: An Introduction
8. Melvin E. Sunquist and Ullas Karanth K: Science and Conservation of Wildlife Populations

Paper III (a): Fishery Biology- Taxonomy and Ecology of Pisces

Unit 1: Taxonomy of fishes up to orders; Detailed taxonomic study of fishes of Uttar Pradesh and Bihar;

Unit 2: Adaptations to different modes of life with special reference to Hill stream and deep sea fishes;

Unit 3: Relationship between fishes and their abiotic and biotic environment; Abiotic factors: density and pressure, temperature, salt contents in water, light, sound, electric currents, bottom deposits and particles suspended in water; Biotic factors- Inter specific, interrelationship among fishes with other organism; Intraspecific interrelationship among fishes and with outer organisms;

Unit 4: Pollutants affecting fishery waters with special reference to oil spills, domestic pollutants, industrial water, Radio-active wastes, Sewage fed fisheries; Planktons in relation to fish production.

Ajit Kumar Saha

Suggested Books:

1. K. C. Jayaram: Fundamentals of Fish Taxonomy
2. Gopalji Srivastava: Fishes Of U.P. & Bihar
3. Leo.S.Berg: Classification of fishes
4. Francis Day: Vol I & II Fishes of India
5. K.S.Mishra: An aid to classification of Fishes.
6. E.P. Odum: Fundamental of Ecology
7. R.G. Wetzel- Limnology
8. P.S. Welsch: Limnology
9. R.G. Wetzel: Laboratory guide of Limnology
10. J. Schwocrbble: Principle of Limnology
11. K.A. Ruttner- Fundamentals of Limnology
12. Hutchinson- A Treatise on Limnology Vol .1 -2.
13. V.G. Cole: Limnology
14. Wootton, Robert: Fish Ecology
15. John F. Craig: Freshwater Fisheries Ecology
16. William J. Matthews: Patterns in Freshwater Fish Ecology
17. Harold M. Tyus: Ecology and Conservation of Fishes

Paper III (b): Entomology- Ecology, Evolution and Taxonomy:

Section 'A'

Unit 1: Insect origin and evolution: Ancestry of insects, origin and evolution of insects, relationships between entognathous and ectognathous apterygotes;

Unit 2: Insects and the abiotic Environment: Effect of temperature, moisture and light on insect population; Insect Plant interactions: Plant and insect herbivore relationship, Primary and Secondary metabolic plant products,

Unit 3: Host selection by insects, Chemical defence in plants, Allocation of protective chemicals, primary role of toxic chemicals, response of insects to chemical defence, temporal avoidance of chemical, semiochemicals.

Unit 4: Outline classification of insects; characters, classification and examples of following taxa:

Thysanura: Machilidae, Lepismatidae; Collembola: Sminthuridae, Entomodryidae; Ephemeroptera: Ephemeridae; Odonata: Zygoptera, Anisoptera, Anisozygoptera; Orthoptera: Schizodactylidae, Tettigoniidae, Gryllidae, Gryllotalpidae, Acrididae; Phasmida: Phasmidae, Phyllidae; Dermaptera: Forficulidae; Dictyoptera: Blattaria (Blattidae), Mantodea (Mantidae); Isoptera: Mastotermitidae, Kalotermitidae, Termitidae; Pscocoptera: Psocidae; Mallophaga: Philopteridae, Trichodactidae; Siphunculata: Haematopinidae, Pediculidae; Hemiptera: Homoptera, Coleorrhyncha, Auchenorrhyncha (Fulgoridae, Lophopidae, Cicadidae, Membracidae, Cicadellidae), Stenorrhyncha (Psyllidae, Aleyrodidae, Aphididae, Margarodidae, Lacciferidae, Pseudococcidae, Coccidae, Diaspididae); Heteroptera: Rediviidae, Cimicidae, Anthocoridae, Lygaeidae,

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Pyrocoridae, Coreidae, Scutelleridae, Pentatomidae, Gerridae, Notonectidae, Belostomatidae, Nepidae Thysanoptera: Terebrantia (Thritidae), Tubulifera; Neuroptera: Megaloptera, Planipennia (Chrysopidae); Coleoptera: Adaphaga (Carabidae, Cicindellidae, Dytiscidae, Gyrinidae), Polyphaga (Hydrophilidae, Lucanidae, Scarabaeidae, Buprestidae, Elateridae, Lampyridae, Dermestidae, Coccinellidae, Tenebrionidae, Meloidae, Cerambycidae, Chrysomelidae, Bruchidae, Curculionidae); Siphonoptera: Pulicidae, Ceratophyllidae; Diptera: Nematocera (Tipulidae, Psychodidae, Culicidae, Simuliidae, Chironomidae, Bibionidae, Mycetophilidae, Cecidomyiidae), Brachycera (Tabanidae, Asilidae, Bombyliidae, Cyclorrhyncha; Lepidoptera: Monotrysis (Neplialidae), Ditrysis (Tineidae, Psychidae, Plutellidae, Gelechiidae, Tortricidae, Cossidae, Pyralidae, Hyblacidae, Nymphalidae, Pieridae, Papilionidae, Geometridae, Bombycidae, Saturniidae, Sphingidae, Arctiidae, Noctuidae, Lymantriidae); Hymenoptera: Symphyta (Siricidae, Cephidae, Tenthredinidae), Apocrita (Ichneumonidae, Draconidae, Evaniidae, Cynipidae, Chalcidae, Aganionidae, Pteromalidae, Eulophidae, Trichogrammatidae, Scoliidae, Formicidae, Pompilidae, Vespidae, Sphecidae, Negachilidae, Xylocopidae, Apidae);

Collection and preservation of insects

Suggested Books:

1. Herbert Ross: How to collect and preserve insects
2. Timothy Duane Schowalter: Insect ecology
3. Micky D. Eubanks, Peter Price, and Robert Denno: Insect Ecology: Behavior, Populations and Communities
4. Peter Price: Insect Ecology
5. Allan D. Watt, Mark D. Hunter, and Martin R. Speight: Ecology of Insects: Concepts and Applications
6. Carl Barton Huffake: Ecological Entomology
7. David Grimaldi: Evolution of the insects
8. B. S. Heming: Insect Development and Evolution
9. Victor Rico-Gray: The ecology and evolution of ant-plant interactions
10. Pierre Jolivet: Interrelationship Between Insects and Plants
11. Imms, A.D., Richards, O.W., Davies, R.G: Imms' General Textbook of Entomology Volume 2: Classification and Biology
12. Gordon Gordh, V. A. Trjapitzin: Taxonomic Studies of the Encyrtidae with the Descriptions of New Species and a New Genus: Hymenoptera: Chalcidoidea
13. R. Singh: Elements of Entomology
14. Cecilia Fitzsimons and Pamela Forey: Insects: Identification Guide

Paper III (c): Cell Biology-- Cellular organization and fundamental processes:

Unit 1: The Nucleus (The nuclear envelop and traffic between the nucleus and cytoplasm), Internal organization of the nucleus, the nucleolus; Plasma membrane structure and chemical composition; movement of substances across the membrane;

Unit 2: Protein shortening and transport: endoplasmic reticulum (the endoplasmic reticulum and protein secretion, the smooth ER and lipid synthesis, export of protein and lipids from the ER); The Golgi apparatus (organization of the Golgi, protein glycosylation within the Golgi, lipid and polysaccharide metabolism in the Golgi, protein sorting and export from the Golgi apparatus); Lysosomes (ultrastructure, lysosomal acid hydrolases, endocytosis and lysosome formation, phagocytosis and autophagy);

Ap. Kumar Sarda

Unit 3 : Bioenergetics and metabolism (mitochondria– organization and function, mechanism of oxidative phosphorylation, proxisomes –functions of peroxisomes); Ultrastructure and functions of ribosomes.

Unit 4: Chromosome morphodynamics and achromatic apparatus in cell division; Physiology of a dividing cell; Apoptosis and natural cell death.

Suggested Books:

1. Robert A. Reid and Rachel M. Leech: Biochemistry and Structure of Cell Organelles
2. Geoffrey M. Cooper: The Cell: A Molecular Approach
3. **Salido**, Gines Maria, **Rosado**, Juan A: Apoptosis: Involvement of Oxidative Stress and Intracellular Ca²⁺ Homeostasis
4. Bruce Alberts, Dennis Bray, Julian Lewis, Karen Hopkin, Keith Roberts, Martin Raff, and Peter Walter: Essential Cell Biology
5. Favor Lesli J.: Eukaryotic and Prokaryotic Cell Structures
6. April Chloe Terrazas: Cellular Biology: Organelles, Structure, Function
7. Guy Orchard and Brian Nation: Cell Structure & Function
8. John Davey and J. Michael Lord: Essential Cell Biology Vol 1: Cell Structure
9. Elli Kohen: Cell Structure and Function by Microspectrofluorometry

Paper IV(a): Fishery Biology- Applied Ichthyology

Unit 1: Marine, freshwater, estuarine reservoirs and coldwater fisheries of India.

Unit 2: Fish culture-Nutritional requirements of Carps, Siluroids and Murrels, Carp cultivation in India; Spawning, collection, hatcheries, rearing, stocking, transport and mortality of fish fry; Fertilization and management of Fishery pond.

Unit 3: Composite fish culture, cage culture and culture of exotic fishes, induced breeding; Methods of fishing in India with particular reference to U. P.; Preservation, processing, transport and marketing of fish, food value and flavour of different fishes.

Unit 4: Larvivorous fishes and public health; Common enemies and symptoms, etiology and treatment of diseases of food fishes; Development of fisheries in India; Fish-based industry and their byproducts.

Suggested Books:

1. S. K. Gupta, and P. C. Gupta: General and applied ichthyology
2. G S Sandhu: Applied Ichthyology
3. Patrick Safran: Fisheries and Aquaculture - Volume III
4. C.B.L. Shrivastava: A text book of fishery science and Indian fisheries
5. Ayyappan, S: Handbook of Fisheries and Aquaculture
6. Gopakumar, K: A textbook of fish processing technology
7. A. G. K. Menon: Indigenous larvivorous fishes of India
8. Nihar Ranjan Chattopadhyay: Induced Fish Breeding
9. Brian J Harvey: The theory and practice of induced breeding in fish

Apri Kohen

10. J. Timmermans and Marcel Huet: extbook of Fish Culture: Breeding and Cultivation of Fish
11. Francis Francis: Fish-Culture: A Practical Guide to the Modern System of Breeding and Rearing Fish
12. Marilyn Chakroff: Freshwater Fish Pond Culture and Management
13. Steve McComas: Lake and Pond Management Guidebook

Paper IV(b): Economic Entomology- Beneficial and Harmful Insects, Insect Pest Management

Unit 1: Beneficial insects: Biology of beneficial insects (*Apis*, *Bombyx*, *Kerria*), insect products, use of insects in medicines, insects in biological research, pollination by insects, insects as consumers, scavengers and as food, forensic entomology.

Unit 2: Harmful insects: Life history, mode of damage and control measures of following insects:

Pests of sugarcane: *Aleurolobus barodensis*, *Pyrilla perpusilla*, *Tryporyza nivella*, *Chilo traea infuscatellus*, *Emmalocera depressella*, *Odontotermes* spp.; Pests of cereal crops: *Hispa armigera*, *Leptocorisa varicornis*, *Hieroglyphus* spp., *Nephotettix bipunctatus*, *Chilo zonellus*, *Pachydiplosis oryzae*; Pests of fruits and fruit trees: *Quadraspidiotus perniciosus*, *Eriosoma lanigerum*, *Idiocerus atkinsoni*, *Oryctes rhinoceros*, *Papilio demoleus*; Pests of vegetables: *Rhaphidopalpa foveicollis*, *Epilachna* spp., *Leucinodes orbanalis*, *Phthorimoea operculella*, *Pieris brassicae*, *Bactrocera cucurbitae*, *Earias vittella*; Pests of oilseeds: *Athalia proxima*, *Lipaphis erysimi*, *Bagrada picta*; Pests of Fibre Crops : *Helicoverpa armigera*, *Pectinophora gossypiella*, *Bemisia tabaci*, *Dysdercus koenigi*, *Diacrisia oblique*; Pests of stored commodities: *Sitophilus oryzae*, *Trogoderma granarium*, *Tribolium* spp., *Callosobruchus chinensis*, *Corcyra cephalonica*, *Sitotroga cerealella*; Pests of live stock: *Phlebotomus* spp., *Tabanus striatus*, *Hippobosca maculata*, *Xynopsylla cheopis*.

Ticks and Mites of Economic Importance.

Unit 3: Components of Insect Pest Management; Physical and mechanical control, handpicking and crushing, use of sticky barriers, electrical grid, low and high temperature, radiation, destruction of crop residues, weeds and trash; Cultural control : Crop rotation, tilling the soil, destruction of places of breeding or over wintering refuge, destruction or provision of alternate hosts, time of planting and harvesting, trap crops, nutrient management;

Unit 4: Chemical control: Insecticides– classification, properties, synergists, formulations, application (including appliances), Mode of action, repellents, attractants, development of insect resistance against insecticides; Herbal insecticides. Biological control: Inoculation, augmentation and conservation of natural enemies (Pathogens, predators and parasitoids), selection criteria of a promising natural enemy; Genetical control: Sterile-male technique, breeding, insect-resistant host plants; Legal (Regulatory) control: Enactment and enforcement of quarantines; Concept of integrated pest management (IPM) in agro-ecosystem.

Apurva Saha

Suggested Books:

1. Hill, Dennis S.: The Economic Importance of Insects
2. C an Ealand: Insects and Man: An Account of the More Important Harmful and Beneficial Insects, Their Habits and Life-Histories, Being an Introduction to Economic ... and General Readers
3. Molly Aloian and Bobbie Kalman: Helpful and Harmful Insects
4. Edward B. Radcliffe, William D. Hutchison, Rafael E. Cancelado: Integrated Pest Management: Concepts, Tactics, Strategies and Case Studies
5. David Pimentel, Rajinder Peshin: Integrated Pest Management: Pesticide Problems, Volume 3
6. Larry P. Pedigo: Entomology and pest management
7. David Dent: Insect Pest Management
8. Rangaswamy Muniappan, E. A. Heinrichs: Integrated Pest Management of Tropical Vegetable Crops
9. West, T.F., Hardy, J. Eliot: Chemical Control of Insects
10. Jackie Stevens, Kerry Dunse, Jennifer Fox, Shelley Evans and Marilyn Anderson: Biotechnological Approaches for the Control of Insect Pests in Crop Plants
11. Daniel L.Mahr, Paul Whitaker and Nino Ridgway: Biological control Of insects and mites
12. George W. Ware and David M. Whitacre: An Introduction to Insecticides
13. Jack E. Rechcigl, Nancy A. Rechcigl: Biological and Biotechnological Control of Insect Pests

Paper IV (c): Cell Regulations - Cell communication and differentiation

Unit 1: Cell signaling: General principles of cell signaling, Forms of signaling. Classes of cell surface receptors protein, Signaling of steroid and thyroid hormones through intracellular receptors, Signaling via-G-Protein linked cell surface receptors; Interferon.

The cell division cycle : The general strategy of the cell cycle, Regulation of the cell cycle by cell growth and extracellular signals, Cell cycle check points, Regulation of cell cycle progression;

Unit 2: Cellular mechanisms of development : Mechanism of cell diversification in the early animal embryo, Cell memory, cell determination and the concept of positional values;

Differentiated cells and their maintenance: Maintenance of the differentiated state, Tissues with permanent cells, Renewal by simple duplication, Renewal by stem cells, epidermis, Renewal by pluripotent stem cells;

Unit 3: The immune system : The cellular basis of immunity, Antigen & Antibody interactions, The functional properties of antibodies, The fine structure of antibodies, Production & Synthesis of polyclonal & Monoclonal antibodies, T-cell receptors and subclasses, AIDS, MHC (Major Histocompatibility Cells), Molecular and antigen presentation on to T cells, Cytotoxic T Cells, Helper T Cells and T Cell activation, Selection of the T cells repertoire;

Ar. Kumar S.A.

Unit 4: Cancer : Cancer as a micro-evolutionary process, causes and types of cancer, Properties of cancer cells, Molecular diagnosis, prevention and treatment , Molecular genetics of cancer;

Controlling gene expression: An overview of gene control, promoter and operator genes,

Hormone regulation or gene control, DNA binding motifs in gene regulatory proteins,

Working of Genetic switches, Post transcriptional controls.

Suggested Books:

1. Stephane Swillens: Cell Regulation by Intracellular Signals
2. Geoffrey M. Cooper: The Cell: A Molecular Approach
3. Coralie A. Carothers Carraway: Cytoskeleton: Signalling and Cell Regulation: A Practical Approach
4. Earl R. Stadtman, P. Boon Chock, Alexander Levitzki: Current Topics in Cellular Regulation, Volume 32
5. James Danielli, Geoffrey H. Bourne: Aspects of Cell Regulation
6. Gregory S. Payne and Julie Donaldson: Trafficking Inside Cells: Pathways, Mechanisms and Regulation
7. Gary H. Perdew: Regulation of gene expression
8. Shuiping Jiang: Regulatory T Cells and Clinical Application

M.Sc. (Final) Semester –IV

Practical Syllabus

Fish Biology:

Time : 6 Hours

Distribution of Marks:

Exercise	Marks
Major dissection	15
Minor dissection	05
Preparation	05
Taxonomy (Identification of two fishes)	15
Ecology Exercise	10
Physiology	10
Spotting (10 Spots)	20
Dissertation/Excursion Report	10
Viva-voce and Class Records	10

Total Marks : 100

Study of organ system of *Mystus*, *Labeo* and *Wallago*.

Study of accessory respiratory organs and their blood supply in *Heteropneustes*, *Clarias*, *Channa* and *Amphipnous*.

Ajit Kumar Sarda

Study of air bladder and ear connection in *Notopterus* and *Gudusia* or *Hilsa*.
Morphology of olfactory organs and their innervation in teleosts.
Preparation of a skeleton and an alizarine mount of fish.
Study of prepared microslides.
Osteology of *Wallago*.
Quantitative estimation of liver glycogen and blood glucose.
Demonstration of colour change.
Systematics of marine and freshwater fishes, with special reference to identification of local forms.
Structural adaptations in fishes.
Qualitative and quantitative study of freshwater plankton.
Estimation of dissolved oxygen, free carbon dioxide and alkalinity in a local fish-pond.
Oxygen consumption in local fishes of different habitats.
Study of food and structural modifications due to feeding habits, gills and gill-rakers, mouth, eye, alimentary canal, olfactory organs etc. Study of age and growth in fishes. Study of amphibious, exotic, poisonous, venomous larvivorous and sound producing fishes. Study of common aquatic vegetation and aquatic insects. Study of fishing gears, with particular reference to Uttar-Pradesh.
Soil factors

Apurva Kumar Sarda

M.Sc. (Final) Semester -IV

Practical Syllabus

Entomology:

Distribution of Marks:

Time : 6 Hours

Exercise	Marks
Major dissection	20
Minor dissection	05
Preparation	05
Taxonomy (Identification of two insects)	15
Physiology	15
Spotting (10 Spots)	20
Dissertation/Excursion Report	10
Viva-voce and Class Records	10
Total Marks-	<u>100</u>

Detailed study of the external features of grasshopper.

Dissections of different systems of; *Grylotalpa*; *Dysdercus*; Housefly/*Calliphora*; Moth/ Butterfly/ Larvae; Wasp/ Honey bee: Dung; Beetle/Water beetle.

Permanent preparation of: Testis of cockroach; Salivary gland of *Dysdercus*; Ovary, spermatheca and accessory gland of housefly; Sting apparatus of wasp/ honey bee; Spiracles of a caterpillar and wing scales of a lepidopteran insect; Legs of terrestrial and aquatic insects showing special adaptations concerning locomotion.

Study of prepared slides of: T.S./L.S. of integument and the various regions of gut, ovary, testis and brain; Whole mounts of thoracic/ abdominal spiracles, different types of antennae, legs, mouth parts, wings and sting apparatus of honeybee/wasp.

Determination of pH of insect guts and haemolymph.

Qualitative assay of free amino acids from haemolymph and fat body.

Quantitative estimation of glycogen, protein and lipid.

Qualitative determination of uric acid from fat body/malpighian tubules.

Determination of the rate of passage of food through gut.

Collection of different kinds of larvae and pupae of insects.

Collection, preservation and identification of locally available insects.

Permanent preparation of mouth parts, antennae, wings, legs, spiracles and external genitalia of insects from different groups.

Apurva Sarda

Identification of various insect pests, their life-histories and materials damaged by them.

Study of various groups of insecticides and equipments used for insecticides application.

To demonstrate the presence of lipid and glycogen in microtomy sections of suitable material.

Study of life- histories of beneficial insects and their products.

M.Sc. (Final) Semester –IV

Practical Syllabus

Cell- Biology:

Distribution of Marks: Time : 6 Hours

Exercise	Marks
Cytochemical localization	15
Vital staining	10
Microtomy	10
Isolation of nucleic acids	15
Spotting (15 spots)	30
Dissertation	10
VivaVoce and Class records	10
Total Marks-	100

Handling and use of phase contrast microscope.

Quantitative estimation of DNA, RNA, alkaline phosphatase.

Cytochemical localization of phosphatases, RNA, DNA, proteins, lipids and glycogen.

Study of chromosomal behaviour during cell division, using squash preparations of animal (testes of rat and grasshopper; bone marrow of rat) tissues and plants (onion root tip) tissues.

Prepared slides of chromosomal behaviour during cell division.

Study of salivary gland chromosomes of *Drosophila* and/or *Chironomous* larvae.

Identification and study of mutant forms of *Drosophila*.

Drosophila culture technique.

Cytochemical localization of golgi complex, mitochondria, acids and alkaline phosphatases and glycogen.

Supravital staining of Nissl bodies, mitochondria and cytoplasmic vacuoles.

Study of prepared slides of various cytoplasmic organelles and inclusion.

Study of prepared slides of various stages during mitotic and meiotic cell divisions.

Bacterial culture techniques.

Isolation of nucleic acids.

Ajita Kumar Saha