West Bengal State University
Department of Zoology

SYLLABUS FOR TWO-YEAR POST GRADUATE COURSE OF ZOOLOGY UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

(With effect from the session 2019-2020)

Semester	Paper	Theory/ Practical		Paper Full marks	Semester Full marks	Paper Credit	Semester credit
Semester 1 (Odd)	Dept 1	Theory	Life Forms, Evolution & Taxonomy	50		4	
	Dept 2	Theory	Genetics, Molecular Biology & Immunology	50		4	
	Dept 3	Theory	Cell Biology & Developmental Biology	50		4	
	Dept 4	Practical	Lab Course I	50		4	
	Dept 5	Practical	Lab Course II	50		4	
	AECC 1		Industrial Biology	25		2	
Total					**275**		**22**
Semester 2 (Even)	Dept 6	Theory	Biochemistry & Biophysics	50		4	
	Dept 7	Theory	Parasitology & Microbiology	50		4	
	Dept. 8	Theory	Ecology & Quantitative Biology	50		4	
	Dept 9	Practical	Lab Course III	50		4	
	Dept 10	Practical	Lab Course IV	50		4	
		SEC	Histopathological Techniques	25		2	
Total					**275**		**22**
Semester 3 (Odd)	Dept 11	Theory	Physiology, Endocrinology	50		4	
	Dept 12	Theory	Animal Behaviour & Conservation Biology	50		4	
	Dept 13	Theory	Cancer Biology & Toxicology	50		4	
	Dept 14	Practical	Lab Course V	50		4	
	Dept 15	Practical	Lab Course VI	50		4	
		GEC	Ecosystem and Environmental Hazards	50		4	
Total					**300**		**24**
Semester 4 (Even)	Dept 16	Theory	Options offered within the department *****	50		4	
	Dept 17	Theory	Options offered within the department *****	50		4	
	Dept 18	Practical	Options offered within the department *****	50		4	
	Dept 19	Practical	Options offered within the department *****	50		4	
	Paper 20	Project Work		100		8	
Total					**300**		**24**
Total Course					**1150**		**92**

Credit							

CBCS PG Zoology

Table: For PG programme

*** Options- Students will have to opt for 2 courses (2 Theory papers in Dept 16 and 17 and their corresponding practical papers in Dept 18 and 19)**

Elective 1- Applied Entomology and Vector Biology

Elective 2- Applied Conservation Biology

Elective3- Advanced Immunology & Experimental Therapeutics

Elective 4- Advanced Molecular Oncology and Biochemical Techniques

Elective 5- Behavioural Endocrinology

Elective 6- Cell Signaling & Cancer Biology

CBCS –PG Zoology, WBSU

Preamble

We are living in a golden age of biology. There is a vast domain of knowledge to teach and learn about biology especially zoology and its applications for the Welfare of society. Reading the newspaper or watching news reminds us daily that the subject of biology is woven into the fabric of our society as never before. As the discovery of biology advances, so does the number of ways that it impacts our lives. Medicine agriculture, forensics, ecology, psychology, environmental issues- these are just a few of the subjects to which zoology especially biology has made significant contributions in recent times. While the present age is rich with learning opportunities it also creates teaching and learning challenges. The present syllabus has been designed very carefully with a view not to create a suffocating condition for students under an avalanche of information/s. Focus on the most important areas of zoology has been organized within core areas like cells, genes, evolution, taxonomy and their useful applications for the welfare of society. This entire process of framing up of curriculum is a holistic product of feedback and suggestions from students, peers and corporate society.

Syllabus-1st Semester

Dept. Course 1: Life Forms, Evolution & Taxonomy (Total Credits: 4)

1. Levels of structural organization: Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems, evolution of interesting vertebrate structures.
2. Hardy-Weinberg theorem and its applications
3. Population Genetics- Modelling Natural Selections, Genetic Drift, Gene Flow,
4. Different impacts of natural selections on normally distributed characters
5. Concept of Adaptations and Critical Evaluation of "Adaptationist Story Telling", adaptive radiation
6. Coevolution- Evolutionary Arms Race
7. Outlines of Human Evolution and pre-historic migrations
8. Evolution of Taxonomy: Pre-Darwinian and Post Darwinian Concepts
9. Applied Taxonomy: ICZN rules regarding types and Nomenclatures
10. Taxonomic Keys
11. Cladistics
12. Molecular Phylogeny

Suggested Readings:

- Evolutionary Biology by D. Futyuama; Principles of Systematic Zoology by Ernst Mayr

Course Objectives:

Course Objectives: "Nothing makes sense in biology except in the light of evolution"- Theodesius Dobzhansky. This oft-quoted and most agreed upon statement among scientists suggest that the theory of evolution is the scientific paradigm for biology and must be taught to every student of life sciences. This Evolution and Genetics part of the course is highly updated and tailor-made to make a PG student strong in the most fundamental aspect of biological sciences.

The course is designed to prepare students with knowledge and skills of Taxonomy for exploring and assessing biodiversity and ecosystem health. There are emerging scopes of jobs as ecologists with good taxonomic knowledge in India and abroad.

Dept. Course 2: Theory- Cell Biology & Developmental Biology (Total Credits: 4)

Group A: Cell Biology

1. Evolution of cell

2. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.
3. Structural organization and function of intracellular organelles: Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility.
4. Transport of Ions and Molecules across cell membranes: Passive diffusion, facilitated diffusion, uniporters, symporters, antiporters , Ion channels, ATP-powered pumps,
5. Extracellular matrix and Cell junctions and cell-cell signaling.
6. Cell Function: Dynamic movements, trafficking, targetting, sorting and localization of macromolecules and signal transduction in the living cells.
7. Cell cycle: Molecular genetics of cell cycle control, cdc mutants, Loss of cell cycle control and cancer, programmed cell death and apopotosis.
8. Biology of excitable (nerve or contractile cells) cells.

Suggested Readings: Text Book: Molecular Cell Biology By Lodish, Cell by Cooper, Molecular Biology of the Cell by Bruce Alberts

Group B: Developmental Biology

1. Basic concepts of development: Potency, induction, competence, differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells.
2. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals.
3. Morphogenesis and organogenesis in animals: Axes and pattern formation in Drosophila, amphibian and chick; organogenesis-vulva formation in Caenorhabditiselegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons.
4. Programmed cell death, aging and senescence
5. Developmental immunology: Immune relations during development; role of cytokines in development.

Suggested Reading:

Developmental Biology by Scott F. Gilbert

Course Objectives:

The cell is a powerful case study to help us explore the functional logic of living systems. All organisms are made up of cells. This course is designed to explore the fundamentals of cell biology. We hope learners will develop a deep intuition to understand the functional logic of a cell. To underscore the importance of cell biology in our lives, we will address questions of cellular disorders, and associated health implications in the human society.

Developmental biology studies the mechanisms involved in growth and development of complex organisms. In many ways the basic understandings of developmental biology provide an invaluable foundation for other aspects of biology as well as medicine, especially as many health issues can be related back to early developmental defects during embryogenesis. This course aims to provide a broad, comprehensive look at embryology with special emphasis on vertebrate models, focusing on both classical experiments and modern molecular and genetic techniques.

Dept. Course 3- Theory: Genetics, Molecular Biology & Immunology (Total Credits: 4)

1. Mendelian Genetics: Laws of Probability and Mendel's experiments, Mendel's reappraisals
2. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.
3. Role of Genetics in evolutionary interpretation
4. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
5. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
6. Recombination: Homologous and non-homologous recombination including transposition.
7. DNA replication, repair and recombination (Unit of replication, enzymes involved,replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).
8. RNA synthesis and processing (transcription factors and machinery, formation ofinitiation complex, transcription activator and repressor, RNA polymerases, capping, elongation,

and termination, RNA processing, RNA editing, splicing, andpolyadenylation, structure and function of different types of RNA, RNA transport).

9. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).
10. Control of gene expression at transcription and translation level (regulating theexpression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin ingene expression and gene silencing).
11. Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity.
12. B and T cell epitopes, structure and function of antibody molecules, generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions
13. MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses.
14. Primary and secondary immune modulation, the complement system.
15. Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity.

Suggested Readings

16. Text Book**:**David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry, Molecular Cell Biology Lodish, Molecular Biology of the Cell by Bruce Alberts, Immunology by Kuby

Course Objectives:

The course aims to equip students with a basic knowledge of the structural and functional aspects of biological macromolecules, viz., DNA, RNA and proteins. After completion of the course, the students can apply this knowledge in their fields of research and higher education. Basic concepts on microbiology and antibiotics for general information (useful for day-to-day life) and further advanced knowledge on the topic.

Dept. Course 4- Lab Course I (Total Credits: 4)

1. Viable cell counting.

2. Organellar fraction isolation by differential centrifugation
3. Assessment of cell size, cell granularity and cell cycle analysis by Flowcytometer
4. Genomic DNA isolation.
5. DNA gel electrophoresis.
6. Semiquantitative PCR
7. Protein Gel electrophoresis
8. PBMC/ Splenocyte isolation and study on cell types

Course Objectives:

Lab course I is intended to introduce students to standard biochemical techniques common in a molecular biology lab, such as DNA isolation, agarose-gel electrophoresis etc. The course also will provide students with a hands-on understanding of how modern cell and molecular biology techniques can be used to discover and understand cellular function.

Dept. Course 5- Lab Course II (Total Credits: 4)

1. Computer Simulation of models of Natural Selection, Drift and Gene flows
2. Calculating Frequencies of alleles from Population data
3. Pedigree Analyses
4. Study of taxonomic characters and key preparations of ants, other insects, fishes, ants and Birds

Course Objectives:

In Lab Course II students will be trained in practical and conceptual issues in taxonomy, biodiversity and evolutionary biology. It will provide methodological background and quantitative skills in morphological and molecular techniques of taxonomy and systematics. Hands-on training in conducting research in this area will be provided.

Ability Enhancement Compulsory Course (AECC- Industrial Biology) (2 credits)

1. Microbial fermentation and production of small and macro molecules.
2. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for animals.
3. Transgenic animals
4. Genomics and its application to health and agriculture, including gene
5. therapy.

6. Bioresource and uses of biodiversity.
7. Bioremediation and phytoremediation
8. Biosensors

Course Objectives:

To integrate scientific and technological knowledge on the use of biological processes for industrial products at the cell and process level enable students to carry out research / investigation to solve practical problems associated with society and industrial applications independently.

Suggested Reading:

Industrial Microbiology, Lester Earl Casida (Jr),Wiley

Bioremediation, Editors: Valdes, J.J. (Ed.), 2000.

Introduction to Cell and Tissue Culture Theory and Technique. Authors: Mather, Jennie P., Roberts, Penelope E. Springer Publication

2nd Semester

Dept. Course 6- Theory Course: Biochemistry & Biophysics (Total Credits: 4)

1. Structure of atoms, molecules and chemical bonds.
2. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids).
3. Stabilizing interactions (van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
4. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
5. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
6. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes
7. Metabolism of carbohydrates, lipids, amino acids nucleotides.
8. Biophysical Methods: Basic Principles and Applications. Centrifugation, Spectroscopy, UV-VIS, Fluorescence, Circular Dichroism, Nuclear Magnetic Resonance Spectroscopy,

Mass Spectroscopy, X-ray Crystallography, Flowcytometry (FACS) and different types of light and electron microscopy.

Suggested Readings

1. David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry
2. Voet, D., Voet, J. G. & Pratt, C. W. Principles of Biochemistry. Wiley, 4th edition, 2013.
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.

Course Objectives:

Identify different classes of biomolecules and structures, explain fundamental relationships between their structure and function and describe the principal organisation of prokaryotic and eukaryotic cells. Understanding Biochemistry enables students to understanding the central theme of life and its associated mechanisms. This stream is the bridge between the physical science and its application in biological processes. Students can intermingle with the different streams of science to create unison of understanding of any topic of biology.

Dept. Course 7- Theory: Parasitology & Microbiology (Total Credits: 4)

Group A: Parasitology

1. Understanding of the evolution of parasitic associations.
2. Emerging parasitic diseases.
3. Understanding of the modifications (physiological, morphological, and behavioral) needed to assume a parasitic lifestyle.
4. Vector-Borne Parasites and Pathogens of Public Health Importance.
5. Zoonoses and its significance.
6. Myiasis and its evolutionary pathway.
7. Nosography of protozoans
8. Helminthology: Phylum Platyhelminthes: Class Cestoidea
   Phylum Platyhelminthes: Class Trematoda
   Phylum Nemathelminthes: Class Nematoda

Group B: Microbiology

1. Structure and organization of bacteria and virus
2. Microbial Physiology: Growth yield and characteristics, strategies of cell division, stress response.

3. Sterilization techniques
4. Molecular mechanisms of commonly used antibiotics.

Suggested Readings:

Foundation of Parasitology by John Janovy& Larry Roberts, Parasitology by KD Chatterjee

Course Objectives:

The course examines the general biology, life cycles, modes of transmission, and pathogenesis of major parasites on global human health. It will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them. The course will enable students to explore a number of important diseases, along with the diverse protozoans, worms, and arthropods responsible for them. Another portion of the course has been prepared to help understand the ability of our immune system to defend against invading pathogens or parasites in a logical fashion.

Dept. Course 8- Theory: Ecology & Quantitative Biology (Total Credits: 4)

Group A: Ecology

1. Population Growth Models: Continuous and Discrete Population Growths; Exponential and Logistic Models
2. Community level interactions: Defining a Community; Lotka-Volterra equations, Niche Dynamics, Ecological Successions
3. Metapopulations: Defining metapopulations, different populations, modelling metapopulations
4. Island Biogeography: MacArthur-Wilson model

Suggested Readings:

- A Primer of Ecology by Gotelli; Ecology by Charles Krebs

Group B: Quantitative Biology

1. Statistic,Variables, Population, Small; Normal and Binomial distribution
2. Hypothesis Testing
3. Central Tendencies and Measures of Dispersion
4. Parametric and Non-Parametric tests; t-Test, Chi-Square, ANOVA, Kruskal-Wallis, Mann-Whitney U tests

Suggested Readings: Biostatistics by Zar

The Ecology section of the course is designed to help students in understanding the ecological dynamics in endangered ecosystems. Conservation biology part would make them capable to participate in conservation activities as professionals or volunteers. This course is designed to prepare the students to be ready for such professions. Quantitative biology section of the course has been designed to remove the alleged traditional fears of biology students in numerical methods of science. The topics included are expected to help the students in designing experiments or surveys, scientific data collection and management, finally in statistical interpretations from the data, the skills demanded in so many types of professions including research.

Dept. Course 9- Lab Course III (Total Credits: 4)

1. Titration curve of acids of monoprotic and Diprotic acids using a pH meter: preparation of buffers
2. Determination of acid dissociation constant Ka and pKa
3. Assay of enzyme activity
4. Identification & staining of relevant protozoan and helminthic parasite.
5. Microbiome Variation Study

Course Objectives

Lab Course III is intended to familiarize students with basic biochemical techniques to plan and carry out experiments. In addition, the course will also provide students with knowledge of identification of parasites which can facilitate

Dept. Course 10- Lab Course IV (Total Credits: 4)

1. Field identifications of Birds, Butterflies, Fishes and Plants
2. Field study to quantify populations, community parameters in the fields by Quadrats, Transect Methods
3. Water parameter analyses in the fields
4. Field visits to study the management practices in any PA or local community reserve

Course Objectives

Lab Course IV will provide an understanding of fundamentals of tropical ecology, including key habitat features, biodiversity, ecological processes and biotic interactions. The course will provide first-hand experience of ecological research in the tropics, through group exercises and field visits.

SEC: Histopathological Techniques (Total Credits: 2)

1. Theory and principles of different staining procedures in Histopathology.
2. Histochemistry.
3. Immunohistochemistry.
4. Study on Histophysiology of – Liver, Spleen, Kidney, Cardiac Muscle, Ovary, Gut.
5. Preparation of various fixatives & Stain solution.
6. Decalcification of calcified tissue before sectioning.
7. Special staining techniques.
8. Processing of tissue for routine paraffin sections and other methods of embedding.
9. Histochemical identification from processed tissue section.
10. Preparation of biopsy report of – Liver, Spleen, Kidney, Cardiac Muscle, Ovary & Gut.

Course Objectives and Scope of Employability

The skill gained through this course in histopathology will introduce students to microscopic features of tissues and organs, giving them the opportunity to compare and contrast the normal with the abnormal in various disease states. Students will use logical and systematic thinking to solve problems with this diagnostic technique and procedure. This course will give students an edge to pursue career in various histopathological laboratories, diagnostic centres or paramedical institutions.

Suggested Reading:

Junqueira's Basic Histology: Text and Atlas, Book by Anthony L. Mescher and L.C.U. Junqueira. McGraw-Hill Education / Medical.

3rd Semester

Dept. Course 11- Theory: Physiology & Endocrinology (Total Credits: 4)

1. An overview of anatomy and physiology
2. Muscles and Muscle tissue
3. Neurophysiology
4. Cardiovascular system
5. Respiratory system

6. Physiology of chemical digestion and absorption
7. Metabolism and body temperature regulation
8. Fluid, electrolyte and acid-base balance
9. Physiology of male and female reproductive system
10. Outline of endocrine glands, mechanism of hormone action and regulation of hormone secretion
11. Hormone receptors and regulation
12. The second messenger system

Suggested Books-

Elaine N Marieb, Guyton and Hall, Schmidt Nielsen, Williams, Franklyn Bolander, Greenspan and Baxter, Hadley

Course Objectives:

The basic "Physiology & Endocrinology" is a powerful study to help the students to explore the functional logic of living systems. All organisms are made up of cells & systems. This course is designed to explore the fundamentals of body structure & its function. We hope learners will develop a deep intuition to understand the functional logic of a basic anatomy & physiology. To underscore the importance of physiology in our lives, we will address anatomy of our body parts, physiological function and disorders endocrinological system associated with health implications in the human society.

Dept. Course 12- Theory: Animal Behaviour & Conservation Biology (Total Credits: 4)

Group A: Animal Behaviour

1. Evolutionary approach in Behavioural studies
2. Critical perspectives of Imprinting and learning behaviours
3. Reviewing Bee-Dance language
4. Sexual selections- modern perspectives
5. Social Behaviours in insects and primates from evolutionary perspectives
6. Human Behaviours- Critical evolutionary analyses

Suggested Reading

Animal Behaviour by Lee Dugatkin

Group B: Conservation Biology

1. Threats to Biological Diversity
2. Conservations at the Population and Species Levels
3. Conserving Biological Communities, Regional Unique Biodiversity
4. Man-Wildlife conflicts and Development vs Conservation
5. Traditional Ethics and Role of Local Communities in Conservation

Suggested Readings:

- Conservation Biology: A Primer for South Asia by Bawa, Primack and Oommen; Univ. Press. Kolkata

Course Objectives:

Studies of animal behaviours brought one of the only two Nobles for Zoology so far. Emerging fast from its psychological capsules, since then, study of animal behaviours in evolutionary approach has become one of the most attractive fields in biology. In a country of high biodiversity like India, students can flourish in research careers in this low-cost demanding field much more easily than any high cost equip dependent fields of biology. The course is hence designed and offered.

Dept. Course 13- Theory: Cancer Biology & Toxicology (Total Credits: 4)

1. General principles of Toxicology
2. The absorption, distribution, metabolism and excretion of Xenobiotics: Toxicokinetics
3. Interaction of toxicants with their target site: Toxicodynamics
4. Toxins and toxicants
5. Environmental Toxicology & Ecotoxicology
6. General Introduction to Oncology
7. Carcinogenesis: the concept of multistage mutations
8. Cell cycle disruption and cancer
9. Oncogenes
10. Tumour suppressors
11. Growth Factors and Signal Transduction in Cancer
12. Tumor Immunology

13. Tumor antigens
14. Life style and cancer

Course Objectives:

The course intends to equip students with the knowledge of effects of toxic substances on molecular and cellular levels and on public health. The principal aim of the course is to make the students familiar with essential toxicological concepts based on toxicodynamics and toxicokinetics to develop an understanding about drug/toxicant disposition, side-effects of drugs and awareness regarding environmental exposures to toxic substances including carcinogens. Life style factor affecting the incidence of cancer is also being dealt with as it will help the students in acquiring knowledge of preventive strategies against cancer incidence.

Dept. Course 14- Lab Course IV (Total Credits: 4)

1. Measurement of serum biochemical markers of hepatotoxicity (ALT, AST, ALP) in murine/piscine models.
2. Assessment of biomarkers of genotoxicity: a) Micronucleus assay
3. Asssessment of Immunotoxicity: Isolation and staining of murine peritoneal macrophages induced by xenobiotics
4. Measurement of oxidative stress: Assessment of Lipid peroxidation in different organs of murine/piscine system.
5. Measurement of antioxidant enzymes after exposure to toxicants /chemotherapeutic agents
6. Identifying the differences between normal and cancer cells
7. Maintenance of transplantable tumor cell line, development of in vivo tumors and identifying dysplastic.

Course Objectives:

Lab Course IV will provide practical training in toxicological methods, to introduce the students to the study of cytotoxicity, genotoxicity, oxidative stress markers in various experimental setup as well as familiarize students with the basic differences between normal and cancer cells.

Dept. Course 15- Lab Course V (Total Credits: 4)

1. Blood pressure estimation

2. TC, DC, Arneath count, Blood Group
3. Haemoglobin count
4. Blood sugar estimation
5. Preparation of hypothyroid rat model
6. Study of Social Behaviour in Crows / Street dogs
7. Study of facial expressions and other behaviours in humans
8. Study of feeding behaviour in Butterflies/Fishes

Course Objectives

Lab course V will provide a thorough understanding of the concept of homeostasis in humans by studying vital physiological parameters. The animal behavior practical course will provide valuable skills to equip students for work in a wide range of fields relating to animal behavior which is vital for wider habitat conservation and handling zoo animals.

GEC: Ecosystem and Environmental Hazards (Total Credits: 4)

1. Biodiversity: different levels and aspects
2. Biodiversity Usages
3. Threats to Biodiversity and Consequences of Biodiversity loss
4. Biodiversity Regulations: Global Treaties, Indian Acts and Laws, Biodiversity Authority and state Boards
5. Concept of Ecosystem
6. Major Indian Ecosystems
7. Study of Resources in Water, Forests, Soil
8. Ecosystem Services- concepts and examples
9. Environmental movements in India relating to the forests and other ecosystems
10. Conservation policies and laws in India
11. Environmental Stressors: Chemicals, Radiations, Noise, climate change.
12. Response to Environmental Stress: Health and cellular impacts of environmental stress, Endocrine Response to Stress, Stress and adaptation, altered cellular signalling.

Suggested Readings:

- Conservation Biology: A Primer for South Asia by Bawa, Primack and Oommen; Univ. Press. Kolkata
- F. J. Roe Occupational cancer: interaction with life style factors. Postgrad Med J. 1990 May; 66(775): 378–383.

Course objectives:

There is very little scope to argue against the claim that the entire life on earth is now highly endangered due to extreme loss of biodiversity and degradation of natural ecosystems. Thus, this course is offered to make all graduate students aware and sensitized well regarding this survival issue, irrespective of their academic specializations. The course content would make a student enriched with basic knowledge regarding the roles of biodiversity and ecosystem services in sustaining humans and other lives on earth and information on how both are threatened by irresponsible human activities. Upon completion of the course the students will understand the major concepts of environmental science, Identify how toxic chemicals used for many purposes are affecting ecosystem and human health and apply the scientific method and quantitative techniques to describe, monitor and understand environmental systems.

4th Semester

Students will have to opt for 2 courses (2 Theory papers and their corresponding practical papers) from the following list of Electives:

Elective 1- Applied Entomology and Vector Biology (Total Credits: 4)

Theory:

1. Classifications of Insects with salient identifying characters (till Order level)
2. Important insect structures and functions (flight, vision, reproductive structures, sensory structures)
3. Concept of Applied Entomology
4. Economically Beneficial Insects and their cultures: Bees and Apiculture, Lac and Lac Culture, Silk Moths and Sericulture
5. Insect Pests: Agricultural Pests (Rice, wheat, vegetable pests)
6. Insecticides: Chemical and Biological Controls, Insecticide resistance and mechanism of resistance, IPM (Integrated Pest Management)
7. Vector Biology of Plasmodium sp, Japanese Encephalitis, Dengue, Leishmaniasis
8. Methods of Vector Control
9. Forensic entomology

Elective 1 Practical: (Total Credits:4)

1. Identification of insect pests and different species of honey bees, mosquitoes, sandfly, lac insects, silkworms
2. Identification of pollen plants from corbicular pollen
3. Study of any crop pest- ecology, behaviour, life history strategies and control
4. Identification of different stages of Lac-insects and their host plants
5. Methods of insecticide application
6. Determination of LC50 and LD50
7. Study of the ecology, behaviours and life history strategies of major vector mosquitoes /sand flies

Suggested Readings:

1. Insects by R.F. Chapman
2. Agricultural pests of South-East Asia and their management – A.S Atwal &G.S. Dhallwal
3. An Introduction to Sericulture- by J Ganga; SulachanaChetty
4. Bees & Beekeeping in India by D.P. Abrol
5. Lac-culture in India- N. Ghorai, International Books and periodical supply service, New Delhi
6. Medical Entomology – A.K. Hati
7. Medical Entomology- Bruce F. Eldridge, John D. Edman, Kluwer Academic Publishers

Course Objectives:

The mission of this course ranges from basic aspects of arthropod ecology, morphology, parasitology, physiology and systematics to applied subjects in apiculture, agricultural, medical and veterinary pest management.

Elective 2- Applied Conservation Biology (Total Credits: 4)

Theory:

1. Biodiversity and Gamut of Conservation Biology
2. Major Wildlife Areas of India

3. Major Wildlife Species of India, their Ecology and behaviours, Population status and Existence crisis
4. Critical review of Conservation Policies and Actions in India and globally

Elective 2 Practical: (Total Credits: 4)

1. Study of Ecology and Management of any Wildlife PA
2. Study of Behaviour and Ecology of any wild species
3. Study of man-wildlife conflicts

Suggested Reading:

1. Conservation Biology: A Primer for South Asia by Bawa, Primack and Oommen; Univ. Press. Kolkata
2. Conservation Biology: Voices from the Tropics by Editor(s): Peter H. Raven, Navjot S. Sodhi, Luke Gibson; Wiley

Course Objectives:

The elective course of Applied Conservation Biology is designed for those PG students who aspire to become a professional in the emerging field of Conservation, as researcher / teacher or a conservation manager of Indian/State Forest Services, Non Gov. conservation related agencies.

Elective 3- Advanced Immunology & Experimental Therapeutics (Total Credits: 4)

Theory:

1. Functional anatomy of local & systemic immune responses; lymphocyte homing.
2. Toll- Receptor & Innate Immunity; Regulation of Immune response.
3. Dendritic cells & its implication in vaccine designing.
4. Insight the Regulatory T Cells & Memory T Cells.
5. NK cells & its Receptor, NK-T Cells & CD1-New dimension in Antigen presentation.
6. Immune Tolerance.
7. Reproductive immunology.
8. Neuroimmunology.
9. Allergy and Asthma.
10. Autoimmunity.
11. Transplantation Immunology

12. Immunodiffusion Techniques.
13. Immunoeletrophoresis& Western blotting.
14. Radio immuno Assay (RIA).
15. ELISA.
16. Fluorescence Activated Cell Sorter (FACS).
17. Hybridoma technique.
18. Detection of Apoptosis.

Elective 3 Practical: (Total Credits: 4)

1. Preparation of growth media and techniques related to sterile culture of cells.
2. Cell proliferation assay by MTT
3. Microscopic detection of apoptosis by DAPI &/or Acridine orange- PI method

Course Objectives:

The course aims to provide students with the necessary training to enable them to understand the principles that underpin clinical research, and to translate that understanding into good research practice.

Elective 4- Advanced Molecular Oncology and Biochemical Techniques (Total Credits: 4)

Theory:

1. Development And Oncogenesis
2. Oncogenes,
3. Growth Factors And Receptors,
4. Stem Cell Biology And Cancer
5. Non-Coding Rna Biology And Cancer
6. Cancer Immunotherapy
7. Cancer Diagnostics And Treatments;
8. Current And New Therapies,
9. Current Methods And Technologies Used In Cancer Diagnostics And Research.
10. Enzymes: Principles Of Catalysis, Enzymes And Enzyme Kinetics, Enzyme Regulation, Mechanism Of Enzyme Catalysis, Isozymes
11. Methods For Purifying And Analysis Of Biomolecules (Gel Chromatography, Ion Exchange Chromatography, Affinity Chromatography, Electrophoresis).
12. Western Blot, Elisa, RIA, Chip Assay, Use Of Shrna, Sirna In Cancer Biology
13. Dna Sequencing Methods, Strategies For Genome Sequencing.

14. Methods For Analysis Of Gene Expression At Rna And Protein Level, Large Scale Expression, Such As Micro Array Based Techniques
15. Expression Of Recombinant Proteins Using Bacterial, Animal Vectors.

Elective 4 Practical: (Total Credits: 4)

1. Zymography
2. Western Blot
3. ELISA
4. CHIP
5. Enzyme Kinetics
6. Flowcytometry:
7. Fluorescence Imaging Techniques
8. Isolation and quantification of Non-Coding RNA from cancer cells

Suggested Reading:

1. Weinberg, Robert A.The biology of cancer 2. ed.: New York: Garland Science, cop. 2014 [dvs. 2013]
2. David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry
3. Voet, D., Voet, J. G. & Pratt, C. W. Principles of Biochemistry. Wiley, 4th edition, 2013.
4. Berg, J. M., Tymoczko, J. L. and Stryer, L. Biochemistry. Freeman, 7th edition, 2011.

Course Objectives

The aim of the course is to provide an in-depth understanding of the molecular mechanisms underlying the development of cancer. The course will provide students with the knowledge and training needed to approach and formulate scientific questions relevant to the cancer biology. The course will also survey the frontiers of cancer research and aims to make the students acquainted with to the applied advanced methods, technologies and state-of-the-art web-tools used in cancer research.

Elective 5- Behavioral Endocrinology (Total Credits: 4)

Theory:

1. The approach of Behavioral Endocrinology
2. Sex Differences in Behavior: Sex Determination and Differentiation
3. Male & female Reproductive Behavior: Endocrinological aspect
4. Hormones and Social Behavior: affiliation & aggression (including parental behavior, homeostasis)

5. Biological Rhythms
6. Hormones & Stress
7. Hormonal aspect of Learning and Memory

Elective 5 Practical: (Total Credits: 4)

1. Behavioural and Endocrinal response to different external stimuli in fishes.
2. Sexual behaviours: Case study
3. Social Behaviours of Humans: Case study
4. Study of play & painting patterns of male & female child
5. Detection of hormones by ELISA
6. Semiquantitative PCR

Suggested Readings:

An Introduction to Behavioral Endocrinology Book by Randy J. Nelson, Publisher- Sinauer

Course Objectives:

The field of behavioural endocrinology is a truly interdisciplinary effort. It involves the study of phenomena ranging from genetic, molecular, and cellular levels of analysis to the study of individual and social behaviour. The course deals about the interaction of hormones and behaviour from diverse perspectives. This course inspires students to enter the exiting field of Behavioral Endocrinology and to work in such an exciting research discipline too.

Elective 6- Cell Signaling & Cancer Biology (Total Credits: 4)

Theory :

1. Principles of Cell Signaling Systems**:** General Introduction. Receptors; transducers; Second messengers
2. Cell signaling and signal transduction: G-protein coupled receptors signaling, TGFbeta signaling, Wnt pathway, Notch signaling, Receptor Tyrosie Kinase Pathway, Ras-MAPK signaling, JAK-STAT pathway,NF-kappa B, Hedgehog pathway, PI3-Akt/mTOR pathway
3. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.
4. Characteristics of cancer cells, Transformation and Mutagenesis

5. Deregulated Signaling Pathways in Cancer.
6. Oncogenes, tumor suppressor genes, virus-induced cancer,
7. Cancer and the cell cycle
8. Proteases and Signaling Ubiquitin-proteasome pathways in signaling; Apoptosis Caspase pathways ; Cytokine Receptors Janus kinase and signal transducer and activator of transcription (JAK-STAT) signaling; Toll-Like Receptors; Signaling in innate immunity
9. Cancer types and Staging : General introduction: Staging, Staging in solid cancer and fluid cancer
10. Tumor micro Environment - Angiogenesis and Molecular aspects of metastasis and
11. Cancer cell metabolism**:** How is the metabolism of a resting cell different from a proliferating cell. What molecules are important for the altered cancer cell metabolism. What pathways contribute to the altered cancer cell metabolism.
12. Therapeutic interventions of uncontrolled cell growth and Therapeutic resistance

Elective 6 Practical: (Total Credits: 4)

- Establishing and maintenance of in vivo tumor models
- Gene expression studies in cancer cells
- Studying proliferation and apoptosis in cancer cells
- Techniques to study angiogenesis and metastasis

Suggested Readings:

1. Weinberg RA. The Biology of Cancer, 2nd Edition. Garland Science, 2013.
2. Molecular Biology of Cell: Lodish

Course Objectives:

The impact of cancer on all our lives emphasizes the need to continue training individuals to pursue research into its cure and prevention. The goal of this course is to provide students with education and training that enables them to make significant contributions to tackle this ever-increasing burden of cancer. Students also learn about the current state of the epidemiology, clinical diagnosis, treatment, and prevention of human cancers. Given this huge investment in cancer research, the job market for individuals with doctoral degrees in cancer biology is very large and growing. This course will provide students an edge to pursue a career in the field of cancer biology.

Dept. Course 20: Dissertation (Total Credits:8)

Includes project on an original problem under the supervision of any faculty WBSU or from other Institute of National repute.

Academic calendar

	Semester begins	Semester ends	TEE Theory	TEE Practical	Publication of results	Note
Semester 1	July	Third Friday of November	First week of December (Mon, Wed, Fri)	Second/ Third week of December For a week	January 31	Buffer time kept to accommodate for any delay in publication of UG Hons results for election etc
Semester 2	First/Second Monday of January	First Friday of May	Third week of May (Mon, Wed, Fri)	Last week of May	July 15	Students can be given option for Summer internship during June
Semester 3	Second Monday of July	Second/ Third Friday of November	last week of November/or First week of December (Mon, Wed, Fri)	First/Second week of December	January 15	Extra time kept to accommodate festival holidays
Semester 4	First Monday of January	Last Friday of April	Second week of May (Mon, Wed, Fri)	Last week of May/ first week of June (Project presentation)	June 30	

Explanations:

1. Semester duration : average 15 weeks
2. Preparatory leave for students: 1 week between end of classes and beginning of TEE
3. Term end Examination duration: 2 weeks