



**SHRI JAGDISHPRASAD JHABARMAL TIBREWALA
UNIVERSITY, CHUDELA, JHUNJHUNU (RAJ.)**

SEMESTER-I

PAPER –I BIOSYSTEMATICS AND TAXONOMY

UNIT-I

1. Definition of basic concepts of biosystematics and taxonomy. History of taxonomy.
2. Importance and applications of biosystematics in biology.
3. Definition and understanding of various taxonomic categories.
4. Species concepts and species categories-subspecies and infra species.

UNIT-II

Modern trends in taxonomy-

5. Chemotaxonomy
6. Cytotaxonomy
7. Molecular taxonomy
8. Neotaxonomy
9. Determination of phylogenetic relation using computer programs.

UNIT-III

- 10 Taxonomic procedures; collection preservation curation and process of identification.
- 11 Taxonomic characters of different kinds. Quantitative and Qualitative analysis of variation.
- 12 Process of typification different zoological types and their significance.
- 13 Theories of biological classification

UNIT-IV

- 14 Different kinds of systematic Publications.
- 15 Taxonomic Keys: their kinds, merits and demerits Use of taxonomic keys.1

- 16 International Code of Zoological Nomenclature (ICZN)
- 17 Interpretation and application of important rules and formation of scientific name of different taxa.

PRATICALS

- Identification, Classification and study of the animals from major invertebrate groups (Protozoa to Hemichordate including minor phyla) using museum specimens, slides, modals or charts.
- Specimens:
- PROTOZOA- Gregarines Monocytes Creation, Euplotes, Dominion Noctiluca, Radiolarian, Stenior, Opelika PEREIRA- Sectional view of sycon (T.S, L.S.) Grantia (T.S)
- CNIDARIA- Slides of Obelia polyp and medusa Pennaria, Aurelia Tentaculocytes Museum specimens of Virgularia, spongodus, Zoanthus, Favia. HELMINTHES- Slides of Temnocephala Museum specimens of Ascarislumbricoides, TaeniaSolium, Planaria.
- ANNELIDA- Slides of Ozobranche, Glossophonia, Museum Specimens of Eunice, chloehava. Polynoe, Terebella. Eurythoe. ARTHROPODA- Slide of Cytops, Daphina, Chelifer, section of Peripatus. Museum Specimens of BalanusLepas, Palinurus. Uca, Pycna, Hippa, Gongylus, Belostoma. Limulus Squilla, Eupagurus.
- MOLLUSCA- Museum Specimens of Dolobella, Pteria, Nerita, Sanguniolaria, Chicoreus, Ficus, Lambis, Tridacna, OnchidiumOliva, Murex Turritella, Bulla, Cardium,

Arca.

ECHINODERMATA- Museum Specimen of Linkia, echinodiscus, Holotharia, Antedon.

MINOR PHYLA- slides of BugulaPlumatalla, Cristatella, Pectinella, Museum Specimen of Phoronis, Dendrostoma.

- LARVAE- Planula, Redia, Cercaria, metacercaria, Trochopore, Nauplius, Zoa, Mysis, Phyllosoma, Trilobite larvae of limulus, Antion, Veliger, Bipinnaria, Ophio and Echinopluteus, Auricularia, tornaria
- Composition assessment of taxonomic diversity in a habitat. (grassland, arid land, wet land etc.)
- Use of taxonomic keys to identify t least 6-10 orders of insets (up to order level only)
- Visit river/ pond/sea.

SUGGESTED BOOKS

- Biodiversity, E.O. Wilson, academic Press; Washington.
- Principle of Animal Taxonomy; G.G. Slmpson. Oxford IBH Publishing Company.
- Elements of Taxonomy.E. Mayer.
- The diversity of life (The College Edition) , E.O. Wilson. W.W. Northern & co.
- Theory and Practice of Animal Taxonomy. V.C. Kapoor. Oxford & IBH Publishing Co.Pvt. LTD.
- Advancement in Invertebrate Taxonomy and Biodiversity. Rajeev Gupta. AgrobiosInternational.



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SEMESTER-I

PAPER –II STRUCTURE & FUNCTION OF INVERTEBRATES

UNIT-I

1. Body organization:
 - 1.1 Origin of life, Uni and multi cellular organisms
 - 1.2 Body cavity: Acoelome, Pseudocoelome, Coelome (schizo and enterocoelous)
 - 1.2 Fate of Blastopore: Protostome, Deuterostome
 - 1.3 Fate of Blastomeres : Determinate and Indeterminate blastomeres
 - 1.4 Type of cleavage : Spiral and Radial
 - 1.5 Type of symmetry : Body planes, asymmetry, Radial, biradial, bilateral symmetry
 - 1.6 Segmentation: Pseudo, superficial and metameric
2. Locomotion:
 - 2.1 Flagella and ciliary movement in Protozoa
 - 2.2 Hydrostatic movement in Coelenterata, Annelida and Echinodermata.

UNIT-II

3. Nutrition and Digestion
 - 3.1 Strategies of feeding in invertebrates and digestion in lower Metazoa.
 - 3.2 Feeding in Polycheata, Mollusca and Echinodermata.
4. Respiration:
 - 4.1 Organs of respiration in invertebrates- Gills book lungs and Trachea.
 - 4.2 Mechanism of respiration.

5. Excretion:

- 5.1 Organs of excretion in invertebrates specially Coelomoducts, Nephridia and Malphigian tubules, organ of bojanus green gland
- 5.2 Mechanisms of excretion.

UNIT-III

6. Nervous System:

- 6.1 Primitive nervous system Coelenterata and Echinodemata.
 - 6.2 Advanced Nervous system Annelida, Arthropoda(Crustacea and insect) and Mollusca (Cephalopoda)
7. Reproduction:
- 7.1 Regeneration, Asexual (paramecium, obelia) and sexual reproduction (annelida, arthropoda and Mollusca)

UNIT-IV

8.Important systems:

- 8.1Canal system in sponges
- 8.2Parasitic helminthes
- 8.3Proto, meso and metanephridia
- 8.4Respiration in unio and pila
- 8.4 Water vascular system in star fish

9.Minor phyla: Organization and general characters.

- 9.1 Tardigrade, Entoprocta, Ctenophora, Rhyncoela, Spincula, Rotifera, Gastrotricha

PRACTICALS

1. virtual dissection of invertebrates using computer software

OR

2. Dissection: Nervous System, Leech, crab Scorpion, Mytilus Sepia, Aplyisa, Sea Urchin Holothuria, Star Fish.

3. Mounting: Hydra, Obelia, Sertulria, companvlaria, Miracidivm larvae, Cercaria, RadiaRarvae, Cyclops, Daphnia, Zoea, MegalopaMuisis planktons

SUGGESTED BOOKS

- Invertebrate Zoology: A Functional Evolutionary Approach Edward E (Edward E. Ruppert, Richard S.Fox
- Invertebrate Zoology Author:R.S.K. Barnes 3 The invertebrates Vol.1. Protozoa through Ctenophora, Hyman, L.H. McGraw Hill Co. New York.
- The Invertebrates Vol 2 Hymani L.H. McGraw Hill Co. New York
- The Invertebrates smaller coelomate groups Vol,5 Hyman L.H. Graw Hill C.o, New York
- Invertebrates Vol.8. Hyman, L.H. Mcgraw Hill Co., New York and London
- Invertebrate structure and function. Barrington, F.J.W. Thoms Nelson and Sons Ltd. London.
- Invertebrates Richard C. Brusca, Gary J. Brusca and Nancy J. Haver
- A Biology of higher invertebrates, Russel- Hunter, WD Mcmillan Co. Ltd London
- Student Text Book of Zoology.Vol .I.II. and III Sedgick. A Central Book Depot, Allahabad.
- Text book of Zoology: Parker T.J. Haswell . W.A. Macmillan Co., London
- Biology of the Invertebrates by Jan A. Pechenik
- Invertebrate Zoology Lab Manual Robert L. Wallace, Waller K. Taylor
- The Invertebrates: A Synthesis R.S.K. Barnes Peter P.Calow P.J.W. Olive D.W. Golding J.I. Spicer



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SEMESTER-I

PAPER –III BIOCHEMISTRY

UNIT-I

1. The scope of biochemistry
 - 1.1 Bio molecules
 - 1.2 Chemical bonds.
 - 1.3 pH
 - 1.4 Acid, Base, Buffer 1.
 - 1.5 Concept of free energy.
 2. Proteins:
 - Covalent properties of Proteins
 - 2.1 Structure and chemistry of amino acids
 - 2.2 Isolation and purification of protein
 - 2.3 Protein sequencing
 - 2.4 Peptide synthesis
 - 2.5 Covalent modifications
 - 2.6 Protein splicing
 - Protein secondary and tertiary structure
 - 2.7 Peptides and peptide bonds
 - 2.8 Ramchandaran plots and amino acid propensities
 - 2.9 Common secondary structure
 - 2.10 Protein tertiary structure and, folding patterns
 - 2.11 Common tertiary structural motifs.
 - 2.12 Role of packing constraints in tertiary structure patterns.
 - 2.13 Divergent vs. convergent evolution of similar structure.
 - 2.14 Water and the hydrophobic effect
 - 2.15 Tertiary and quaternary effect.
 - 2.16 Motifs in globular proteins
 - 2.17 Properties of protein interiors and surface

- 2.18 Fibrous proteins (keratin, fibroin, collagen and elastin) Protein folding and thermodynamics
- 2.19 Protein folding and dynamics
- 2.20 Folding Overview: the Levinthal paradox.
- 2.21 Condensation and molten globules
- 2.22 Chaperone- Assisted protein folding
- 2.23 Amino acid sequence variation and protein misfolding diseases Allostery (Hemoglobin), Myoglobin structure and oxygen binding
- 2.24 Hemoglobin subunits cooperative, the Hill coefficient.
- 2.25 Quaternary structure changes and Sickle cell and other molecular diseases

UNIT-II

- 3. Carbohydrates: Structure and biological importance of-
 - 3.1 Monosaccharide
 - 3.2 Oligosaccharides
 - 3.3 Polysaccharides (Storage and structural polysaccharides, glycosaminoglycans
 - 3.4 Glycoconjugates (glycoprotein and proteoglycans)
- 4. Lipids
 - 4.1 Fatty acids: structure, nomenclature, acylglycerols, wax , phospholipids, sphingolipids, glycolipids, lipoproteins
 - 4.2 Terpenoids and sterols: structure, properties and function
 - 4.3 Function of lipids
 - 4.4 Signal transducing molecules
- 5. Nucleic acid structure
 - 5.1 Nucleotides
 - 5.2 Primary structure of nucleic acid.
 - 5.2 Secondary and tertiary structures of nucleic acids; Triple helices and H-DNA; unusual secondary structure of DNA
 - 5.3 Duplex stability
 - 5.4 Hybridization
 - 5.5 DNA and RNA sequencing

UNIT-III

- 6. Vitamins
 - 6.1 Classification, structure, occurrence and functions of fat soluble vitamins
 - 6.2 Classification, structure, occurrence and biological water soluble vitamins

6.3 Phenolics and alkaloids: structure, biological properties and functions

7. Enzymes:

- 7.1 Enzyme as biocatalyst
- 7.2 The kinetics of enzyme catalysis
- 7.3 Principle of enzyme catalysis
- 7.4 Proteases, polymerases, other example
- 7.5 Coenzymes and Cofactor
- 7.6 Isozymes
- 7.7 Enzyme inhibition
- 7.8 Allosteric enzyme
- 7.9 RNA catalysis
- 7.10 Chemistry and structure of ribozymes
- 7.11 Evolutionary implications
- 7.12 Immobilized enzymes and their applications
- 7.13 Enzymes as biosensor

UNIT-IV

8. Metabolism

- 8.1 Catabolism, anabolism, Metabolic pathway, regulation, concept of free energy
- 8.2 Carbohydrate metabolism: Enzymatic reaction, regulation and importance of Glycolysis, Citric acid cycle. Pentose Phosphate pathway, glycogenolysis, glycogenesis, gluconeogenesis.
- 8.3 Lipid metabolism: fatty acid oxidation, fatty acid biosynthesis, biosynthesis of triglycerides, Cholesterol
- 8.4 Amino acid metabolism: Catabolism of amino acid, transamination, deamination, biosynthesis of nonessential amino acid, fate of carbon skeleton
- 8.5 Nucleotide metabolism : Degradation of purine and pyrimidines nucleotids, biosynthesis (De novo, salvage pathways) of purine and pyrimidine nucleotids
- 8.6 Oxidative phosphorylation and mechanism of ATP biosynthesis.

9. Inborn error of metabolism : (Important diseases of)

- 9.1 Carbohydrate
- 9.2 Protein

9.3Lipid

9.4nucleotide metabolism

PRACTICALS

- Identification of protein, carbohydrate and lipid in various tissues/food material
- Identification of different kinds of mono-di and polysaccharides in biological/ Food materials
- Verification of Beer-Lamber's Law using any colour solution
- Determination of absorption maxima of a coloured solution
- Plotting of standard curve
- Quantative estimation of the following in various tissues
 - Carbohydrates: Glycogen, glucose and ascorbic acid
 - Proteins: Total proteins
 - Lipids: Total lipid, Phospholipids and cholesterol.
 - Nucleic acid: DNA and RNA
 - Enzymes: Acid and alkaline phosphates
- Paper chromatography: Unidimesional chromatography, Using amino acids from purified sampled and biological materials
- Paper / PAGE electrophoresis, determination of serum protein through paper/PAGE electrophoresis Determination of pH of different solutions

SUGGESTED BOOKS

- Biochemistry by Albert's R.H. Frey P.A. and Jencks W.P. Jones, & Bartlett publisher, Boston/ London, 1992
- Lehninger Principles of biochemistry by Nelson D.L. and Cox M.M. Macmillan/Worth Publishers. 2000
- Stryker L. Biochemistry W.H. Freeman and Co. New York, 2001
- Fundamental of Biochemistry by Voet. D. Voet J.G. and Prett C.W. Johan Wiley and sons Inc. New York, 1999
- Principles and Techniques of Practical Biochemistry by Wilson K. and Walker J. Cambridge University Press, Cambridge, 1994
- Principles of Biochemistry by Zubay G.L. Parson W.W. and Vence D.E. Wm C. Brown Publishers Oxford, England, 1995
- Harper's biochemistry by Murray Granne: Mays Rodewell, McGraw Hill Publication, 2000
- Biochemistry by Mathew , C. K. Van Holder, K.E. Ahren K.G. Pearson education Pvt. Ltd., Delhi, India , 2003
- Principles of Biochemistry by Horton H.R., Morsan, L.A. Scrimgeour, K.G., Perry, M.D. Rawn, J.D., Pearson Educations, International, 2006.
- Biochemistry(The Molecular basis of Life) by McKee, T., McKee, J.R. Mc Grew Hill Companying.
- Biochemistry and moleculer Biology by Elliott, W.H. Elliott, D.C. Oxford University Press, Oxford, 2003.
- Lippincott's Illustrated Review by Champe, P.C., Harvey, R.A. Lippincott Williams & Wilkins, Philadelphia



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SEMESTER-I

PAPER –IV BIOSTATISTICS AND BIOINFORMATICS

UNIT-I

1. Introduction to Biostatistics
 - 1.1 Definations of biostatistics
 - 1.2 Statistical symbols
 - 1.3 Scope & Applications of biostatistics
 - 1.4 Collection, organization and representation of data
2. Measure of Variability
 - 2.1 Mean deviation
 - 2.2 Standard deviation
 - 2.3 Variance and coefficient of variation
3. Correlation and Regression
 - 3.1 Types of correlation
 - 3.2 Methods of studying correlation
 - 3.3 Regression analysis
 - 3.4 Uses of regression analysis

UNIT-II

4. Tests of Significance
 - 4.1 Significance of different in means
 - 4.2 Standard error of mean
 - 4.3 Student's t-test
 - 4.4 F-test
5. Chi- square test
 - 5.1 Testing goodness of Fit
 - 5.2 Chi- square distribution and characteristics
 - 5.3 Applications of Chi- square- test
 - 5.4 Yate's correction
6. Analysis of Variance
 - 6.1 One- way classification
 - 6.2 Two- way clasification

UNIT-III

- 7. Introduction of bioinformatics
 - 7.1 Definitions of bioinformatics
 - 7.2 Application of bioinformatics
 - 7.3 Scope of bioinformatics
 - 7.4 Bioinformatics in India

UNIT-IV

- 8. Biological Databases
 - 8.1 Primary, secondary and composite database
 - 8.2 Nucleotide sequence database
 - 8.3 Protein sequence database
 - 8.4 Structural database
- 9. Sequence Analysis
 - 9.1 Types of sequence alignment
 - 9.2 Methods of sequence alignment
 - 9.3 Scoring schemes
 - 9.4 Gaps and gap penalties
- 10. Genomics and proteomics
 - 10.1 Structural genomics
 - 10.2 Functional genomics
 - 10.3 Comparative genomics
 - 10.4 Classification of proteomics
 - 10.5 Data mining in proteomics
 - 10.6 Significance of proteomics

PRACTICALS

- Preparation of frequency tables, histograms, frequency curves, ogives and pie diagrams.
 - Calculation of standard deviation and coefficient of variation.
 - Estimation of significance between sample using Student's t-test, F test and Chi-square test.
 - Plotting of regression lines, calculation of correlation and regression analysis
 - Analysis of variance (One- way & Two-way classification)
 - Study of the tools used in bioinformatics.
 - Retrieve the sequence for the database.
 - Genome sequence techniques.
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- Methods of sequence alignment
 - Nucleotide and protein Sequence database
 - Gene bank flat file format.
 - Data mining in proteomics
 - Class Record
 - Viva-voce

RECOMMENDED BOOKS

- Sokal, R.R. and Rolf F.J. Biometry: Freeman, San Francisco, US
- Snedecor, H.W. and Cochran, W.G. Statistical Methods, Affiliated East- West Press, New Delhi
- Green R.H. Sampling Design and Statistical methods for Environmental Biologist, John Wiley & Sons, New York
- Attwood, T.K. and Parry Smith, D.J. (2006) Introduction Bioinformatics. P 240, Pearson Education, Singapore
- Bourne, P.E. and Weissig, H. (Eds.) (2003) Structural Bioinformatics. P.649, Wiley-Liss, New Jersey, USA
- Lesk, A.M. (2005) Introduction to Bioinformatics. 2nd ed. Oxford Press.
- Krane, D.E and Raymer, M.L. (2006)
- Fundamental concepts of Bioinformatics. P.314, Pearson Education, Singapore
- Mount, D.W. (2001) Bioinformatics: Sequence and Genome Analysis, P.564, Cold Spring Harbor Laboratory Press, New York, USA
- Tisdall J.D. (2001) Beginning Perl for Bioinformatics. p. 368 O'Reilly, California, USA
- David W. Mount, Bioinformatics: Sequence and Genome Analysis Second Edition
- Jae K. Lee Statistical Bioinformatics: A Guide for Life and Biomedical Science Researchers.
- Allan Bluman Elementary Statistics: A Brief Version (5th Edition)



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SEMESTER-II

PAPER –I EVOLUTION AND POPULATION GENETICS

UNIT-I

1. Concepts of evolution and theories of organic evolution (Lamarckism, Darwinism, Mendelism) Evolution in our hands major transitions in Evolution.
2. Neo- Darwinism, Darwinian medicine
 - 2.1 Hardy- Weinberg law of genic equilibrium.
 - 2.2 Detailed account of destabilizing forces- Natural selection, mutation, Genetic drift, Migration, Meiotic drive
 - 2.3 Genetic structure of natural populations
 - 2.4 Phenotypic variations

UNIT-II

3. Genetics of speciation
 - 3.1 Phylogenetic and biological and other concepts of species
 - 3.2 Patterns and mechanisms of reproductive isolation
 - 3.3 Models of speciation (Allopatric, sympatric, parapatric, peipatric)
 - 3.4 Co- evolution and sexual selection , altruism, punctuated equilibrium, Phyletic gradualism
4. Molecular population genetics
 - 4.1 Gene duplication and divergence
 - 4.2 Patterns of change in nucleotide and amino acid sequences
 - 4.3 Ecological significance of molecular variations

UNIT-III

5. Genetics Of Quantitative traits in populations
 - 5.1 Analysis of quantitative traits
 - 5.2 Quantitative traits and natural selection
 - 5.3 Estimation or heritability
 - 5.4 Genotype- environment interactions

5.5 Molecular analysis of quantitative traits

5.6 Phenotypic plasticity

6. Molecular Evolution

6.1 Gene Evolution

6.2 Evolution of gene families

6.3 Molecular drive

UNIT-IV

7. Molecular Phylogenetics

7.1 How to construct phylogenetic trees

7.2 Phylogenetic inference- Distance methods, parsimony methods, maximum likelihood Method

7.3 Immunological techniques

7.4 Amino acid sequence and phylogeny

7.5 Nucleic acid phylogeny- DNA-DNA hybridizations, Restriction Enzyme sites, Nucleotide sequence comparisons and homologies.

7.6 Molecular Clocks.

PRATICALS

Numerical based on theory

SUGGESTED BOOKS

- Genetics and Origin of Species. Dohnzhansky, Th., F.J. Alaya, G.L. Stebbines and J.M. Valentine, Surjeet Publication, Delhi
- Evolutionary Biology, Futuyamma, D.J. Suinuaner Associates, INC Publishers Sunderland.
- A Primer of Population Genetics. Hart, D.L. Suinuaer Associate, Inc, Massachusetts.
- Genes and Evolution. Jha A.P. John Publication, New Delhi
- Species Evolution- The role of chromosomal change. King M. Cambridge University Press, Cambridge.
- Evolution and Genetics Merral, D.J. Holt, Rinchart and Winston, Inc.
- Evolution Genetics Smith, J.M. Oxford University Press, New York.
- Evolution Strickberger, M.W. Jones and Barlett Publishers, Boston London
- Evolution and population genetics, Rashmi Sisodia, Paragon International Publishers.
- Encyclopedia of Evolution Vol I and Vol II By Mark Pagel, Oxford University Press.



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SEMESTER-II

UNIT-I

1. Digestive system:
 - 1.1 Nature of food- stuff
 - 1.2 Various types of digestive enzymes and their action in alimentary canal,
 - 1.3 Absorption and assimilation of food
 - 1.4 Nervous and hormonal control of digestion
 - 1.5 Energy Balance
2. Circulatory system.
 - 2.1 Composition and function of blood,
 - 2.2 Haemopoiesis, blood clotting
 - 2.3 Blood volume, blood volume regulation,
 - 2.4 Immunity, homeostasis
 - 2.5 Comparative anatomy of heart structure,
 - 2.6 Myogenic heart, ECG- its principle and significance, cardiac cycle,
 - 2.7 Heartbeat, blood pressure and blood groups.
3. Respiratory system:
 - 3.1 Respiratory organs (gills, trachea and lungs), respiratory pigments
 - 3.2 Mechanism of breathing,
 - 3.3 Physiology of respiration, control of breathing,
 - 3.4 Aerodynamics and BMR.

UNIT-II

4. Excretory system:
 - 4.1 Comparative physiology of excretion,
 - 4.2 Functional architecture of kidney and nephron,
 - 4.3 Nitrogenous end products, formation of urine and its hormonal control.
 - 4.4 Role of kidney in osmoregulation, urine concentration
 - 4.5 Waste elimination micturition
 - 4.6 Electrolyte balance, acid- base balance.
5. Muscular system:
 - 5.1 Types and properties of muscles,
 - 5.2 Functional architecture of skeletal muscles,

5.3 Biophysical and biochemical events during muscular activity.

6. Nervous system:

- 6.1 Functional architecture of neurons,
- 6.2 Origin and propagation of nerve impulse through axon,
- 6.3 Action potential, synaptic transmission,
- 6.4 Reflex arc and reflex action,
- 6.5 Gross neuroanatomy of the brain and spinal cord,
- 6.6 Central and peripheral nervous system.
- 6.7 Neural control of muscle tone and posture.

UNIT-III

7. Sense organs:

- 7.1 Structural architecture and functioning of eyes and ears,
- 7.2 Tactile response.

8. Thermoregulation and cold tolerance.

- 8.1 Heat balance and exchange, endotherms vs ectotherms,
- 8.2 Counter-current heat exchange,
- 8.3 Torpor, hibernation and estivation,
- 8.4 Adaptations to extreme climate,
- 8.5 Comfort zone, body temperature- physical, chemical and neural regulation.

9. Stress:

- 9.1 Basic concepts of environmental stress and strain,
- 9.2 Homeostasis, physiological response to body exercise,
- 9.3 Meditation, yoga and their effects.

UNIT-IV

10. Endocrinology:

- 10.1 Endocrine glands in vertebrates, hormones and related diseases.

11. Reproduction

- 11.1 Reproductive cycle,
- 11.2 Reproductive processes (implantation, parturition and lactation), neuroendocrine regulators in insects and mammals, pheromones.

PRACTICALS

- Demonstration of the use and operation of oscilloscope for recording neuroelectric activity and electrocardiogram.
- Kymographic recording of muscle twitch, summation of twitches, chronic contractions, tetanus, fatigue and stair- case phenomenon from the sciatic nerve gastrocnemius muscle preparation of frog.
- Demonstration of Kymographic recording of the frog heart beat and the study of the effect of electrical stimulation. Hot and cold, drugs, etc,
- Study of spinal and convulsive reflexes in frog.
- In case, frogs become available students may be asked to perform the various exercises. Otherwise following CAL exercise may be included (Please see E – pharm programme)
 - The effect of K^+ , Ca^{++} , Ach and Epinephrine on the isolated heart of frog and conclude your data with the graphic representation
 - The effect of various doses of Ach and Nor- epinephrine on Blood pressure, Heart Rate and Respiratory Rate of the dog.
 - The effects of Atropine, Epinephrine, Ephedrine and Eserine on Rabbit's eyes and other such exercise can be from the E- Pharm software.
- Photometric determination of haemoglobin in blood sample.
- Determination of MCV, MCH, MCHC and colour index of the given sample of blood.
- Demonstration of the blood clotting time erythrocyte sedimentation rate, haemolysis and crenation
- Determination of the urea in urine.
- Determination of the glucose in urine.
- Radiation uptake in various tissues: elementary idea of using radioactivity detection instruments.
- Study of digestive enzyme in different parts of the alimentary canal.

SUGGESTED BOOKS

- Eckert Animal Physiology Mechanisms and Adaptation R Eckert (ed) 5th Edition W.H. Freeman and Company, New York.
- Biochemical adaptation P.W. Hochachka and G.N. Somero (eds), Princeton Univ. Press, Princeton, New Jersey.
- General and Comparative Animal Physiology, W.S. Hoar(ed), Prentice Hall of Indian.
- Animal Physiology: Adaptation and Environment, K.S. SchiemdtNielsen (ed), University Press, Cambridge,U.K.
- A regulatory Systems Approach Strand, F.L. Physiology: Macmillan Publishing Co; New York
- Practical Biochemistry, L. Lummer (ed), Tata McGraw Hill
- Environment Physiology, P. Willmer, G. Stone and I. Johnson (eds), Blackwell Publishing, Oxford,UK.
- Adaptation to Environment: Essays on the Physiology of Marine Animals. R.C. Newell (ed), 1976. Butterworths, London,UK.
- Physiological Ecology: An evolutionally approach to resource use. Townsend, C.R. and P. Cawlow. Blackwell Sci. Inc. Pub., Oxford, UK.
- Optima for Animals. R.M. Alexander (ed), Princeton Univ. Press. Princeton, New jersey.
- Comparative Physiology: Life in water or land. P. Dejours.L. Boils, C.R. Taylor and E.R. Weibel (Eds), Liviana Press, Padova, Italy
- Animals and Temperature: Phenotypic and Evolutionary Adaptation I.A. Johnson & A.F. Bennett (eds), Cambridge Univ. Press, Cambridge UK.
- Physiological Animal Ecology. G.N. Lonw, Longman Publishing Group, Harloss, UK.
- An Introduction to General and Comparative Endocrinology , E.J.W. Barrington (ed), Clarendon Press, Oxford
- Comparative Vertebrate to Endocrinology. P.J. Bentley (ed) Cambridge University Press.
- Text Book of Endocrinology, R.H. Williams (ed), W.B. Saunders, Company.
- Endocrine Physiology. C.R. Martin (ed), Oxford Univ. Press, New Year
- Comparative Endocrinology A Gorbman et al, John Wiley & Sons.



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SEMESTER-II

PAPER –III MOLECULAR BIOLOGY & BIOTECHNOLOGY

UNIT-I

1. DNA replication
 - 1.1 Prokaryotic and eukaryotic DNA replication.
 - 1.2 Mechanics of DNA replication.
 - 1.3 Enzymes and accessory proteins involved in DNA replication.
2. Recombination and repair.
 - 2.1 Holiday junction.

 - 2.2 FLP/FRT and Cre-Lox recombination.
 - 2.3 Rec A and other recombinases.
 - 2.4 DNA repair mechanisms.

UNIT-II

3. Transcription.
 - 3.1 Prokaryotic transcription.
 - 3.2 Eukaryotic transcription.
 - 3.3 Regulatory elements and mechanisms of transcription regulation.
 - 3.4 Transcription termination- attenuation and antitermination.
4. Post- transcriptional modifications in RNA
 - 4.1 5- Cap formation.
 - 4.2 End processing and polyadenylation.
 - 4.3 Splicing and editing.
 - 4.4 Nuclear export of mRNA.
 - 4.5 RNA stability.

UNIT-III

5. Translation

- 5.1 Genetic code
- 5.2 Prokaryotic and eukaryotic translation
- 5.3 Regulation of translation
- 5.4 Co- and post- translation modifications of proteins.

6. Proteins sorting Organelle biogenesis and protein synthesis.

- 6.1 Synthesis and targeting of mitochondrial and chloroplast protein
- 6.2 Synthesis and targeting of peroxisomal proteins.
- 6.3 Secretory pathways
- 6.4 Translocation of secretory proteins across the ER membrane
- 6.5 Insertion of membrane proteins in the ER membrane
- 6.6 Post- translation modifications in rER.
- 6.7 Protein glycosylation in ER and Golgi complex.
- 6.8 Golgi and post- Golgi protein sorting and proteolytic processing
- 6.9 Receptors- mediated endocytosis and sorting of internalized proteins
- 6.10 Molecular mechanisms of vesicular traffic.

UNIT-IV

7. Molecular mapping of genome

- 7.1 Genetic and physical maps.
- 7.2 Southern hybridization, fluorescence in situ hybridization (FISH) for genome analysis.
- 7.3 Molecular markers in genome analysis (RFLP, RAPD and AFLP)
- 7.4 Application of RFLP in forensic, disease prognosis, genetic counseling and pedigree analysis.

8. Transgenic animals and knock- outs.

8.1 Production

8.2 Applications

8.3 Embryonic stem cells

8.4 Bioethics

9. Assisted reproduction technologies.

9.1 Embryo sexing and cloning

9.2 Screening for genetic disorders.

9.3 ICSI, GIFT etc.

9.4 Cloning of animals by nuclear transfer.

PRACTICALS

- Squash and smear preparation of testis of cockroach/ grasshopper aceto-orcein and Fuelgen staining of these preparations.
- Study of mitosis in onion root tip and meiosis in testes of insect or mammal.
- Study of giant chromosomes in the salivary gland of Chironomus larva of Drosophila
- Vital and supravitalstaining(with Neutral red and Janus green (B) of cells of the testis of an insects to mammal to study the mitochondria.
- Preparation of multipopularnerve cell form the spinal cord a mammal.
- Study of prepared microscope slides, including those showing various cell types, mitosis and giant chromosomes.

SUGGESTED BOOKS

- Molecular Biology of the Gene. I.D. Waston, N.H. Hopkins, J.W. Roberts, J.A. Steiz and AM Weiner The Benjamin/ Cummings Pub. Co., Inc. California.
- Molecular Cell Biology, J. Damell H. Lodish and D. Baltimore Scientific American Books, Inc., USA.
- Molecular Biology of the cell. B. Alberts D.D. Bray, J. Lewis, M. Rafif, K. Roberts and J.D. Watson. Garland Publishing inc., New York.
- Gene IV, Benjamin Lewin. Oxford University Press, UK.
- Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (ed.) VCH publishers, Inc., New York.
- Molecular cloning: A Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold spring Harbor Laboratory Press, New York.
- Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd. New York.
- Molecular Biology Lab fax, T.A. Brown (ed), Bios Scientific Publishers Ltd. Oxford.



**SHRI JAGDISHPRASAD JHABARMAL TIBREWALA
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SEMESTER-II

PAPER –IV ECONOMIC ZOOLOGY

UNIT-I

1. Economic importance of Protozoa: Beneficial and Harmful Protozoa.
2. Economic importance of Helminthes: Beneficial and Harmful Helminthes.
3. Economic importance of Arthropods: Beneficial and Harmful mites and ticks, crustaceans, spiders, insects.
4. Insects as pollination, ornamental insects, as food.
5. Lac insect, Honey bees, Silk worm and industries related to them.
6. Harmful insects- Insect pests: pests, storage pests, pests of fruits and vegetables, Pests of medical and veterinary importance and their management.

UNIT-II

7. Pisciculture and products of fishing industry.

7.1 Common Freshwater and Marine Food Fishes of India

7.2 Freshwater Aquarium, Common Freshwater aquarium Fishes.

7.3 Exotic Food and Game Fishes.

8. Prawn fisheries.

9. Economic importance of Mollusca : Pearl Culture.

UNIT-III

10 Poultry keeping and Duck poultry.

11 Dairy farming and Piggery.

12 Leather industry, wool industry, (Fur and Fur Industry)

UNIT-IV

- 13 Pharmaceuticals from animals(Snake venom.)
- 14 Wild life in India and its conservation and Significance.
- 15 Economic Importance of Mammals (Rodents and their management)

PRACTICALS

- General introduction to stains, preservations and fixatives.
- Museum specimens
 - Protozoa- Selected species of economic importance
 - Platehelminthes –Selected species of economic impotance
 - Arthropoda- Mites, Ticks, Spiders, Insects
- Permanent preparations- Whole mounts, various body parts/Appendages
- Visit to fish industry/Poultry farm/Dairy/Leather industry etc.
- Viva voce.
- Record

RECOMMENDED BOOKS:

- Economic Zoology by G.S Shukla&Upadhyay, 1991-92 Rastogi Publications, Meerut, India
Fish& Fishers by KamaleshwarPandey& J.P. Shukla 2007.Rastogi Publications, Meerut, India
- Fish& Fisheries of India by V.G. Jhingran 1982, Hindustan Pub. Corp. India.
A hand book on Economic Zoology by JawidAhsan and Subhas Prasad Sinha, S. Chand & company Ltd. Ramnagar.



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SEMESTER-III

PAPER –I BIOLOGY OF CHORDATES

UNIT-I

1. Origin and outline classification of the chordates.
2. Salient features and interrelationships of Hemichordata, Urochordata and Cephalochordata.
3. Origin, evolution and adaptive radiation of chordates.
4. Origin evolution and general characters of Agnatha: Ostrachoderms and Cyclostoms.
5. The early Gnathostomes(placoderms).

UNIT-II

6. A general account of the Elasmobranchil, Holocephali, Dipnoi and Crosspterygil.
7. Adaptive radiation in bony fishes.
8. Crigin, evolution and adaptive radiation of Amphibia
9. Parental care in Amphibia
10. Neotany in Amphibia

UNIT-III

11. Origin and evolution of Reptiles: Seymouria and Cotylosuuria
12. Skull of Reptiles
13. Venom in Ophidian
14. Dinosaurs.
15. Living reptiles : a brief of RhynchocephaliaChelonia, Crocodile and Squamata.

UNIT-IV

16. Origin and evolution of birds.
17. Origin of flight: Flight adaptation.
18. Flightless Birds.
19. Modifications of Beak, feet and Palata in Birds,
20. Origins of mammals: Primitive mammals (Prototheria and Metatheria)

21. General account on adaptive radiations in Eutherian mammals.
22. Evolution of man.

PRACTICALS

1. Virtual dissections using computer software.

Dissections:

- Cranial Nerves of Wallagoattu or any other locally abundant fish
- Neural Complex of Herdmania
- Accessory respiratory organs of Heteropustes fossilis
- Labyrinthine organs of Anabas estuinus

2. Museum specimens:

Lower Chordates: Salpa Asexual and Sexual stage, Dolliolumoozoid, Botrylus, Herdmania, and Amphioxus.

Pisces: Petromyzon, MyxineRhinobatus, Pristis, Trygon, Chimaera, Polydon, Acipenser, Amia, Lepidosteus, Protoperus, Lepidosiren, Neoceratodus, Notopterus, Exocoetelus, Echeneis, Pieuroneustes, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophicephalus

Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotl, Salamander, Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus, Rana.

Reptilia: Testudo, Chelonea, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus, Chamaleon, Cobra, Hydrophis, Rattle Snake, Viper, Pit Viper, Krait, Eryx, Gravidalis.

Aves: Taylor Byrd, Indiana Hoel, Jungle fol, Pavois, Columbia, Psittacide, Wood paquer, Bubo (Horme l), Archeopteryx, Flamingant.

Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mongoose, Hystrix Otter.

3. Microscopic Slides.

Lower Chordates: Herdmania specular, Herdmania tadpole larva, Amphioxus T.S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoetelarve whole mount.

Pisces: Placod scale, Cycloid scale, Ctenoid scale.

Amphibia: V.S. skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, scale, kidney, testes, ovary, spinal cord, bone,

Reptelia: V S skin of bird of Lizard.

Aves: V S skin bird, contour feather, down feather,

Mammals: V S skin of mammals, T S passing through stomach, interstine, liver, pancreas, kidney, testes, ovary, thyoid gland, adrenal gland, lung bone, spinal cord, Blood smear, Simple cuboidal epithelium, Simple columnar epithelium, Simple squamous epithelium Adiposetissue, Reticular tissue.

4.Comparative Osteology Comparative account of Axial and Appendicular skeletons of Frog.Varanus, Fowl and Rabbit (both articulated and disarticulated).

Skull of Reptiles(Anapside and disarticulated).

Palate in Birds.

Skull and lower jaw of Carnivore mammal & herbivore mammal.

SUGGESTED BOOKS

- The chordate, Alexander, R.M. Cambridge University Press, London.
- The Biology of Hemichordata and Protochordata. Barrington. E.J.W. Olter and Boyd. Edinhourgh.
- Structure and Habit in vertebrate evolution- carter, G.S. Sedwick and Jackson. London.
- Comparative anatomy of vertebrates. Kent .C.G.
- Chordate morphology. Malcom Jollie. East- West Press Pvt. Ltd., New Delhi.
- Analysis of vertebrate structure. Milton Hilderhrand. John Wiley and Sons., inc, New York
- Text Book of Zoology, Sedgwick, A.A. Students Vol.II.
- Vertebrate Body. Romer A.S.W.B. Saunders Co.Philadelphia.
- Life of Vertebrate, Young. J.Z. The Oxford University Press. London.
- Life of mammals, Young J.Z. The Oxford University Press. London.
- Evolution of the verebrates, Colbert E.H. John Wiley and Sons Inc. New York.
- Chordata structure and function. Waterman. A.J. Macmillan Co. New Yok.
- Vertebrate evolution. Joyey. K.A. and T.S. Kemp. Oliver and Boyd. Edinbourgh.
- The Phylogeny of vertebrate. Lovtrup. S. John Wiley and Sons. London
- The biology of the Amphibla, Kingsley Noble G. Dover Publication. New York.
- Avian Biology(in several volumes),Farmer, D.S. and King, J.R., Academic Press, New York,1995
- Analysis of Vertebrate Structure, Hildebrand, M. 4th edition, John Wiley & Sons, Inc., New York,1995.
- Biology and Comparative Physilogy of Birds, Marshall, A. J. Volume I & II, 1960
- Vertebrate Life, McFarland W.N. Pough, F.H, Cade, T.J. and Heiser, J.B., Macmillan Publishing Co., Inc., New York, 1979.
- Text Book of Zoology, Parker, T.S. and Haswell, W.A. ELBS, 1978



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SEMESTER-III

PAPER –II GENES AND DIFFRENTIOATION

UNIT-I

1. Introduction to animal development
 - 1.1 Problems of development biology
 - 1.2 Develop patterns in metazoans
 - 1.3 development in unicellular eukaryotes
2. Creating multicellularity
 - 2.1 Cleavage types
 - 2.2 Comparative account of gastrulation
3. Early vertebrate development
 - 3.1 Neurulation and ectoderm
 - 3.2 Mesoderm and endoderm
4. Cytoplasmic determinants and autonomous cell specification
 - 4.1 Cell commitment and differentiation
 - 4.2 Cell specification in nematodes
 - 4.3 Germ cell determinants
 - 4.4 Germ cell Migration.
 - 4.5 Progressive cell- cell interaction and cell specification fate.

UNIT-II

5. Body Axes
 - 5.1 Establishment of body axes in mammals and birds.
 - 5.2 Proximate tissue interactions
 - 5.3 Genetics of axis specifications in Drosophila
6. Homeobox concept in different phylogenetic groups.
7. Tetrapod limb development
8. Hormones as mediators of development
 - 8.1 Amphibian metamorphosis
 - 8.2 Insect metamorphosis
 - 8.3 Ovarian luteinization and mammary gland differentiation.

UNIT-III

9. Environmental evolution and animal development.
 - 9.1 Environmental cues and effects.
 - 9.2 Malformations and disruptions.
 - 9.3 Changing evolution through development modularity.
 - 9.4 Developmental constraints.
 - 9.5 Creating new cell types- basic evolutionary mystery.
10. Biology of sex determination
 - 10.1 Mammals and *Drosophila*.
 - 10.2 Testis determination genes
 - 10.3 Ovarin development
 - 10.4 Secondary sex determination in mammals.
 - 10.5 Environmental sex determination.

UNIT—IV

11. Cell diversification in early embryo.
 - 11.1 *Xenopus* blastomeres
 - 11.2 Morphogen gradients
 - 11.3 Totipotency & Pluripotency
 - 11.4 Embryonic stem cells.
 - 11.5 Renewal by stem cells- epidermis
 - 11.6 Skeletal muscle regeneration
 - 11.7 Connective tissue cell family.
12. Hemopoietic stem cells.
 - 12.1 Stem cell disorders.
 - 12.2 Blood cell formation
 - 12.3 Bone marrow transplants
 - 12.4 Gene therapy

PRACTICALS

- Identification of male and female *Drosophila*
- Identification of wild and mutant forms of *Drosophila*
- Monohybrid and dihybrid inheritance in *Drosophila*
- Simple problems based on mendalism to be done by the students.
- Identifications of blood groups in man.
- Demonstration of sex chromatin.
- Embryology of Frog
- Embryology of Chick

SUGGESTED BOOKS

- Development Biology S.F. Gilbert, Sinauer Associates Inc. Massachusetts
- Morphogenesis of vertebrate. Torrey, T.W. John. Wiley and Sons Inc., New York and London
- An Introduction to embryology, Balinsky, B.I: W.B. Saunders Comp.,?
- Davidson, E.H. : Gene activity in early development. Academic Press, New York.,
- Modern embryology, Bodemer, C.W. : Holt Chart and Winston, Inc. New York; Chicago
- Principle of animal development Biology. Geol, S.C. Himalaya, Publishers 1984.
- Metamorphosis, Etkin, W.L.I. Gilbert: North- Holland Co., Amsterdam.
- Development Biology R.M. Twyman. Viva Books Private Limited. New Delhi.
- From egg to Embryo. Slack J.M.W. Cambridge University Press, Cambridge UK.
- Principles of Development Wolpert, L. Oxford University Press, Oxford, UK.



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SEMESTER-IV

PAPER –I -ENVIRONMENTAL BIOLOGY AND ETHOLOGY

UNIT-I

1. Ecological law of minimum and law of tolerance
2. Ecological niches, overlapping of niches, ecotone
3. Energy flow, food chain, food web and trophic levels, ecological pyramids
4. Nutrient cycles in nature- carbon, nitrogen, phosphorus and water,
5. Ecozones of India- habitat and fauna
6. Population ecology:
 - 6.1 Characteristics of a population.
 - 6.2 Population growth curves, population regulation
 - 6.3 Life history strategies (r and K selection)
7. Environmental Pollution- air, water, noise and radiation (electromagnetic and ionizing); carbon foot print

UNIT-II

8. Biodiversity:
 - 8.1 Species diversity, ecosystem diversity, genetic diversity and molecular Diversity.
 - 8.2 Alpha, Beta and Gamma Diversity
 - 8.3 Biodiversity indices. Measuring- species richness, species evenness Simpson's diversity Index and Shannon's diversity index.
 - 8.4 Biodiversity act of India and Biodiversity hot spots in India (with special reference to Western Ghats and North east), UNESCO heritage sites (Kaziranga National park)
9. Ecological communities: (succession, zonation, environment, biota and adaptations)
 - 9.1 Terrestrial
 - 9.2 Fresh water
 - 9.3 Marine and estuarine
10. Climatic changes- El Nino and La Nina, Earth quacks and Tunami
11. Elementary knowledge of : Wildlife acts and schedules, CITIES, TRAFFIC, WWF, Ramsar

Convention, IUCN, ZAI, ENVIS, IGCMC, Project Tiger, Biosphere reserves world heritage sites and

Hot spots.

UNIT-III

12. Scientists and their works: Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Skinner B F and Harlow Harry, Richard Dawkins, EO Wilson, Desmond Morris.

13. Concepts of Ethology (SS, FAP, ASE, IRM) , Flush Toilet model; Genes and behavior; Evolution of behavior, Development of behavior

14. Neuroethology:

14.1 Methods of studying brain and behavior: neuroanatomical, neurophysiological and neurochemical

14.2 Basic knowledge of EEG, LASER, PET, CAT, MRI and nuclear medicine imaging

14.3 Mammalian Brain and Behaviour, Limbic system and hypothalamus

14.4 Sleep- arousal and reticular formation

15. Definition of Social behavior

15.1 Properties and advantages of social grouping social group on monkeys

15.2 Sociobiology- Darwinian fitness, individual fitness, kin selection, group selection, cooperation,

Reciprocation, altruism, reciprocal altruism, Proximate and Ultimate and Ultimate causations

15.3 Home range, territory, core area and aggression

15.4 Human behavior

UNIT-IV

16. Feeding and sexual strategies in animals

17. Parental care in animals

18. Communication in animals- vocal, tactile, visual and chemical

19. Learning:

19.1 Introduction and definition

19.2 Types- Habituation, trial and error, conditioning, cognition and imprinting

19.3 Short and long term memory, neural mechanism of learning

PRACTICALS

- Estimation of alkalinity, acidity, dissolved oxygen, chloride Ph in water, nitrogen, phosphorous
- Microbial analysis in soil
- Limnological study of a local water body submission of written report
- Study of movement of fish in aquarium
- Study of courtship in birds
- Food preference in tribolium
- Pheromones in earthworms
- Study of imprinting in chick.

SUGGESTED BOOKS

- Ecology, Individuals. Populations and Communities Begon. M., J.I., Harper and C.R. Townsend, Blackwell Science. Oxford U,
- Ecological concepts. Cherrett, J.M. Blackwell Sci. Publi. Oxford U.K.
- Population biology. Elseth B.D. and K.M. Baumgartner. Van Nostrand Co., New York.
- Fundamentals of ecological modeling. Jorgenson. SE. Elsevier. New”
- Animal behavior: A synthesis of ethology and comparative psychology. Hinde. R.A. McGraw- Hill. New York.
- Behavioural ecology: Krebs J.R. and N.B. Davis : Blackwell. Oxford.U.K.
- Sociology: The new synthesis, Wilson. E.O. Harbard Univ. Press. Cambridge. Mass. USA
- A New Ecology- systems Perspective
Sven Erik Jorgensen, Brain Fath, Simone Bastianoni, Joao Marques, Felix Muller, S. Nors Nielsen, Bernard Pattern, EnzoTiezzi and Robert Ulanowicz
Elsevier May 2007
- Ecological Census Techniques – A Handbook (2nd edition)
Edited by William J. Sutherland
CUP August 2006
- The Life of mammals (Life of Mammals)
by David Attenborough
- Alcock, John. Animal behavior- an evolutionary approach.(Sinauer Associates).
547 pages
- Barnard, C.J, Animal behavior. (Croom Helm, London). 340 Pages
- Barnett, S.A. Modern Ethology
- Chauvin, Remy. Ethology: The biological study of animal Behavior.
(International Univ. Press).245 pages.

- Colgan, Patric W. Quantitative Ethology.
- Immelman, C. Introduction to Ethology.
- Manning, Aubrey. An Introduction to animal behavior. (Edward Arnold Publ. London). 208 Pages
- 18. Manning, Aubrey. An introduction to animal behaviour. (Addison- Wesley Publ., Co. 294 Pages
- 19. McFarland, David. Animal behaviour : Psychology, Ethology & Evolution (ELBS Publ.)
- 20. Slater, P.J.B.. Essentials of animal behaviour. (Cambridge Univ. Press). 233 Pages.
- 21. Wallace, Robert A.. The ecology and evolution of animal behavior.
(Good year Publ. Co. Inc.) 284 Pages
- Fundamentals of Ecology by Eugene Odum, Gary W. Barrett, Hardcover: 624 pages, Brooks Cole
- The Science of Ecology by Richard Brewer, Hardcover: 816 pages, Publisher Brooks Cole
- Applied Ecology and Environment Management(2ND 00) Edward I. Newman (Paperback ISBN 10: 0632042656; ISBN 13: 9780632042654)
- Applied Ecology and Natural Resources Management (03) Guy R. Mcpherson and Stephen DeStefano ISB 10: 051105811X ; ISBN 13: 978051105810)
- Essentials of Ecology C Townsend, M Begon, J L Harper



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SEMESTER-IV

PAPER –II TOOLS & TECHNIQUES

UNIT-I

1. Principle, construction and application of
 - 1.1 Light Microscopy
 - 1.2 Phase contrast Microscopy
 - 1.3 Interference Microscopy
 - 1.4 Polarized Microscopy
 - 1.5 Fluorescence Microscopy
 - 1.6 Electron Microscopy (TEM+SEM)
 - 1.7 Confocal and Atomic Force Microscopy

UNIT-II

2. Electrophoresis; Principle, construction, application and equipment used
 - 2.1 Various types such as; paper, agarose, PAGE, submerged DNA, Pulse chase
 - 2.2 Isoelectric focusing points and capillary electrophoresis
 - 2.3 Various media for Electrophoresis
3. Chromatography; Principle, construction, application and equipment used
 - 3.1 Various types such as; paper, TLC, GLC, HPLC, Ion- Exchange and affinity chromatography.

UNIT-III

4. Colorimetry and Spectrophotometry; Principle, construction, application and equipment used
 - 4.1 Various type such as; fluorescence, UV, IR, Atomic Absorption
 - 4.2 Lamert- Beer's Law
5. Principle and application of radiations in biology
 - 5.1 Radiation Dosimetry and equipment used for it
 - 5.2 Radioisotopes, type, characteristics and uses it
 - 5.3 Tracer techniques in brology
 - 5.4 Scintillation techniques.

UNIT-IV

6. Principle of cytological and cytochemical techniques
 - 6.1 Fixation, chemical basis of fixation by formaldehyde, gluteraldehyde, chromium salts, mercury salts, osmium salts, alcohol and acetone.
 - 6.2 Chemical basis of Staining of carbohydrates, proteins lipids and nucleic acids.
7. Cell and Tissue Culture techniques
 - 7.1 Design and functioning of tissue culture laboratory
 - 7.2 Cell proliferation measurements
 - 7.3 Cell viability testing
 - 7.4 Culture media preparation and harvesting techniques.

PRACTICALS

- Demonstration of different types of Microscopes
- Demonstration of different types of Spectrophotometers
- Demonstration of Chromatographic equipment
- Demonstration of Electrophoresis equipment.
- Visit to tissue culture lab
- Some exercise based on the syllabi may be devised according to the availability of equipments.

SUGGESTED BOOKS

- Principle and Techniques of Practical Biochemistry; Wilson & Keith Cambridge Publications
- Biotechniques; Theory and Practice; SVS Rana. Rastogi Publications, Meerut
- Clinical Biochemistry; Techniques and Instrumentation, JS Varcoe, World Scientific Publication Company, ISBN; 978-981-02-4556-6



**SHRI JAGDISHPRASAD JHABARMAL TIBREWALA
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CO PAPER –I – ENTOMOLOGY

Insect systematic and taxonomy and insect ecology

UNIT-I

1. Historical review of insect classification. Basis of insect classification
Phylogeny of Arthropoda and Hexopoda. Introduction to primitive insects.
2. Detailed classification of important and selected super families of the following orders-
Orthoptera, Isoptera, Hemiptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera

UNIT-II

3. Social life in Isoptera and Hymenoptera. Life cycle of locusts and aphids
4. Origin and evolution of insects with special reference to fossil insects. Cause of success of insects.

UNIT-III

5. Ecology of Insects-
 - (a) Effect of physical factors.
 - (b) Intra and specific relation. (Biotic Factors)
 - (c) Insect plant interaction.

UNIT-IV

6. Population ecology. Population dynamics. Size, fluctuation, biogeography, community ecology, species interaction, community, structure, diversity.
7. Biochemical adaptations to environmental stress (metamorphosis, diapause, polymorphisms, swarms, outbreaks and migration).



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CO PAPER –II – ENTOMOLOGY

Insect morphology, Physiology, embryology and development

UNIT-I

1. General organization of insect body.
 - 1.1 Integument
 - 1.2 Head suture and area of cranium, tentorium Gnathal appendages
 - 1.3 Thorax: legs and their modifications, wings and wing coupling.

UNIT-II

2. (a) Digestive system.
 - 2.1 Alimentary canal and its modifications
 - 2.2 Physiology of digestion.
3. Physiology of circulatory system.
4. Excretory system and its modifications
5. Respiratory system and its modification s, adaptations for aquatic respiration.

UNIT-III

6. Nervous system and its modifications
7. Morphology and physiology of neuroendocrine systems
8. Sense organs: Mechanoreceptors, Chemoreceptor
9. Auditory organs, light producing organ, sound producing organ, visual organ (Compound eye and ocelli).
10. Muscular system and distribution of muscles

UNIT-IV

11. Reproductive system. Morphology and physiology of male and female, reproductive system, its associated ducts and gland and external genitalie.
12. Embryology:- Structure of egg. Embryonic and embryonic development.
13. Types of larvae, pupae and metamorphosis



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CO PAPER –III – ENTOMOLOGY

Economic entomology

UNIT-I

1. Concept of pest. How and why insects have become pests?
2. Bionomics, distribution; mode of damage and management of major pests.

UNIT-II

3. Cash crops: sugar cane, tobacco and mustered, come,
4. Cereal crops: wheat, paddy, millet, maize, sorghum, pulse,

UNIT-III

5. Pests of vegetables, fruits and oil seed crops.
6. Pests of medical (stored grains and milled products).
7. Storage pests (stored grains and milled products).

UNIT-IV

8. Forensic entomology with special reference to man and wild life.
9. Beneficial insects (silk worm, honey bee, lac insect and industries related to them).



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CO PAPER –IV – - ELECTIVE/SPECIAL PAPER- ENTOMOLOGY

Insect to xicology and pest control

UNIT-I

1. Definition and history of various methods of insect pest control
 - 1.1 Physical
 - 1.2 Mechanical
 - 1.3 Chemical
 - 1.4 Cultural
 - 1.5 Quarantine regulation

UNIT-II

2. Nomenclature and classification of insecticides Concept of
 - 2.1 Ist, IInd and IIIrd generation pesticides
 - 2.2 Pesticides act of India.
 - 2.3 Selection of insecticides, their formulation and mode of action.
3. Preventive measures and antidotes
4. Fumigants and appliances used for application of insecticides.
5. Mechanism of insecticides resistance in insects. insecticide synergists and antagonist.

UNIT-III

6. Biological control:
 - 6.1 Definition, biological control agents.
7. Parasites:
 - 7.1 Parasitoids
 - 7.2 Predators

7.3 Microbial pesticides

7.4 Mass production and distribution

7.5 Advantages and disadvantages of biological control.

UNIT-IV

8. Integrated pest management (IPM)

8.1 Definition, Importance,

8.2 Tolls, basic principles

8.3 Evolutionary trends.

(b) Dynamics of environmental pollution.

9. Pesticides:

9.1 Their impact on wild life

9.2 Their impact on human health (bio accumulation, bio magnification, biodegradation)

PRACTICALS: SEMESTER III& IV

1. Dissection

- a. Cockroach- Endocrine complex, Nervous System, Alimentary Canal
- b. Gryllus – Nervous System, Alimentary Canal
- c. Poecilocerous pictus- Nervous System, Alimentary Canal
- d. Honey bee- Nervous System
- e. Butter fly- Nervous System
- f. White grub- Nervous System
- g. House fly- Nervous system

2. Permanent preparation

- a. Sting apparatus(Honey bee)
- b. Pollen basket (Honey bee)
- c. Mouth parts
 1. Piercing & sucking – (Mosquito)
 2. Siphoning- (Butterfly)
 3. Chewing & lapping – (Honey bee)
 4. Sponging- (Housefly)
 5. Biting & Chewing – (Cockroach)
- d. Tympanum (Grasshopper)
- e. Spiracle (Grasshopper)
- f. Antennae(Mosquito, house fly, honey bee, butterfly, beetle, grasshopper, bug, cockroach)
- g. Legs (All insects as given above)
- h. Wings (Mosquito, house fly, honey bee, Grasshopper, bug, cockroach)
- i. Whole mounts of insects(Lice, ants, aphids, termite, bedbug, thrips, mosquito etc.)

3. Appliances for application of insecticides.

- (i) Knap sack sprayer
- (ii) Knap sac duster
- (iii) Hand sprayer

4. Insect rearing

- (i) Tribolium
- (ii) Rhizopertha
- (iii) Heliothis armigera
- (iv) Corcyra
- (v) Callosobruchus spp
- (vi) Lesiodermaserricornse

5. Testing of insecticide- Bioassay method

6. study of prepared slides

- (i) Whole mount of insects
- (ii) Legs
- (iii) Mouth Parts
- (iv) Wings

(v) Histology

(Vi) Antennae

7. Museum study
8. Microtomy
9. Field trips for insects collection
10. Collection and preservation of insects
11. Bioassay

Spots

1. Insects of economic importance.
2. Morphological adaptation
3. Whole mount insects slide.
4. Histology slide
5. Specialized organ (Antennae / leg/ mouth parts)
6. Insects identification and rearing
7. Appliance for application of insecticide



**SHRI JAGDISHPRASAD JHABARMAL TIBREWALA
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CO PAPER A-I – Environmental Biology

Atmosphere, ecosystems, resources and conservation

UNIT-I

1. Environment

- 1.1 Earth (core, mantle, tectonic plates) ; atmosphere,-Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere
- 1.2 Climate, koppen scale
- 1.3 Cloud types and winds easterly, westerly, Beaufort wind force scale, Fujita, Scale
- 1.4 Mountain building and evolution of continents.

2. Biomes

- 2.2 Desert
- 2.3 Grassland
- 2.4 Tundra
- 2.5 Tropical and temperate forests
- 2.6 Deciduous and evergreen rain forests
- 2.7 Ecozones of India.

UNIT-II

3. Ecosystem

- 3.1 Eco system dynamic, concept of ecosystem
- 3.2 Types of ecosystem
- 3.3 Human ecosystem, man made ecosystem on earth- urban rural, a agriculture and industrial ecosystem
- 3.4 Impact of growing population
- 3.5 Role of human faith and tradition in ecosystem preservation

4. Aquatic ecosystem (zones and adaptations)

- 4.1 Fresh water (Limnetic) – lakes (lacustrine) and rivers (riverine)
- 4.2 Wetland (Palustrine) : sunderban (Estuarine), kaeoladeo (FW) and sambhar lake (SW)
- 4.3 Estuaries: Chika, Kerala Backwaters
- 4.4 Marine zonation, animals and adaptations
- 4.5 Coral reef: Great barrier reef, Lakshadweep and the Gulf of Mannar

UNIT-III

5. Species interactions:
 - 5.1 Herbivory, Carnivory, parasites
 - 5.2 Prey- Predator
 - 5.3 Commensalisms, mutualism, Symbiosis

6. Non conventional renewable resources.
 - 6.1 Solar
 - 6.2 wind
 - 6.3 water/ Tidal
 - 6.4 solid biomass
 - 6.5 geothermal
 - 6.6 bio fuel, biogas, field crops specially corn
 - 6.7 green data book

UNIT-IV

7. Conservation
 - 7.1 Environmental degradation, role of man in changing the environment
 - 7.2 IUCN classification of endangered species, red data book,
 - 7.3 Restoration of wildlife populations by reintroduction (Soft and hard release) and Captive breeding
 - 7.4 in situ and ex situ conservation
8. Basic knowledge of national and international organizations:
 - 8.1 MoEF, ZSI, WII, BNHS
 - 8.2 Zoo authority of India, Salim Ali Centre for Ornithology & Natural History (SACONH)
 - 8.3 Environmental information System (ENVIS), Indira Gandhi Conservation Monitoring Centre (IGCMC)
 - 8.4 The Animal Welfare Board of India, Centre for Environment Education (CEE)
 - 8.5 TRAFFIC, CITES, WWF, UNEP
 - 8.6 World Heritage and biodiversity Convention
 - 8.7 Convention on Biological Diversity (CBD)
 - 8.8 Ramsar (Wetlands) Convention and Hot spots



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CO PAPER A-II– Environmental Biology

Population ecology, environment awareness and Wildlife

UNIT-I

1. Factors influencing population
 - 1.1 Natality, Fecundity&fertility
 - 1.2 Mortality and survivorship
 - 1.3 Age structure
 - 1.4 Emigration, Immigration
2. Factors : Influencing population growth
 - 2.1 Density independent factors
 - 2.2 Density dependent factors
3. Method of population estimations of animal
 - 3.1 Arial and marine survey
 - 3.2 Belt and quadrature transect
 - 3.3 line transect
 - 3.4 Population Indices

UNIT-II

4.Environment awareness:

- 4.1 Earth summits
- 4.2 Carbon footprint and carbon tax
- 4.3 Global warning, ozone layer depletion
- 4.4 Important dates and their significance:

(World Wetlands Day- February 2, National Bio diesel Day- March 18.UN World Water Day- March 22, Earth Day- April 22, International Day for Biological Diversity (World Biodiversity Day)-May 22, UN world Environment Day- June 5 ,UN world Day to Combat

Desertification and Drought – June 17, UN World Population day-July 11, International Day for the Preservation of the Ozone Layer- September 16, World Rivers Day- every last Sunday in September, UN World Habitat Day- first Monday in October, International Day for Natural Disaster Reduction-second Wednesday in October, World soil Day- December5)

5.Climate disasters: Tsunami, earth quack, cyclone

UNIT-III

6. Environmental awareness and education regarding conservation of wildlife
7. Impact of tourism related activities on environment
 - 7.1 Basic principles of ecotourism
 - 7.2 Island ecology and tourism

 - 7.3 Pollution related to tourism- solid and liquid waste from tourist destination

UNIT-IV

8. Wildlife
 - 8.1 History
 - 8.2 causes of depletion
 - 8.3 Techniques of studying- Radiometry, photographic identification of animals and remote sensing.
 - 8.2 Wildlife of India- Wild life schedules, Ecozones, National parks, sanctuaries, reserves
- 8.3 Management special protection programs, (Tiger, Rhino, lion, tailed macaque elephant)

PRACTICALS

- Write characteristics of different biomes and mark their location on world map
- Mark major rivers of world on world map and five riverine system of India on India map- visit a river or pond- submit a write up
- Make a diagram of zones of sea, write characteristics of each- visit any sea- submit a report
- Understand about coral reef, their types structure and their mark their location in submit a write up
- Mark major Ecozones of India's map- visit a desert, grass land or rain forest submit a write up
- Observe behavior of Chita/ spotted deer/ Axis axis at any reserve/ zoo/ national park and write details of appearance, distribution, habit and behavior
- Mark important sanctuaries and national parks of Rajasthan on map, and write details of any three
- Write principle and method of mark and recapture method (Lincoln index)
- Find out density of monkeys/ cheetal in an area using line transect method
- Write methods of collecting and displaying insects- make a list of insects found in a habitat of your choice.

Muller, S. Nors Nielsen, Bernard Patten, BazoTiezzi and Robert Ulanowicz Elsevier

- Ecological Census Techniques – A Handbook (2nd edition) edited by William J. Sutherland
- Ecological Methods T.R.E. Southwood, Dr. Peter A. Henderson
- Ecological Methodology Charles J. Krebs

- Ecology, Individuals. Population and Communities. Begon. M., J.I. harper and C.R. Townsend, Blackwell Science Oxford
- Ecological concepts. Cherrett, J.M. Blackwell Sci. public. Oxford U.K.
- Population biology. Eisehart, B.D. and K.M. Baumgartner. Van Nostrand Co. New York
- Fundamentals of ecological modeling. Jorgenson. S.E. Elsevier. New
- A New Ecology- Systems Perspective
Sven Erik Jorgensen, Brian Fath, Simone Bastianoni, Joao Marques, Felix Muller, S. Nors Nielsen, Bernard Patten. EnzoTiezzi and Robert Ulanowicz Elsevier
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CO PAPER A-III– Environmental Biology

Ecotoxicology and Metagenomics

UNIT-I

1. Environmental Health and Toxicology
- 1.2 Fundamentals of Toxicology
 - 1.2.1 Toxicants of Public Health (pesticides, metals, solvents, Radiation)
 - 1.2.2 Dose & Toxicity
2. Movement, distribution and fate of toxins
 - 2.1 Bioaccumulation
 - 2.2 Biomagnification
 - 2.3 Translocation of Xenobiotics: absorption, Biotransformation, Excretion
3. Measuring toxicity (Acute, Sub chronic and Chronic)
4. Good Laboratory Practices (GLP)
5. environmental impact assessment (EIA); Process and Methods
6. Risk Assessment
7. Sustainable Development

UNIT-II

8. Environmental , Management
 - 8.1 Solid Waste Management
 - 8.2 E- Waste & Hazardous Waste
 - 8.3 Legislative approach for waste management
 - 8.4 Bioterrorism / Biological warfare

UNIT-III

9. Microbial Diversity in
 - 9.1 Air
 - 9.2 Water
 - 9.3 Soil
 - 9.4 Extreme environments

UNIT-IV

10. Metagenomics (molecular method for studying microbial diversity)
 - 10.1 Identifying new genes with metagenomics
 - 10.2 Culture enrichment for environmental samples.
 - 10.3 Sequence depending techniques for metagenomics

10.4 Function or activity based evaluation of the environment

10.5 ecology and metagenomics

10.6 natural attenuation of pollutants



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CO PAPER A-IV– Environmental Biology

Environmental microbiology and biotechnology

UNIT-I

1. Microbial Interaction with Xenobiotic inorganic pollutants
 - 1.1 Persistence and Biomagnification of xenobiotic molecules
 - 1.2 Polychlorinated Biphenyls and Dioxins
 - 1.3 Synthetic Polymers
 - 1.4 Microbial Interaction with some inorganic pollutants
 - 1.5 Acid mine drainage
 - 1.6 Microbial conversions of Nitrate
 - 1.7 Microbial Methylations
 - 1.8 Microbial Accumulation of heavy Metal and Radionuclides

UNIT-II

2. Biodegradability Testing and Monitoring the Bioremediation of Xenobiotic Pollutants
 - 2.1 Biodegradability and ecological side effect testing
 - 2.2 Biosensor detection of Pollutants
 - 2.3 Bioremediation
 - 2.4 Environmental modification for bioremediation
 - 2.5 Microbial Seeding and Bioengineering Approaches to the Bioremediation of Pollutants
 - 2.6 Bioremediation of Marine oil pollutants
 - 2.7 Bioremediation of air pollutants

UNIT-III

3. Microorganism in Mineral and Energy Recovery, and Fuel and Biomass Production
 - 3.1 Recovery of metals
 - 3.2 Recovery of Petroleum
 - 3.3 Recovery of Fuels
 - 3.4 Production of Microbial Biomass
 - 3.5 Single- Cell protein production

UNIT-IV

- 4. Microbial Control of Pests
 - 4.1 Microbial control of plant and animal pests
 - 4.2 Microbial control weeds and cyanobacterial blooms
 - 4.3 Genetic engineering in biological control
 - 4.4 Frost protection
 - 4.5 *Bacillus thuringiensis* pesticide
 - 4.6 Other applications