SAMBALPUR UNIVERSITY
JYOTI-VIHAR, BURLA

FACULTY OF SCIENCE

SYLLABUS

M.Sc. (ZOOLOGY)

(CBCS Pattern)

[Syllabus With effective from 2018-19 onwards]

A BREIF INTRODUCTION OF THE PROGRAMME

Zoology is a branch of biology that focuses on animals and animal life. There are many sub-fields in Zoology. Some Zoologists study very small organisms, such as mold, viruses, and even cells and parts of cells. Other Zoologists study very large organisms, such as whales, elephants and even *whole populations* of animals. Zoologists observe and sometimes conduct experiments on animals, either in the wild or in a controlled setting (such as a zoo or a laboratory). The subjects studied range from: inter-species interactions to neural mechanisms; molecular biology to vertebrate evolution; genetic foundations of behaviour to the importance of biodiversity. Zoology is important for many reasons. For one, the study of animals and communities provides insight into how "life" works, and, consequently, how *we* work. The higher mammals provide especially useful insight into the human world. Many Zoologists are directly involved with the conservation of threatened or endangered species; the maintenance of biodiversity is considered by many to be crucial to our survival. These are just a few of the reasons why understanding animal life is important to humans.

The Academic Requirements

Students will take basic and advanced science and math classes, including biology, chemistry, anatomy, ecology, etc. There will be lots of work done in the lab and in the field, preparing the student for typical employment in Zoology professions. Students should do an internship if possible; labs, zoos, farms, and veterinarian offices make great places to look for assistantship positions.Graduate and Ph.D. students will do more intensive lab and field work in a specific area of Zoology. The original research you start now could lead to an entire career's pursuit. This is also a great time to make professional and academic connections. Masters-level courses in Zoological Science are well suited to Biological Science students seeking to specialise further at postgraduate level. Some offer a general grounding in Zoology, but most have a specific focus in the understanding and classification of specific species (and / or their environments). As a result, postgraduate Zoology is as diverse as the animal kingdom itself. Whatever specific interest, it’s probably reflected in one or more of the courses below.

Professional Outlook

Jobs in Zoology are usually fall under the heading of research, or of applying research in "real world" situations. Researchers generally hold somewhat regular hours, unless they are deeply involved in a project. Then you may spend extended hours at the lab or in the field - however, the love of research that comes with the field is incentive enough to work extra hours. Researchers, both independent and in teams, usually prepare reports on their findings for upper management or peer review. Researchers need to have good communication skills, a cooperative spirit, and an inquisitive mind. Employment opportunities and outcomes are equally varied. The student’s will be well equipped for PhD research, perhaps leading to an academic career. Alternatively, the students could work for a range of organisations, from research centres to conservation groups.

COURSES OF STUDY

M.Sc ZOOLOGY

SAMBALPUR UNIVERSITY, JYOTI VIHAR

FOUR SEMESTER COURSE

(Effective from the Session 2018-2019)

OUTLINE OF THE COURSE

SEMESTER	PAPER	COURSE TITLE	MARKS	CREDITS
First	I	Animal Diversity (Non-Chordates and Chordates)	50	4
	II	Cell Biology and Cancer Biology	50	4
	III	Genetics and Molecular Biology	50	4
	IV	Biostatistics, Bioinformatics and Taxonomy	50	4
	V	Practical	100	4
Second	VI	Biophysics and Instrumentation	50	4
	VII	Animal Physiology and Endocrinology	50	4
	VIII	Ecology and Evolution	50	4
	IX	Biochemistry and Microbiology	50	4
	X	Practical	100	4
Third	XI	Immunology and Biopharmaceutics	50	4
	XII	Developmental Biology and Reproductive Biology	50	4
	XIII	Genetic Engineering	50	4
	XIV	Animal Biotechnology and Animal Behaviour	50	4
	XV	Practical	100	4
Fourth	XVI	Environmental Biotechnology	50	4
		Special Paper (Students has to choose one))		
		A. Fish and Fisheries		
	XVII	Ichthyology	50	4
	XVIII	Fish Culture and Ethology	50	4
	XIX	Practical	100	4
		B. Biochemistry		
	XVII	Metabolism and Regulation	50	4
	XVIII	Proteomics and Enzymology	50	4
	XIX	Practical	100	4
	XX	Project Report/ Study Tour Report	50	4
		Grand Total	**1200**	**80**

NB: In each theory paper, out of 50 marks, 40 marks end semester and 10 marks mid semester examination. In all the practical examinations 10 marks will meant for seminar presentation and seminar report preparation.

PAPER I

ANIMAL DIVERSITY (NON CHORDATE AND CHORDATE)

Objectives:

- To be familiar with the different non chordate and chordate phyla, their general and distinguishing characters.
- To study how the different systems evolved in their complexity.
- To compare and contrasts the life processes in different phyla.

Learning Outcomes:

At the end of the course, the students will be familiar with the animal world that surrounds us. They will be able to appreciate the process of evolution and see how it progressed from simple, unicellular cells to complex, multicellular organisms. Students will be able to identify the invertebrates and vertebrates and classify them up to the class level.

UNIT- I: **Non-chordates**

Protozoan diseases in man, Canal system in Sponges, Coral reef formation and significance, Polymorphism in Coelenterates, Helminthes parasites (Taenia, Ancylostoma), metamerism and segmentation in annelids.

UNIT-II: **Non-chordates**
Vision In insects, Torsion in Gastropoda, Nervous system in Cephalopods, Water vascular system in Echinoderms, Reproduction and development in Echinoderms with evolutionary significance.

UNIT III: Protochordates and Lower Vertebrates
General characters and interrelationship of Proto-chordates. General characters and affinities of Cyclostomata. Accessory Respiratory organs in fishes, Luminous organ in fishes, Origin and ancestry Of Amphibia.

UNIT-IV: **Higher Vertebrates**
Adaptive radiation in reptiles, Classification of reptiles based on skull pattern, Flight adaptation in Birds. General characters of Prototheria and Metatheria, Adaptive radiation in mammals, Dentition in mammals.

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
- Parker and Haswell: Text book of Zoology (Vol I).
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.

PAPER II
CELL BIOLOGY AND CANCER BIOLOGY

Objectives

- To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
- To understand how these cellular components are used to generate and utilize energy in cell.
- To be familiar with the various genetic and molecular changes occur in a normal cell during malignant transformation.

Learning Outcome:

At the end of this course, Students will be well acquainted with the membrane structure and composition, transport and trafficking, the cytoskeleton and cell movement. The general mechanism of cell division and their regulation through different check points will be thoroughly understood. The association between defect in cell cycle, apoptosis, signal transduction and cancer biology will be the land mark towards understanding different human diseases.

Unit I: Membrane structure and function.

Plasma membrane: chemical composition, structure and function of membrane proteins, membrane lipid and membrane fluidity, the dynamic nature of plasma membrane, movement of substances across cell membrane. Junctional Complexes. Cell signaling: receptor, second messengers, signaling through G-protein coupled receptors, regulation of signaling pathways.

Unit II: Structural organization and function of intracellular organelles.

Endomembrane system: Structure and function of endoplasmic reticulum, Golgi bodies, lysosomes. Structure and function of mitochondria. Cytoskeleton: types and major functions.

Unit III: Nucleus and cell cycle.

Nucleus: nuclear envelope, nuclear pore complex, nucleolus. Chromosomes, Karyotype and its significance, nuclear packaging. Cell cycle: cell cycle *in vivo*, regulation and checkpoints of cell cycle. Molecular mechanism of mitosis and meiosis. Apoptosis.

Unit IV: Cancer Biology.

Biology of cancer cell, Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth. Role of carcinogens and DNA repair in cancer.

SUGGESTED READINGS

- Karp, G. (2014). *Cell Biology*. VII Edition. John Wiley and Sons. Singapore Pvt. Ltd.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

PAPER III
GENETICS AND MOLECULAR BIOLOGY

Objectives

- To provide a fundamental knowledge on genetics, its laws, genes and chromosomes, inheritance, heredity, causes of genetic disorders and the methods of gene transfer.
- How the DNA in a genome is organized, replicated and repaired.
- How genetic information in the DNA is selectively expressed as functional proteins.

Learning Outcomes:

The course will able to explain the fundamentals of genetics and the Mendelian laws, the concept of alleles, concept of linkage and crossing over of genes. The course will open an avenue to be familiar with a variety of types of genetic data (genotyping, expression, sequence data), chromosomal mapping, genetic composition of biological population and evolutionary factors that explain the variation. An in-depth knowledge of chemical and molecular processes that occur in between cell including the central dogma will be assured at the end of this course.

Unit I: Mendelian principles.
Mendels law of inheritance, Mendelian principles**:** Dominance, segregation, independent assortment. *Concept of gene***:** Allele, multiple alleles, pseudoallele, complementation tests *Extensions of Mendelian principles***:** Codominance, incomplete dominance, gene interactions, pleiotropy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit II: Chromosomal mapping and Population Genetics.
Chromosomal mapping, gene mapping method**:** Linkage maps, Sex chromosomes, sex determination in animal, Sex linked genes in man and Drosophila. *Human genetics***:** Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. *Quantitative genetics***:** Polygenic inheritance, heritability and its measurements, QTL mapping. Population Genetics: Gene pool, gene frequency, Hardy-Weienberg genetic equilibrium, gene flow, genetic drift.

Unit III: DNA replication and Repair.
Nucleic acid as Genetic material. DNA replication: Replication in prokaryotes, replication fork, initiation, elongation, termination, Replication in eukaryotes, D-loop model of DNA replication, DNA replication in single stranded DNA, rolling circle replication and DNA Repair: mismatch repair, base excision, nucleotide excision, direct repair, SOS repair. Homologous and site-specific recombination.

UNIT –IV: Transcription and Translation.
Genetic code and its attribute. Molecular mechanism of transcription (Prokaryotes and eukaryotes). Translation: proof reading, translational inhibitors, Post- translational modification of proteins . Control of gene expression at transcriptional and translational level. Role of chromatin in gene expression and gene silencing.

SUGGESTED READINGS

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings

- Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Lewin B. (2008). *Gene XI*, Jones and Bartlett
- McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

PAPER IV
BIOSTATISTICS, BIOINFORMATICS, TAXONOMY

Objectives

- To learn about key biostatistical concepts and efficient tools for summarizing and plotting data, make decisions in the presence of uncertainty.
- To familiar students with the use of wide variety of computational tools to find sequence, analysis of protein and nucleic acid.
- To obtain a thorough understanding of the principle and practices of systematic, diversity and relationship in the animal world and to develop a holistic appreciation of the geological time scale, fossil, phylogeny and adaptation.

Learning Outcomes:

The course will provide knowledge of biostatistics approach used to analyze and presentation of data in biological research and other fields with strong emphasis on major steps in pair wise and multiple sequence alignment by dynamic programming. The students will be able to predict the secondary and tertiary structure of protein sequences. The course provides methodological background and quantitative skills in morphological and molecular phylogeny of taxonomy and systematics,

Unit I: Bioststistics
Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X2 test.

Unit II: Bioinformatics
Bioinformatics: Definition and applications. Protein sequence database (primary, secondary, composite and structural). Data base search for DNA, sequence comparison, multiple sequence alignment, dynamic programming approach: Fast A, BLAST, BLOSUM.

UNIT III: Taxonomy: Principles and methods of taxonomy
Concepts of species and hierarchical taxa, biological nomenclature, classical and quantititative methods of taxonomy of animals and microorganisms. Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy. Criteria used for classification in each taxon; classification of plants, animals and microorganisms; evolutionary relationships among taxa.

Unit IV: Natural history of Indian subcontinent
Origin and development of taxonomy, Types of classification (artificial, Natural, Phylogenetic and Phenetics), modern trends in taxonomy (biochemical, serological, numerical and molecular phylogeny). Types of fossil and fossilization, Biological realm, principles of zoogeography.
Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent.

SUGGESTED READINGS

- Principle of Animal Taxonomy; G.G. Simpson. Oxford IBH Publishing Company.
  Elements of Taxonomy. E. Mayer.
- Theory and Practice of Animal Taxonomy. V.C. Kapoor. Oxford & IBH Publishing Co. Pvt. LTD.

Advancement in Invertebrate Taxonomy and Biodiversity. Rajeev Gupta. Agrobios International.
Principles of animal taxonomy by GG Simpson

- Goulden C. H (1939). Methods of Statistical Analysis, John Wiley and Sons Inc., New York.
- Fundamentals of Applied Statistics- S.C Gupta, V. V Kapoor, Sultan and Chand.
- Robert R. Sakal and F. James Rohlf. (2009).Introduction to Biostatistics. Dover Publication Inc., Mineola, New York.
- Bernard Roshner (2010). Fundamentals of Biostatistics. 7th Edition.Cengage Learning Inc., United States.
- *Pevsner*, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell
- Ghosh Z and Mallick B. (2008). Bioinformatics: *Principles and Applications*, Oxford University Press.
- Zvelebil, Marketa and Baum O. Jeremy (2008). *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.

PAPER V

PRACTICAL

100marks

A. Invertebrate and Vertebrate

1. Study of Museum specimens and slides/Model

Protozoa: Euglena, Plasmodium, Paramoecium
Porifera: Sycon, Hyalonema, Euspongia
Coelenterata: Physalia, Gorgonia, Pennatula, Aurelia, Fungia
Platyhelminthes: Fasciola, Ascaris, Taenia
Annelida : Hirudinea, Sabella, Aphrodite, Nereis, Heteronereis, Trochophore larva, Lepas, Sacculina, Eupagurus
Arthropoda: Larval forms in Arthropoda, Leaf insect and Arthropoda Stick insect
Mollusca: Chiton, Dentalium, Larval forms in Mollusca, Sepia, Nautilus, Loligo
Echinodermata : Larval forms , Asterias, Echinus, Sea cucumber
Hemichordata: Balanoglossus
Cephalochordata : Amphioxus
Urochordata: Salpa, Doliolum, Ascidea
Cyclostomata: Petromyzon , Myxine
Pisces: Lung fish, Torpedo, Trygon, Exocoetus, Echines,Eel, Clarias, Hippocampus
Amphibia: Hyla, Alytes, Ichthyophis, Axolotl Larva, Salamander, !ecturus
Reptilia: Chelone, Varanus, Draco, Russel viper, !aja naja, Gavialis
Aves: Psittacula, Dinopium, Type of Beaks, claws and feet
Mammalia: Echidna, Macropus, Pteropus, Rattus, Squirrel

2. Mounting of mouth parts of mosquito-identification of genera

B. Cell Biology:

1. Preparation of temporary stained squash of onion root tip to study various Stages of mitosis
2. Preparation of temporary stained squash of grasshopper testis to study of various stages of meiosis.

C. Genetics and Molecular Biology

1. Pedigree analysis
2. Population genetics and Hardy-Weinberg Law (blood group, ear lobe and tongue rolling movement)
3. Isolation of genomic DNA from animal tissue/blood.

D. Biostatistics

1. Statistical analysis of the hypothetical data provided according to the course studied.

E. Others

1. Practical Record
2. Viva
3. Seminar Report

SECOND SEMESTER

PAPER VI
BIOPHYSICS AND INSTRUMENTATION

Objectives

- To learn the biophysical properties and functioning of life processes
- To introduce the tools and techniques available for studying biochemical and biophysical nature of life
- To equip the learner to use the tools and techniques for project work/ research in biology

Learning Outcomes

At the end of the course the student will be able to: Demonstrate knowledge of the fundamental concepts in physics and chemistry that underlie biological processes. Define the structural characteristics of nucleic acids and proteins and examine parameters that variously determine their stability and function(s). Describe the principles that govern biomolecular interactions and appreciate how established methods of research and enquiry are employed to analyze the different aspects of these interactions.

Unit I: Biophysics

Structure of atoms, molecules and chemical bonds. Stablizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principle of thermodynamics. Electromagnetic and ionizing radiation. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).Its interaction with living matters.

Unit II: Microscopy and Spectroscopy

Principle and operation of light, Fluorescence and Electron microscopy. Principle, Instrumentation and application of Fluorescence spectrophotometer. Radioisotopictechniques : Nature of radioactivity, application of radioactivity in biology (carbon dating, liquid scintillation counting, autoradiography).

Unit III: Centrifugation and chromatography

Centrifugation techniques: Basic principles of sedimentation, Chromatographic techniques: Principles of chromatography (Adsorption and Partition chromatography), Planar chromatography (Paper and Thin-layer chromatography), Column chromatography (Gas chromatography, Gel exclusion/permeation chromatography, Ion exchange chromatography, Affinity chromatography, HPLC).

UNIT IV: Electrophoretic and Immuno techniques

General principle, electrophoresis of proteins (SDS - PAGE, native gels, gradient gels, isoelectric focusing gels and two dimensional gels), electrophoresis of nucleic acids (Agarose, pulse-field and sequencing gels). Blotting techniques (Southern, Northern and Western blotting).ELISA, RIA, immunoprecipitation, flowcytometry. Detection of molecules in living cells, in situ localization by techniques such as FISH

SUGGESTED READINGS

- Instrumental Methods of Analysis – H.H Willard and L. L. Dean .John Wiley and Sons
- Modern methods of Chemical Analysis- R. L Recsok and L. D Shields. John Wiley and Sons
- Instrumental method of Chemical Analysis- G.W Euing. Mc Grand Hill
- Fundamentals of Molecular Spectroscopy – C. N Banwell, Mc Grad Hill
- Instrumental Methods of Chemical Analysis- G Chatwal and S Anand, Himalaya Publishing house, Mumbai
- Biophysical Chemistry: Principles and Techniques – A . Upadhyay, K. Upadhyay and N. Nath. Himalaya Publishing house, Mumbai
- Biophysical Chemistry – J. P Allen. Wiley-Blackwell (John Wiley and Sons) 2008.
- Karp, G. (2014). *Cell Biology*. VII Edition. John Wiley and Sons. Singapore Pvt. Ltd
- Wilson K and Walker J 2010. Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

PAPER VII
ANIMAL PHYSIOLOGYAND ENDOCRINOLOGY

Objectives

- To learn and understand the fundamental scientific concepts relating to a broad range of topics in animal physiology and Endocrinology.
- The course aim to provide basic understanding of different physiological systems and their interaction to maintain Homeostasis.
- To understand the role of chemical messenger or hormones, whether they are of endocrine or neural origin.

Learning Outcomes

The course will provide detailed knowledge on the various physiological organ-systems and their importance to the integrative functions of the human body. The students will be able to compare and contrast endocrine and nervous control systems. Students will be able to name the key events involved in signaling by hormones, infertility and birth control measures.

Unit I: Control and Coordinating System

Neuroanatomy of the brain and spinal cord, Organisation of central and peripheral nervous system, Blood brain barrier, neural control of muscle tone and posture. Neurons, Nerve conduction and synaptic transmission. Muscle: Structure, molecular mechanism of muscle contraction.

Unit II: Life sustaining System

Physiology of digestion of carbohydrate, protein and fat. Respiration: Oxygen and carbon dioxide transport and regulation of respiration. Excretion: Mechanism of urine formation. Circulation: Blood and its composition, ABO and Rh system. Hemostasis. Cardiac cycle and its regulation, ECG.

Unit III: Endocrinology

Pituitary pathophysiology, Biosynthesis of Thyroid hormone, Adrenal hormone, Testosterone, Estrogen, Progesterone .Mechanism of hormone action: Messenger concpt, Biosignaling pathway of peptide hormone Molecular mechanism of steroid hormone action. Long loop and short loop feed back mechanism.

Unit IV: Hormonal Regulation

Hormonal Regulation of carbohydrate, calcium and phosphorus metabolism. Thermoregulation, Osmoregulation and hormonal regulation of excretion. Sterility, its causes and control, Artificial insemination, IVF, ICSI. Fertility control: contraception- natural and chemical methods, oral contraception, contraceptive of future.

SUGGESTED READINGS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Dee Unglaub Silverthorn(2010). Human Physiology: An integrated Approach. 5th Edition.Pearson Education Inc., New Jersey.
- General Endocrinology - Turner C D and Bagnara JT, Saunders publication,1976.
- Endocrinology: An Integrated Approach; Stephen Nussey and Saffron.

PAPER VIII
ECOLOGY AND EVOLUTION

Objectives

- Describe the structure and function of ecological systems and explain how ecological systems work at different spatial and temporal scales.
- To understand the interaction of organisms with their environment
- To understand the evidence that living species share descent from common ancestry and how this fact explains the traits of living species
- To understand that evolution entails changes in the genetic composition of populations.

Learning Outcome

The students will able to demonstrate an understanding of ecological relationships between organisms and their environment. Also be able to demonstrate an understanding of key concepts in evolutionary biology, the history of life on earth, and phylogenetic relationships between organisms and of structure/function relationships in organisms.

Unit I Fundamentals of Ecology and Biogeography

Physical environment; biotic environment; biotic and abiotic interactions. Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Unit II: Pollution and Conservation Biology:

Environmental pollution: Air pollution, Water pollution, Noise pollution, global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit III: Population and community Ecology

Population ecology: Basic concept, Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, inter demic extinctions, age structured populations. Population interactions: positive and negative interactions, interspecific relationship Population regulation: competitive exclusion, density dependent and independent regulation.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit IV: Evolution

Theories of evolution (Lamarckism, Darwinism), Evidences of evolution (Morphology to molecular level), Variation and selection as underlying mechanisms' of evolution (Isolation, speciation and Natural selection). Evolutionary trends (micro, macro and mega patterns of evolution), Molecular and genomic evolution.

Paleontology and Evolutionary History:

The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

SUGGESTED READINGS

- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
- Fundamentals of Ecology –M. C Dash, Mc Graw Hills publication.
- Ridley,M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Organic Evolution- V. B Rastogi. MEDTEC publication.
- Ridley,M (2004) Evolution III Edition Blackwell publishing.

PAPER IX
BIOCHEMISTRY AND MICROBIOLOGY

Objectives

- To appreciate the chemical foundation of life processes.
- To understand the structure and metabolism of biologically significant molecules.
- To understand the microorganism that inhabit soil and water ,
- To study the contribution of microbes in the field of medicine, Industry and Agriculture,

Learning Outcome

The course will provide an understanding of fundamental biochemical principles such as biomolecules, metabolic pathway and regulation of biological process. The learners will be able to describe the structure of bacterial cells, the form, arrangement and replication of genetic material within a bacterial cell.

Unit I: Biomolecules

Carbohydrates: Classification, Glycoconjugates (Proteoglycans, Glycoproteins and Glycolipids).
Amino acids and proteins: Types of amino acids and their properties, The peptide bond, biologically active peptides, three dimentional structure of proteins (secondary, tertiary and quaternary structure), Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Protein denaturation and folding. Lipids: Storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments Coenzymes and vitamins.

Unit II: Glycobiology and Lipids

Bioenergetics, glycolysis, TCA cycle, oxidative phosphorylation, Gluconeogenesis, Glycogen metabolism, Regulation of carbohydrate metabolism, Oxidative phosphorylation, Electron transport chain and ATP synthesis. Metabolism of amino acid: Transamination, oxidative deamination and urea cycle. Metabolism of lipids: Biosynthesis of fatty acids, beta oxidation of fatty acids. Regulation of fatty acid metabolism.

Unit III: Enzymes

Enzymes: Nomenclature, Classification and properties, kinetics and mechanism of action (carboxypeptidase), Regulation (allosteric, phosphorylation and proteolytic cleavage). Enzyme inhibition (Competative, Non competitive, Uncompetative inhibition).

Unit IV: Microbiology

History and development of microbiology, General features of Bergy's manual for classification of microbes, Whittakar's five kingdom concept, Carl Woese's 3 domain classification, Isolation, culture and maintenance of microorganisms, Microbial growth, continuous culture (chemostat), Factors influencing growth of microbes, Role of microbes in agriculture and industry. Structure of bacteria, concept of genetic recombination of bacteria, virus structure (Bacteriophage) and multiplication (Lytic, cycle and Lysogenic cycle). Microbial toxins: types, mode of actions and pathogenicity.

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Satyanarayan U and Chakrapani U (2006).Biochemistry. Books and Allied Pvt. Ltd. Kolkata.
- Prescott LM, Harley JP and Klein DA.(2003). Microbiology .Tata Mac Graw Hills Publisher.
- Pelzar MJ. Microbiology. Tata Mac Graw Hills Publisher.

PAPER X
PRACTICAL
100marks

A. Biophysics and Instrumentation

1. Chromatographic separation of the supplied amino acids.
2. Microtomy,microscopic preparation and histological techniques.
3. Separation of protein fraction using SDS- PAGE.
4. Agarose gel electrophoresis of DNA.

B. Physiology and endocrinology

1. Estimation of haemoglobin using Sahli's haemoglobinometer.
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Study of endocrine glands (microphotograph/visual aid)
4. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, Rectum, liver, trachea, lung, kidney

C. Ecology and Evolution

1. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
2. Determination of dissolved oxygen, COD, Free carbon dioxide in the water samples.
3. Study of fossil (model/visual aid)

D. Biochemistry

1. Estimation of carbohydrate, protein and lipid.
2. Enzyme activity of salivary amylase and demonstrate the effect of temperature, pH and substrate conc.

E**. Others**

1. Practical Record
2. Viva
3. Seminar Report

THIRD SEMESTER
PAPER XI
IMMUNOLOGYAND BIOPHARMACEUTICS

Objectives

- To understand the immune system with respect to origin, development and structure
- To understand the underlying complexities and mechanism of different immune reactions.
- The primary objective of the course is to help students grasp the basic theories and basic skill of biopharmaceutics and pharmacokinetics
- Develop the student's ability to analyze and solve problems

Learning Outcome

This course will describe the immune systems of vertebrates that enable them to recognize and respond specifically to foreign substances. The students will be able to understand the roles of antigens, antibodies and immunocompetent cells in pathogenesis and immunity to infectious diseases. The basic pharmacokinetic processes, as absorption, distribution and elimination, are defined, expressed, calculated, and how these processes in combination determine drug disposition in the organism over time drug administration and course of action will be well understood on completion of this course.

Unit I: Immunology

Phylogeny of immune system. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, Structure of immunoglobulins.

Unit II: Immunology

Humoral and cell mediated immunity, Regulation of immune response, Major histocompatibility complex and HLA system, Activation and regulation of B and T lymphocytes, Cell mediated cytotoxicity and antibody depenedent cell mediated cytotoxicity, Complement system (Classical, Alternate and lectin pathway), Cytokines- Types and their role in immune regulation. Toll-like receptors, cell-mediated effector functions.

Unit III: Immunology

Immunological aspects of transplantation, Autoimmunity, lmmunotolerance, inflammation, Hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies , Vaccines, Interferons.

Unit IV: Biopharmaceutics

Basic concept of Bioavailability, factors influencing bioavailability. Pharmacokinetics: Drug administration, Absorption, Distribution, Biotransformation, Excretion. Sustained release dosage forms.

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology.* V Edition. Saunders Publication.
- M. Rowland and T. Tozer (2011). Clinical pharmacokinetics and pharmacodynamics. 4th Edition
- L. Shargel and A.B.C. Yu and Wu Pong (2005). Applied Biopharmaceutics and Pharmacokinetics. 5th Edition.
- G.R. Chatwal (2011). Biopharmaceutics and Pharmacokinetics. Himalaya Publishing House.
- LiuJianping, Biopharmaceutics and pharmacokinetics, Fourth edition, People's Medical Publishing House, December 2011

PAPER XII
DEVELOPMENTAL BIOLOGY AND REPRODUCTIVE BIOLOGY

Objectives

- To understand the basic concept of developmental biology
- To study the experimental aspect of developmental biology
- To acquire an in depth knowledge of the relationship between gene and development as well as environment and development.

Learning Outcome

The course will provide a broad area from embryology to developmental biology. The students will be able to apply their understanding of embryonic development, reproductive function and fertilization to methods for assisted reproductive technologies to circumvent infertility. The students will also apply their understanding of reproductive function and hormonal regulation to the various methods for male and female contraceptions.

UNIT I: Basic concepts of Development

History of developmental biology (Contributions of Spemann, Hilde Mangold, Holtfreter, Needham, Waddington, Spratt, Briggs and King, Patric Steptoe and Robert Edwards). Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit II: Gametogenesis, fertilization and early development:

Gametogenesis: Spermatogenesis, Oogenesis, Fertilization: morphological aspects, Biochemical events of fertilization. Cell-cell interaction and cell signalling during morphogenesis in early embryo: gastrulation, neurulation and primordial organ rudiments, origin and fate of neural crest cells. blastula formation, Embryogenesis.

Unit III: Reproductive Biology

Histology and Anatomy of Testis and accessory sex organs (Epididymis, Vas Deferens, Prostate and Cowpers gland , Ovary: Anatomy, histological structure. Female accessory sex organs (Oviduct, uterus, vagina, mammary gland). Hormonal Regulation of gametogenesis and reproductive cycle in mammals.
Endocrinology of implantation, parturition, Role of hormone during pregnancy, Endocrinology of lactation.

Unit IV: Reproductive Health

Major endocrine disorders related to reproduction. Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning

SUGGESTED READINGS

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

PAPER XIII
GENETIC ENGINEERING

Objectives

- To illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- To expose students to application of recombinant DNA technology in biotechnological research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

Learning Outcome

The course will acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology. A sound knowledge on methodological repertoire allows students to innovatively apply these in basic and applied fields of biological research. Students will introduced to properties, application and limitation of versatile DNA modifying enzymes, gene cloning, sequencing and genetic transformation. etc. This course may be deemed as a foundation course serving as a platform for introduction of more advanced cutting-edge technologies that essentially are an amalgamation of basic techniques combined in diverse forms of modern applications.

Unit I: Recombinant DNA Technology

Concept and scope of genetic engineering, molecular techniques in gene manipulation, DNA isolation and purification, DNA sequencing method(Maxam-Gilbert, Sangers Method), Restriction endonucleases, ligase. Cloning vectors: plasmid, Cosmid, Lambda bacteriophage, M13, BAC, YAC and expression vectors. Genomic and C-DNA libraries.

Unit II: Molecular Techniques

Polymerase chain reaction and its application in biological sciences, Nucleic acid hybridization, DNA finger printing, site directed mutagenesis, Gene knock out strategies. RNA interference, Anti-sense technology, siRNA, miRNA, DNA microarray.

Unit III: Genetic Transformation

Genetic transformation, Strategies for gene transformation(Calcium phosphate method, electroporation,biolistic,liposomal,microinjection snd agrobacterium mediated transformation). Selection and screening of transgenic animal using molecular marker (RAPD and RFLP).

Unit IV: Application and Limitation

Production of genetically modified organisms, production of cloned and transgenic animals: nuclear transplantation, retroviral method, DNA microinjection. Application of genetic engineering in medicine, agriculture and industries. DNA vaccine and its application. Genetic engineering regulation and guidelines.

SUGGESTED READINGS

- Mulhardt C. Molecular Biology and Genomics. Academic Press, Elsevier.
- Broown T A. Gene Cloning and DNA analysis. Blackwell Science ltd.
- Molecular Clonning: A laboratory manual by J. Sambrook and E.F. Fritsch.
- DNA Science. A First Course in Recombinant Technology by Mickloss and Freyer
- Molecular Biotechnology by S.B. Primrose
- Watson JD, Baker TA,Bell SP,Gann A, Levine M, Losick R. 2004. Molecular Biology of Gene. 5th Edn.Pearson education Inc., Publishing as Benjamin Cumming.Sanfransico, Canada.

PAPER XIV
ANIMAL BIOTECHNOLOGY AND ANIMAL BEHAVIOUR

Objectives

- To provide a solid foundation on the tools and techniques employed in genetic engineering.
- To study the contribution of biotechnology in disease diagnosis and advanced therapeutics.
- To introduce animal behaviour taking an integrative approach that addresses animal behaviour from ethological, ecological and evolutionary aspects and to review the basic concepts of behaviour as a science.

Learning Outcomes

On successfully completion of this course will be able to: Design an experiment with step-by-step instructions to address a research problem in biotechnology, Provide examples of current applications of biotechnology and advances in the different areas like medical, microbial, environmental, bioremediation, agricultural, plant, animal, and forensic science. The course also describe and explain the basic concepts of animal behaviour using two approaches – ethology and behavioural ecology. It gives a thorough idea about biological rhythm and instinct behavior.

Unit I Animal Biotechnology

Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques, Culture media(Composition) :Natural media, Synthetic media, Nutritional compounds of media, Role of serum in cell culture, Primary culture and its maintenance: Various techniques of tissue disaggregation, Monolayer and suspension cultures. Maintenance of cell culture, cell cloning and manipulation.

Unit II Animal Biotechnology

Teratogenesis: Environmental assult, teratogenic agents like alcohol, retinoic acid etc. Application and approaches of cell and tissue engineering. Application of animal cell culture, stem cell culture, embryonic stem cell and its application.

UNIT III Animal Behaviour

Classification and analysis of behavior patterns, Tools and Techniques in behavioral study, Neural & hormonal control of behavior, Communication in animals, neural basis of learning, memory, cognition, sleep and arousal, development of behavior; social communication; social dominance .

Unit IV Behaviour and Evolution

Biological rhythms: types and characteristics, Circadian rhythms, use of space and territoriality; mating systems, parental investment and reproductive success; parental care; aggressive behavior; habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes. Migration of fish and bird.

SUGGESTED READINGS

- Animal Cells Culture and Media, D.C. Darling and S.J. Morgan, 1994.BIOS Scientific Publishers Limited.
- Methods in Cell Biology, Volume 57, Jennie P. Mathur and David Barnes,1998. Animal Cell Culture Methods Academic Press.
- T.A. Brown: Gene cloning and DNA analysis: An Introduction, Blackwell Science (2001).
- Bernard R. Click & Jack J. Pasternak: Molecular Biotechnology, ASM Press, Washington (1998).
- Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman &H.H. Zhang, 1997, CRC Press, New York
- David McFarland, Animal Behaviour, Pitman Publishing Limited,London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA

PAPER XV
PRACTICAL

100marks

A. Immunology

1. Determination of ABO blood group (Antigen antibody interaction)
2. Preparation of blood smears for differential count and type of leucocytes.
3. Histological study of spleen, thymus and lymph nodes through slides/photographs

B. Developmental Biology

1. Study of life cycle of different anurans
2. Effect of thyroxin on amphibian development
3. Whole mount preparation of chick embryos
4. Study of Frog development through prepared slides

C. **Animal Biotechnology and Animal behaviour**

1. Sterilization & Preparation of media (liquid & solid)
2. Estimation of plasma level of any hormone using ELISA
3. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

D**. Genetic Engineering**

1. Study of model of DNA and RNA.
2. Preparation of project on DNA sequencing

E**. Others**

1. Practical Record
2. Viva
3. Seminar Report

FOURTH SEMESTER
PAPER XVI
ENVIRONMENTAL BIOTECHNOLOGY

Objectives:

- Know the basic physiology of a microorganism and how their structure dictates their function in the environment
- Understand the bases for microbial metabolism of environmental contaminants
- Know various techniques to modify and augment microorganisms in the laboratory and environment
- Understand the principles of bioremediation, phytoremediation, and to know the basic design and application of microbial fuel.

Learning outcomes:

The student will acquire knowledge of degradation and elimination of persistent, bioaccumulative and toxic organic substances, pollutants Bioremediation, remediation processes in use in the biotic, abiotic environment, as well as in manufacturing technologies.

Unit I:

Basic Environmental biotechnology: Scopes and issues, basic environmental problems-pollution, land degradation, deforestation, biodiversity loss and eutrophication, biotechnology for safer environment, biotechnology for resource management and biomass production, biotechnology for generation of biogas and bio fuels.

Unit II:

Bioaccumulation: Concept and measurement, food chain and lipophilicity approach, quantitative structure activity relationship, kinetics of uptake and retention, factors affecting bioaccumulation. Bioaccumulation of metals: metal accumulation by flora and fauna; biosorption, phytofiltration, phytochelation and phytoextraction; role of metalphores.

Unit III:

Bioremediation: Types and application, Biodegradation of pesticides and hazardous wastes, Degradation of oil spills. Biosorption, use of bacteria in biosorption, use of fungi in biosorption, use of algae in biosorption, biomineralisation and bioleaching. Microorganism involved in bioleaching of ores, mechanism of bioleaching.

Unit IV:

Biological Wastewater treatment and disposal: Activated sludge process, biological filters, rotating biological contractors. Anaerobic Biological treatment (contact digester, packed Bed reactor Baffled digester, Biological reactor). Land reclamation and crop productivity.

SUGGESTED READINGS

1. Mahapatra, P.K. (2006) Textbook of Environmental Biotechnology, IK International Publishing House.
2. Varun Mehta (2008).Environmental Biotechnology , 1st edition, Campus Book s International, New Delhi
3. M. Jay (2007). Environmental Microbiology and Biotechnology. 1st edition. Swastik Publishers & Distributors, New Delhi
4. P. Vashisth (2005). Environmental Biotechnology. 1st Edition, Dominant Publishers and Distributors, New Delhi
5. D.K. Markandey and Neelima Rajvaidya (2004). Environmental Biotechnology. Ist Edition. APH Publishing Corporation, New Delhi.
6. Indu Sekhar Thakur (2006). Environmental Biotechnology: Basic concepts and applications. IK International Publishing House.
7. B. E. Rittmann, P. L. McCarty, (2001) Environmental Biotechnology: Principles and Applications, McGraw-Hill.
8. Seviour R, and P.H. Nielsen. (2010.) Microbial Ecology of Activated Sludge, IWA Publishing,

SPECIAL PAPER- FISH AND FISHERIES
PAPER XVII
ICHTHYOLOGY

Objectives

- To appreciate the scope of study of fishery biology
- To understand the structure and functioning of different organ systems.
- To acquire an in depth understanding of the unique feature of fishery biology.

Learning outcomes:

This course will provides a comparative examination of selected freshwater and marine fishes to illustrate the influence of aquatic environments on life styles, behavioral patterns, physiological responses, population biology and community structure.

Unit I: Classification, body form and Diversity

Classification of fish with distinguish characters and important examples of principal subdivisions, phylogenetic significance of Acanthodians and placoderms. Evolution and adaptive radiation of chondrichthyes Elasmobranchi and Bradyodonti. Hill stream fishes emphasizing on adaptation, deep sea fishes, fin structure, modification and function, theories regarding origin of paired fin, colouration in fishes.

Unit II: Anatomy and Physiology

Food, food habits, feeding adaptation, feeding behavior, physiology of digestion and absorption, structure of heart, blood vessel and circulation of blood, blood forming organ, transport of respiratory gases. Functional significance of bladder and muscle. Organisation and modification of gill.

Unit III: Special organ

Sound production mechanism, electric fishes-their types, location of electric organ, structure and function of electric organ. Bioluminiscence- physiology and biological significance of luminescence, poisonous fishes and their poisonous apparatus.

Unit IV: Ecology and behaviour

Ecology of aquatic ecosystem- river, estuary, lake, sea and reservoir. Growth and age studied in fishes. Fish population- density, structure and estimation of population dynamics. Aquatic population and fisheries. Circardian rhythm in fishes, pairing, courtship and parental care in fishes.

SUGGESTED READINGS

- Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
- H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor.The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
- C.B.L. Srivastava, Fish Biology, Narendra Publishing House
- J.R. Norman, A history of Fishes, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

SPECIAL PAPER- FISH AND FISHERIES
PAPER XVIII
FISH CULTURE AND ETHOLOGY

Objectives

- To appreciate the economics of Fishery Biology
- To gain thorough understanding of culture fisheries
- To understand the equipments required for the fishing industries
- To study certain aspects of fish pathology
- To obtain a thorough understanding of the production process of fish by products and future research.

Learning outcome

This course will provide an increased understanding of the evolutionary origins of the major fish taxonomic Classes, genetic and environmental factors regulating reproduction in fishes. And various 'modes' of reproduction in fishes. The course also deals with a knowledge of how abiotic factors influence adaptive capabilities in fishes, have greater insight into how growth is regulated in fishes, gain a heightened understanding of the various sensory modalities in fishes and how these anatomical and physiological adaptations interact in the social development of fishes.

Unit I: Breeding and Culture

Natural breeding of Indian major carps, factors responsible for natural breeding, techniques of breeding in Indian major carps. Induced breeding of fishes special reference to major carps. Fisheries of Indian sea with special reference to costal fisheries of Odisha. Fresh water fish culture in India.

Unit II: Methods of Fishing and Conservation

Crafts and Gears used in India for fishing Inland and marine waters. Advantage I fishing method: electrical fishing, light fishing, fish finders (echo sounder and sonar) and their utilities. Fish preservation, handling of fresh fish(chilling, freezing, use of chemicals, preservative and antibiotics, irradiation, salting, freeze drying, smoking, canning and packaging).Preservation of prawn and tail of lobster and their quality control.

Unit III: Pathology and sustainable aquaculture

Fish pathology symptoms, etiology, prophylaxis and treatment of common diseases and pathological condition in cultivable fish. Exotic fishes, history of transportation of important exotic fishes in India. Larvivorous fishes, exotic and indigenous species with special reference to malarial control. Biochemical composition of raw fish, nutritive value of raw and preserved fish as food. Fish products and bi products. Sustainable aquaculture, extensive, semi intensive and intensive culture of fish, pen culture, cage culture, composite fish culture. Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic;

Unit IV: Adaptation Features and Fish Research

Colouration-chromatophores, pigments and colouration, physiological and morphological significance of colour change. Causative factor for development of development of air breathing. Structural adaptation for air breathing and gas exchange in air breathing fishes. Brackish water fish and prawn culture in India, oyster culture and pearl industry. Application of remote sensing and GIS in fisheries; Fisheries law and regulations. Transgenic fish, Zebra fish as a model organism in research.

SUGGESTED READINGS

- Q Bone and R Moore, Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.
- H. Evans and J. D. Claiborne, The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK von der Emde, R.J. Mogdans and B.G. Kapoor.The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands
- C.B.L. Srivastava, Fish Biology, Narendra Publishing House
- J.R. Norman, A history of Fishes, Hill and Wang Publishers
- S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

PAPER XIX

Practical- Special paper Fish and Fisheries

100marks

A. FIsheries

1. Study of petromyzon, Myxine, Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas.
2. Study of different types of scales (through permanent slide/photograph).
3. Study of crafts and gears used in fisheries.
4. Water quality assessment of aquaculture (pH, Conductivity, total solid, total dissolved solid).
5. Study of air breathing organs in channa, heteropneustes, Anabas and Clarias.
6. Demonstration of induced breeding in fishes (visual aids).
7. Collection of pituitary gland and preparation injection extract.
8. Demonstration of parental care in fishes (visual aid) through visit to any fish farm.
9. Taxonomical status of local fishes (atleast 30)
10. Microscopic preparation of fish scales.
11. Dissection of afferent, efferent branchial arteries of Scoliodon.
12. Dissection of cranial nerves of scoliodon, internal ear of Scoliodon. (Virtual dissection through computer aided programme may be done if dissection not allowed).
13. Seminar presentation and report preparation.

B. Environmental Biotechnology

1. Determination of alkalinity, total hardness,chloride content and primary productivity in different water samples.

SPECIAL PAPER- BIOCHEMISTRY
PAPER XVII
METABOLISM AND REGULATION

Objectives

- To learn fundamental biochemical principle such as the structure/function of biomolecules, metabolic pathways and the regulation of biological /biochemical processes.
- To learn the chemical reactions constitutive of main metabolic pathways
- To explain the role of catabolic and anabolic pathways in cellular metabolism.

Learning Outcome

On completion of the course, the students will understand the fundamental energetic of biochemical processes and chemical logic of metabolic pathways. The course also deals with the integration of metabolic process in cellular systems and organization of cellular pathways.

Unit I: Bioenergetics

Energy transduction in cell and types of transducers, energetic of biochemical reaction, redox potential. Energy transformation in mitochondria, energy complex and electron carrier in mitochondrial membrane, energetic of electron transfer reaction, mechanism of oxidative phosphorylation and electron transfer. Protein gradient as the central motif of bioenergetics in mitochondria.

Unit II: Metabolism

Nucleic acid; *de novo* and salvage pathway of nucleic acid biosynthesis; Biosynthesis of essential , non essential and aromatic amino acid, oxidative degradation of amino acid leading to acetyl CoA, alpha keto glutarate pathway, succinic pathway, fumarate pathway and oxalo acetate pathway of amino acid oxidation.

Unit III: Lipid metabolism

Degradation of odd and even carbon fatty acid, oxidation of mono and polygenic fatty acid. Fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acid and triglyceride. Biosynthesis of phospholipid and cholesterol, Regulation of cholesterol biosynthesis.

Unit IV: Metabolic regulation

Glycolysis and its regulation, TCA cycle and its control, glyoxylate cycle and its regulation, regulation of glycogen metabolism. Energetics of lipid oxidation and its regulation. Signal transduction pathways. Signal response coupling in metabolic processes; ca-calmodulin signaling, cAMP as second messenger, GTP binding protein and kinase/phosphatase cascade.

Suggested Reading:

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Satyanarayan U and Chakrapani U (2006).Biochemistry. Books and Allied Pvt. Ltd. Kolkata.

SPECIAL PAPER - BIOCHEMISTRY
PAPER XVIII
PROTEOMICS AND ENZYMOLOGY

Objectives

- To provide general knowledge on protein structure and function, as well as the experimental techniques in protein chemistry and protein engineering.
- To develop the ability of identifying the experimental techniques required to solve specific problems related to proteins and enzyme functions.
- To train students in the evaluation of the consequences of biochemical and biological tools in their professional activities.

Learning Outcome

On completion of the course, students will learn about the principles of globular protein structure, as well as techniques. The students have insight in the physicochemical properties of proteins and their underlie purification methods. They will apply their knowledge on action of enzyme as biocatalyst and the factors that influence the enzymatic activity.

Unit I: Protein Engineering

Protein sequencing (N and C-terminal determination, amino acid composition). Protein stability (vander Waals force, electrostatic hydrogen bonding, weakly polar interaction and hydrophobic effects), Factors affecting stability (pH, temperature, amino acid sequence, aggregation propensities etc). Ramchandran plot.

Unit II: Proteomics

Characterization of protein (Affinity and specificity) using different spectroscopic methods (UV, CD, fluorescence and NMR), 2D electrophoresis of proteins, isoelectrofocusing , Peptide finger printing. Computational approach of 3D structure analysis of proteins. Protein microarray, proteomics and drug discovery.

Unit III: Enzymology

Briggs and Haldane quasi steady-state approximation, enzyme inhibition (competitive, non-competitive, uncompetitive) and inhibition kinetics, Turnover number and Kcat. Factors affecting enzyme activity.Bi-substrate reaction kinetics, ordered and random kinetics, Ping-pong catalysis (Delziel's form). Allosteric enzymes and its significance.

Unit IV: Enzyme Immobilization

Extractionand purification of enzymes illustrating the downstream processing. Enzyme immobilization; methods and application. Enzyme biosensors (Bio electrodes, Optrodes, Immunochemical sensors). Application of enzyme in food industries.

Suggested Reading:

- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Satyanarayan U and Chakrapani U (2006).Biochemistry. Books and Allied Pvt. Ltd. Kolkata.

PAPER XIX
Practical- Special paper Biochemistry

100marks

A. Biochemistry

1. Estimation of protein content in the biological samples.
2. Estimation of reducing sugar content
3. Determination of crude lipid content of oily seeds.
4. Estimation of free amino acid content.
5. Effects of pH, temperature, enzyme concentration on enzyme activity
6. Effect of substrate concentration on enzyme activity
7. Determination of Vmax and Km of enzyme activity through line weaver Burke plot.
8. Solving problem related to enzyme kinetics using the supplied data.

B. Environmental Biotechnology

1. Determination of alkalinity, total hardness, chloride content and primary productivity in different water samples.

PAPER XX
Project Report and Viva-Voce
50 Marks

Project report should include introduction, methodology, techniques, results, discussion and bibliography. Institutional cum industrial study tour report emphasizing theoretical aspects should be included. Evaluation of the project report and viva-voce will be open defense type through PowerPoint presentation and evaluated by external examiner.

Identification of problem-05 marks, Literature Review- 05, Methodology – 05, Finding and analysis – 20, Project report-05, Viva-10.