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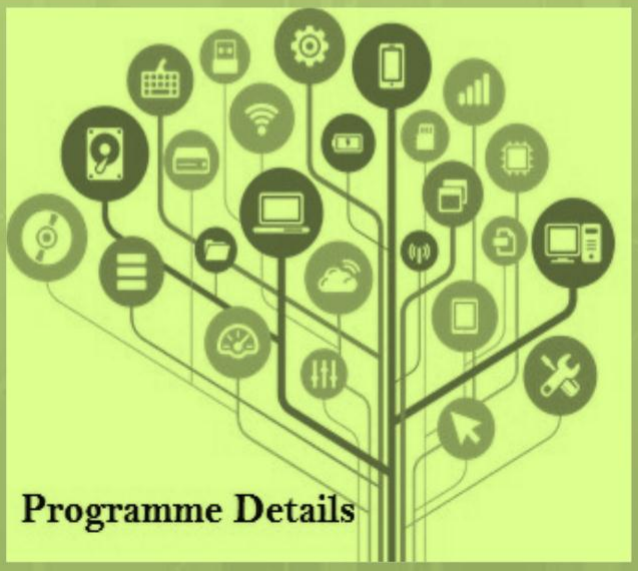
University of Mysore

(Estd.1916)

M.Sc. ZOOLOGY

Choice Based Credit System (CBCS)



UNIVERSITY OF MYSORE

Department of Studies in Zoology

Manasagangotri, Mysuru-570006

Regulations and Syllabus
Master of Science in Zoology (M.Sc.)
(Two-year semester scheme)

Under
Choice Based Credit System (CBCS)

5/1/21

CHAIRMAN
BOS in Zoology
Department of Zoology
UNiversity of Mysore
Manasagangothri
MYSORE - 570 006

UNIVERSITY OF MYSORE

GUIDELINES AND REGULATIONS
LEADING TO
MASTER OF SCIENCE IN ZOOLOGY
(TWO-YEAR SEMESTER SCHEME UNDER CBCS)

Programme Details

Name of the Department	:	Department of Studies in Zoology
Subject	:	Zoology
Faculty	:	Science and Technology
Name of the Programme	:	Master of Science in Zoology (M.Sc.)
Duration of the Programme	:	2 years divided into 4 semesters

Programme objectives

The main objective of this M.Sc., programme is

to provide strong foundation in the subject of Zoology starting from Animal diversity to advance techniques

to prepare the students Faculties in undergraduate colleges, Academic Institutions and Universities Researchers in research institutions, fishery, Animal husbandry, forest department Forensic department Entrepreneur to start their own company

Programme Outcomes

The M.Sc., programme in Zoology is highly reputed programme among life sciences in the University. On successful completion of this programme each student will:

Have a strong foundation in understanding the basic s of Animal science both in non-chordate and chordate. Further, the student will be able to learn technology in the field of Genetics, cell biology, human genetics, molecular biology, immunology, molecular basis of animal development, environment biology, Biodiversity and wild life biology and evolutionary biology.

Develop practical skills along with their theory components, which will help in their research programme both in academic institutions and in R & D programmes of different national and international institutes.

Inculcate skills for teaching in academic institutions for undergraduate and postgraduate students.

Develop confidence in taking competitive examination in the field of life science both in India and abroad so that they can pursue higher education.

Programme Specific Outcomes

1. Acquire knowledge through practical work in fields as well as in laboratory.
2. Project helps for creating research attitude among the post graduate students
3. Comprehend about economically important fishery, poultry, animal husbandry, goat and sheep farming.
4. Demonstrate the application of bio-pesticides; know about sources, methods and production of bio-fuel.
5. Employ the methods of cultivation & economic importance of various species, honeybees, lac insects, fruit fly, sericulture, vermiculture etc.

Programme Pedagogies

- Class room teaching will be using black board and chalk, power point presentation and information and communications technology.
- One to one interaction during tutorial classes and theory
- Each student performs experiments individually in all subjects
- Student seminar/research paper presentation in tutorials and during dissertation
- Students will be tested for their writing abilities to answer precise and essay type questions.
- Every semester students face many frequent and surprise tests for C1 and C2
- Every semester the students will be subjected to viva voce examinations by external examiners in each practical exams
- IV semester they conduct project work on a research problem given by the teachers
- Students present the Literature review and the results of the work done at the end of the IV semester

Scheme of Examination and Details of Course Patterns for M.Sc. Degree Course (CBCS)

FIRST SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	19111	Non-Chordata	HC	3	0	1	4
2	19118	Transmission Genetics	HC	3	0	0	3
3	19119	Cell Biology	HC	3	0	0	3
4	19114	Animal Physiology	HC	2	0	2	4
5		Practical Cytogenetics	HC	0	0	2	2

6	19113	Biological Chemistry	SC	2	0	2	4
7	19120	Vectors & Communicable diseases	SC	3	1	0	4

SECOND SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	19131	Chordata	HC	3	0	1	4
2	19132	Reproductive Biology	HC	3	0	0	3
3		Practical Reproductive Biology & Histology	HC	0	0	2	2
4	19133	Molecular Biology	HC	3	0	1	4
5	19138	Histology and Histopathology	SC	3	0	0	3
6	19139	Advanced Genetics	SC	4	0	0	4
7	19137	Principles of Animal Science	OE	3	1	0	4
8	19140	Drosophila Genetics	OE	3	1	0	4

THIRD SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	19181	Ethology & Evolutionary Biology	HC	4	0	0	4
2	19182	Applied Zoology	HC	3	0	1	4
3	19183	Advanced Developmental Biology	HC	3	0	1	4
4	19184	Molecular Endocrinology	HC	3	0	0	3
5	19185	Genetic Engineering & Biotechnology	SC	3	0	1	4
6	19186	Adaptation Biology	SC	3	1	0	4
7	19187	Reproductive Health	OE	3	1	0	4

FOURTH SEMESTER

Sl. No.	Code	Title of the Paper	Course Type	Credit pattern in			Credit value
				L	T	P	
1	19171	Environmental Biology	HC	3	0	1	4
2		Advance D Cell Biology	HC	4	0	0	4
3		Major Project	SC	0	2	6	8
4		Research Methodology	SC	3	1	0	4
5	19174	Medical & Environmental Impact of Developmental Genetics	SC	3	1	0	4
		Biodiversity & Wildlife Biology	SC	3	1	0	4
6		Economic Zoology	OE	3	1	0	4

FIRST SEMESTER

HARD CORE

COURSE-I: CHORDATA

Objectives

To study the structure and functional anatomy of invertebrates

To study the taxonomy and systematics of invertebrate groups

Course outcome

- Understand the basic of Non-chordata
- Understand the external as well as internal characters of non chordates.
- Understand the economical ecological and evolutionary significance of invertebrates

COURSE CONTENT

UNIT - I: Animal Taxonomy and Systematics

Introduction to taxonomy – Principles, stages, importance and rise of taxonomy.

a. Taxonomic Procedures – Traditional or evolutionary method, Phonetic and Cladistic Methods.
b. Taxonomic collections, identification and description; Taxonomical hierarchy (Linnean hierarchy); Vertical and Horizontal Classification; Concepts of Taxon, holotype, paratype, topotype etc.
c. ICZN regulations and Zoological Nomenclature including use of suffixes 'i', 'orum', 'ae', 'arum', 'ensis' and 'iensis'. oidea, idea, inae,; Tautonyms, synonyms and Homonyms.
d. Concept of species- Different Species concepts, sub-species and other intra-specific categories.
e. New trends in taxonomy: Ecological, Ethological, Cytological and Biochemical approaches and Numerical taxonomy.
f. Molecular basis of animal taxonomy- DNA hybridization, Restriction analysis and sequencing of nucleotides.

UNIT – II: Coelom, Nutrition and Locomotion

a. Origin and importance of Coelom: Acoelomates and Pseudocoelomates; Coelomates - Prostomia and Deuterostomia.
b. Locomotion - Flagella and ciliary movement in Protozoa. Hydrostatic movement in Coelenterata, Annelida and Echinodermata.
c. Patterns of feeding and digestion in lower metazoa; Filter feeding in Polychaeta, Mollusca and Echinodermata

UNIT – III: Respiration, Excretion and Nervous system

a. An overview of patterns of respiration in Invertebrates; Emphasis to be given to organs of respiration like Gills, Book-lungs and trachea and Respiratory pigments in Invertebrates
b. An overview of patterns of excretion in Invertebrates; Emphasis to be given to organs of excretion: Coelomoducts, Nephridia and Malphigiantubules,Cocal glands.
c. Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Crustacea and Insecta) and Cephalopoda, Trends in neural evolution.

UNIT – IV: Development and Paleontology

An overview of patterns of reproduction in Invertebrates; Direct and Indirect developments; Larval forms of free living and Parasitic invertebrates, Strategies and Evolutionary significance of larval forms; Fossils: Formation, Types and importance of fossils and an overview of Geological Time Scale

Practical: NON-CHORDATA

1. Study of Nervous system : Crab, Sepia / Loligo
2. Study of mounting of Nephridium and Spermatotheca in Earthworm
3. Study of Respiratory system: Mounting of Gills, Trachea and Booklungs
4. Protozoa: Gregarines, Monocystis, Ceratium, Euplotes, Didinum, Noctiluca, Radiolaria, Stentor, Opalina
5. Porifera: Sectonal view of *Sycon*(T.S., L.S.) Grantia (T.S.)
6. Cridaria: Obelia polyp and medusa, Pennaria, *Aurelia* –Tentaculocysts Virgularia, Spongodus, Zoanthus, Favia
7. Helminthes – Slides of Temnocephala, *Ascarislumbricoides. Taenia solium, Planaria*
8. Annelida: Slides of Ozobranchus, Glossiphonia, Eunice, *Chloieaflava*, Polynoe, Terrebella, Eurythoe. Chaetopterus
9. Arthropoda – Balanus, Lepas. Palinurus, Uca, Pycna, Hippa, Gongylus. Belostoma Limulus, Squilla, Eupagurus
10. Mollusca – Museum specimens of Dolobella, Pteria, Nerita, Sanguinolaria, Lambis
11. Mollusca - Tridacna, Onchidium, Oliva, Murex, Turritella, Bulla, Cardium, Arca
12. Echinodermata – Echinodiscus, Holothuria and Antedon
13. Visit to campus – to study invertebrates in their natural forms
14. Visit to Earth Science Department – to study different fossils and GTS

COURSE-II: TRANSMISSION GENETICS

Objectives

To study Mendel's principles of inheritance and extension of Mendell
To study gene structure and functions both in prokaryotes and eukaryotes

Course outcome

- Understanding of Mendel's principle, its extension and chromosomal basis.
- Understand fine structure of gene (rII locus), one gene one enzyme concept and inheritance sex-linked, sex-limited traits. Inheritance of haploid organisms.
- Understand linkage and crossing over with suitable examples including microbial genetics transduction, conjugation, transformation in bacteria

COURSE CONTENT

Mendel's principles of inheritance:, The principles of dominance, segregation and independent assortment.

a. Extensions of Mendelian principles: Allelic variations-a diagnostic test for allels: Dominance: incomplete dominance, codominance, overdominace, pseudoalleles, multiplealleles, lethalalleles, penetrance and expressivity, pleiotropy; Interaction of genes: Epistasis, Supressors; Polygenic inheritance; Phenocopy.

a. **Fine structure of gene:** Beadle and Tatum's One gene one enzyme concept, one gene one polypeptide concept, Complementation test, Intragenic complementation, Cistron, Recon and MutonEg. lz gene in *Drosophila* (Lozenge gene), rII locus in T4 phage.
b. Sexlinked inheritance: In *Drosophila* and Humans, Inheritance of sex limited and sex influenced traits.
c. Study of inheritance in haploid organisms- Neurospora, cross (tetrad analysis); Mitotic recombination.

a. **Linkage and crossing over:** Chromosomal theory of inheritance; Concept of linkage- Experiments of Bateson and Punned, Morgan's experiment ; Genetic recombination and construction of linkage maps in *Drosophila* ; Interference and coincidence
b. **Extranuclear inheritance:** i) Organelle heredity-Chloroplast-Variegation in 4'o clock plant; Mitochondria- Petite in Saccharomyces, ii) Maternal effect- Shell coiling in Limnaea, iii) Cytoplasmic Inheritance - Paramecium (Kappa Particle), iv), Infectious heredity - Sigma virus and *Wolbachia* bacterium in *Drosophila.*

Microbial Genetics: (i) Conjugation: Discovery, nature of donor strains and compatibility, molecular mechanism of conjugation, Hfr, F (ii) Transformation: Discovery, Natural transformation systems, development of competence, Events involved in transformation (iii) Transduction: Discovery, generalized and specialized transduction, mechanism of generalized transduction, abortive transduction, mechanism of specialized transduction, sexduction.

COURSE-III: CELL BIOLOGY

Objectives

To study, cellular architecture of both prokaryotes and eukaryotes. -
Structural and functional differences in the different cellular organs
To study meiotic and mitotic division and cellular dynamics during division including abnormality

Course outcome

- Understand the differences between eukaryotic and prokaryotic cells along with function
- Molecular organization of different cell organelles with their function and molecules involved in building the tissues
- understand types of cell division and its regulation, dynamics during cells division and consequences of its misregulation

COURSE CONTENT

a. **Overview of Cells and their functional specializations**
   i. Prokaryotic cells: Bacteria, Mycoplasma;
   ii. Eukaryotic specialized cells: RBC, muscle cells, neurons, Osteoblast

b. **Molecular architecture of eukaryotic cells**
   i. **Biomembranes –** composition, structure, fluid mosaic model.
   ii. **Basic functions of biomembrane**: permeability, osmotic principles, carrier proteins, channel proteins, passive transport, active transport, membrane pumps, multidrug resistance transport protein, pinocytosis, phagocytosis, receptor mediated endocytosis, transcytosis, electrical properties of membranes.

iii. .Integrating cells in to tissues: Cell junctions: occluding junctions, Anchoring junctions and communicating junctions, (Tight junctions, Desmosomes, Gap junctions), Cell adheshion:NCAM, Cadherins, fibronectins and integrins

iv. Endoplasmic Reticulum (ER): Protein secretion, targeting proteins into ER, insertion of proteins into ER membrane, export of proteins and lipids from the ER, fate of misfolded proteins

UNIT II Cellularorganelles and their function

a. Mitochondria: Ultra structure, inner membrane, transport proteins, synthesis and targeting mitochondrial proteins, biological energy transducers

b. Lysosomes:Lysosomal acid hydrolases, mechanism of membrane resistance to lysosomal enzymes, pathways and mechanisms of intracellular digestion, lysosomal secretion/defecation, lysosomal storage diseases

c. Golgi complex: Ultrastructural organization, protein glycosylation within Golgi, lipid and polysaccharide metabolism in Golgi, protein sorting and export from the Golgi. microbodies (Peroxisomes),

d. Nucleus: Nuclear envelope, nuclear pore complex, import and export between nucleus and cytoplasm, NLS, structure and function of Nucleolus (Ribosome factory)

UNIT-III: Cell division and chromosomes

Molecular mechanism of cell division: i) Amitosis, Endomitosis and Mitosis ii) Ultra structure and organization of centrosome, centromere, Kinetochore, iii) Microtubules and their dynamic instability, Microtubule Associated proteins, Anaphasic movements, Cytokinesis

a. Chromatin organization : (i) Molecular organization of Eukaryotic chromosome - Nucleosomes, Telomeres, Histone and Non-Histone proteins. ii) Chromosome Banding, Karyotyping and its importance

b. Heterochromatin: Constitutive and facultative heterochromatin- Properties and functions, Gene silencing by heterochromatinization (telomeric effect).

c. Special chromosomes: (i) Polytene chromosomes: Structural organization and significance. (ii) Lampbrushchromsomes: Structural organization and significance.

d. Chromosomal rearrangement:

i) Structural rearrangements in chromosomes: (i) Deletions, Evolution by gene duplications, Inversion heterozygotes, Permanent structural (Translocation) heterozygosity. Ex. Oenothera , Centric fusion and Centric fission (ii) Practical applications of rearrangements- Balancers, Ring chromosomes, Attached X-chromosome in Drosophila.

ii) Numerical variations in chromosomes: (i) Aneuploidy – causes and consequences with examples from Man (Trisomy 21 and sex chromosomal) (ii) Polyploidy – causes and consequences. Ex. Raphanobrassica, Wheat.

COURSE-IV: ANIMAL PHYSIOLOGY

Objectives

The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.

to understand how these principles are incorporated into the adaptations of different animal groups

The discipline covers key homeostatic processes, such as the regulation of temperature, blood flow, Cellular Respiration ,Bioenergetics, Circulation , Excretion and Neurophysiology

Course outcome

- understand the mechanisms that work to keep the animal body alive and functioning, through scientific enquiry into the nature of mechanical, physical, and biochemical functions of animals, their organs, and the cells of which they are composed.
- have an enhanced knowledge and appreciation of mammalian physiology
- understand the functions of important physiological systems including the cardio-respiratory, Neurophysiology and metabolic systems
- understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, jumping, swimming and flight.
- be able to perform, analyse and report on experiments and observations in physiology be able to recognise and identify principal tissue structures.

COURSE CONTENT

UNIT-I: Transport across the membrane, Cellular Respiration & Bioenergetics

a. Molecular mechanisms of passive and active transport.
b. i) Energy – Concept, laws of thermodynamics ii) Redox potential iii) Stepwise release of energy through cytochromes, production of ATP, uncoupling of oxidative phosphorylation, inhibitors iv) Anaerobic and aerobic breakdown of glucose, alternate pathway – HMP shunt and glucoronic acid pathway v) Citric acid cycle as common metabolic pathway.

UNIT-II: Circulation and Excretion

a. i) Major types of body fluids and their composition, ii) Neurogenic and myogenic hearts iii) Mammalian heart – cardiac cycle, ECG.
b. i) Nitrogenous waste products in animals ii) Formation of ammonia, urea and uric acid. iii) Nitrogen excretion in relation to water economy iv) Overview of urine formation in mammals with emphasis on regulation of fluid volume, blood pressure, sodium levels and Acid-base balance.

UNIT III: Muscle and Neurophysiology

a. Molecular organization of sarcomere ii) Mechanism of contraction with emphasis on sliding filament and Davies models, regeneration of storage phosphate iii) Physiological adaptations of muscles for jumping, swimming and flight.
b. i) Electrochemical gradients – Nernest and Goldman equations ii) Axonal and synaptic transmission of nerve impulses iii) Synaptic integrity, synaptic plasticity iv) Molecular mechanism of sensory transduction and neural output in receptor cells.

UNIT IV: Environmental Physiology

i) Concept of homeostasis, Regulators and conformers ii) Tolerance, resistance acclimation and acclimatization iii) Overview of thermal homeostasis in homeotherms, CNS regulation of body temperature maintenance iv) Temperature compensation in poikilotherms
a. Overview of osmoregulation in aquatic and terrestrial animals
b. Stress: Metabolic and immunological responses.

PRACTICAL: ANIMAL PHYSIOLOGY

1. Estimation of blood glucose content.
2. Estimation of glycogen in liver

3. Determination of Blood cholesterol content.
4. Determination of Iodine number of fats to evaluate the biological value.
5. Total count of RBC and WBC.
6. Differential count of WBC.
7. Determination of serum phosphatase activity.
8. Estimation of blood urea content.
9. Determination of serum acetylcholine esterase activity.
10. Estimation of RNA concentration by Diphenylamine method.
11. Estimation of serum LDH activity.

PRACTICAL: CYTOGENETICS

Objectives

to study the chromosomal structure, location and function in cells. It includes the study of chromosome number, appearance and chromosomal behaviour in processes such as cell division. gaining expertise in culture and maintenance of *Drosophila melanogaster*
to study the morphology of wild type and mutants of Drosophila flies, including their life cycle

Course outcome

- be knowledgeable about genetic crosses and analysis of progeny
- understand the details of polytene chromosome and chromosomal anomalies
  understand different stages of meiosis and chromosomal segregation
- understand the technologies employed and the technical workflow

Course Content

1. Study of Life cycle, culture and maintenance of *Drosophila melanogaster.*
2. Study of Morphology (wing, sex comb, genital plate and bristles) of *Drosophila melanogaster*
3. Study of mutants of *Drosophila melanogaster*– Dominant, Recessive, Autosomal, Sex-linked and Multiple mutations
4. Genetic crosses and analysis of P_1, P_2, F_1, F_2 & test cross progeny in *Drosophila:*(a) Monohybrid (b) Dihybrid (c) Sex-linked inheritance
5. Study of Polytene chromosomes of *Drosophilamelanogaster*
6. Study of inversion heterozygotes in *D.anannassae*
7. Study of meiotic stages and chromosome anomalies in grass hopper testis
8. Study of Barr body using buccal smear of volunteers
9. Observation of mitochondria using Janus green stain

SOFT CORE

COURSE-V: BIOLOGICAL CHEMISTRY

Objectives

Its aim is to understand the fundamental chemical principles that govern complex biological systems
The program is an interdepartmental major between biology and chemistry that emphasizes the importance of a solid foundation in the natural sciences, including mathematics and physics
The program seeks to graduate students who are conversant in concepts ranging from biological evolution to quantum chemistry. Understanding the molecular logic of life and being able to participate in the acquisition of this knowledge is integral to the zoology course.

Course outcome

- understand the core principles and topics of Biochemistry and their experimental basis.
- able to demonstrate advanced knowledge and understanding in the principles of protein structure, Principles of bio-physical chemistry, Principle and Types of Chromatography, an overview of carbohydrates and lipids chemistry, structural organization of nucleic acids and the behavior of proteins.
- understand the enzyme kinetics including their nomenclature and classification.
  able to estimate the amount of proteins and amino acids
- able to explain theoretical aspects of colorimetry and Spectrophotometry
  Critically analyses experimental data
- Present orally contemporary biochemical topics

Course Content

UNIT–I: Foundations of Biochemistry and Techniques in biochemistry

a. Structure of atom and molecules
b. Stabilizing interactions – Vandervaal's, electrostatic, hydrogen bonding, hydrophobic interactions.
c. Principles of bio-physical chemistry –pH, buffer, reaction kinetics, molarity, normality
d. Principle and Types of Chromatography; Principle, method and application of Ion exchange and HPLC.
e. Principle, method and applications of NMR spectroscopy, Flow cytometry and ELISA

UNIT–II: Carbohydrates and lipids

a. Carbohydrates – an overview of chemistry and classification, stereochemistry- D and L isomers, epimer, chair and boat conformations, cyclic structure.
b. Lipids – an overview of chemistry and classification, fatty acid synthesis & breakdown, blood lipid profile & its impact on health, steroids – Types and outlines of biosynthesis, eicosanoids- types.

UNIT–III: Proteins and Nucleic acids

a. Primary structure – determination of protein structure, Anfinsen's experiment, Secondary structure - alpha helix, beta sheets (dihedral angles, circular dichroism, Ramachandran plot, tertiary and quaternary structures, protein folding and denaturation, misfolding (Prion).
b. Nucleic acids – chemistry, types and structural organization, alternate models, cyclic nucleotides – chemistry and biosynthesis.

UNIT–IV: Enzymes and Vitamins

a. Enzymes – Nomenclature and Classification, Mechanism of enzyme action, Enzyme inhibition, Factors affecting enzyme catalyzed reactions, abzymes, ribozymes, isozymes
b. Vitamins: Classification; sources, effects and deficiency diseases of water soluble and fat soluble vitamins; vitamins as co-enzymes; Trace elements and significance in nutrition.

PRACTICAL: BIOLOGICAL CHEMISTRY

1. Colorimetry: Theoretical aspects of colorimetry and Spectrophotometry to be Explained.
   Determination of absorption maxima using dye solutions. Demonstration of Beer-Lambert's law.
2. Thin layer chromatography of a plant extract.
3. Demonstration of gel electrophoresis (Proteins).
4. Preparation of osazones and identification of carbohydrates.

5. Test for non esterified fatty acid
6. Colour reactions of albumin.
7. Estimation of amino acids by Sorenson's formal titration.
8. Estimation of Proteins by Lowry et al method.
9. Effect of enzyme concentration on rate of enzyme catalyzed reaction
10. Effect of temperature on rate of enzyme catalyzed reaction

COURSE-VI: VECTORS AND COMMUNICABLE DISEASES

Objectives

its aim is to give an introduction to vector biology

Create a framework for to improve surveillance and monitoring of emerging vector-borne zoonotic diseases of viral origin

to learn the control methods for vectors and vector borne diseases

to create an awareness and to know the importance of educating people and community participation

Course outcome

- understand the importance of vectors from its historic background to current drug discovery
- know the Epidemiology and symptoms of malaria, filariasis, yellow fewer, leishmaniasis, anthrax, dengue, chikungunya, Japanese encephalitis, schistosomiasis and plague
- gaining a basic knowledge regarding Cultural control methods, chemical methods, genetic and environmental methods, biological methods using microbes and predators
- able to spread an awareness of the added value of integrated surveillance, risk assessment and early warning to prevent and control epidemics and epizootics in the society

Course Content

UNIT-I: Introduction to vector biology

a. Scope and importance of vectors:
b. Historical perspective – epidemics, scientists involved in the discovery of vectors and pathogens of communicable diseases.
c. Bio-ecology and life cycle of vectors.
d. Vector-parasite interaction; Host-pathogen interaction, insect transmitting bacteria and viruses.

UNIT-II: Biological vectors and Communicable diseases

a. Epidemiology and biology of vectors and pathogens,
b. Transmission cycles and symptoms of malaria, filariasis, yellow fewer, leishmaniasis, anthrax, dengue, chikungunya, Japanese encephalitis, schistosomiasis and plague.

UNIT-III: Mechanical vectors

a. House flies, cockroaches and bedbugs – Transmission of dysentery, diarrhea, typhoid cholera, epidemic conjunctivitis and skin infections.
b. Nematodes: Ancylostoma, Ascaris, Enterobius&Wuchereria
c. Tikes: Morphology and life history of : Argas and Haemaphysalis

UNIT-IV: Control of vectors and vector borne diseases

a. Cultural control methods, chemical methods, genetic and environmental methods, biological methods using microbes and predators. Integrated Vector Control and Management (IVCM).
b. Insecticide resistance in vectors, Drug resistance in pathogens.
c. Importance of education, awareness and community participation.

SECOND SEMESTER

HARD CORE

COURSE-I: CHORDATA

Objectives

Learn and recognize the four major characteristics of chordates
Learn and identify the major groups within the Phylum Chordata
To understands the level of organization in chordate subphylum
Study of museum specimens and slides with emphasis on evolutionary and adaptive significance
To understand the origin and evolutionary relationship in different subphylum of chordates

Course outcome

- able to describe unique characters and classification of Protochordata. Phylogenetic interrelationship between Protochordates and Chordates
- explain the mechanisms of respiration, circulation and locomotion among the vertebrates
- understand the details of vertebrate Integument, Excretory system, Nervous system and Sense organs among the chordates
- understand the diversity of chordates

COURSE CONTENT

UNIT I. Origin and interrelationships

a. General characters and outlines of classification of Chordata - the construction and interpretation of classifications. Origin of chordates in the light of recent theories.
b. Fine structure and role of notochord and endostyle in Amphioxus and Ascidia with their evolutionary significance.
c. General characters and classification of Protochordata.. Phylogenetic interrelationship between Protochordates and Chordates.
d. Reproduction in Tunicates and significance of retrogressive metamorphosis.
e. The Nature of Vertebrate Morphology – Definition, Scope and Relation to other disciplines; Importance of the study of vertebrate morphology.

f. Some principles and considerations. Origin and Classification of Vertebrates.

UNIT II. Vertebrate Integument, Excretory system, Nervous system and Sense organs

a. Development and general structure of skin and its functions; Integument of fishes with emphasis on dermal derivatives; Integument of Tetrapods with emphasis on epidermal derivatives - glands, scales, horns, claws, nails, hoofs, feathers and hairs.
b. Excretion- Evolution of uro-genital system in Vertebrates; Comparative account of kidney in Vertebrates.
c. Nervous system: Development of spinal cord and peripheral nervous system; Evolution of spinal nerves, cranial nerves and autonomic nervous system; Development and organization of the brain; Comparative account of brain in Vertebrates.
d. Sense organs: Types of receptors; Organs of olfaction and taste-Vomero-nasal/Jacobson's organ in reptiles; lateral line system; electroreception in fish; ear and eyes in Vertebrates.

UNIT III. Respiration, circulation and locomotion:

a. Structure and mechanism of cutaneous, branchial and pulmonary respirations.
b. Outline of origin and evolution of cardiovascular system in vertebrates.
c. Form, function, size and skeletal and muscular elements of the body –Appendicular skeleton – origin of tetrapod limbs and their modifications. Appendicular musculature of Tetrapodes.
d. Axial skeletons- Overview of Skull Morphology, Skull Function and Design. Origin of Jaw and modification of Jaw bones and types. Functional and evolutionary significance of Jaw suspension in Vertebrates. Origin and evolution of Webbarianossicles in fish and ear ossicles in mammals.
e. Types of vertebrae of Procoelus, Opisthocoelus, Amphicoelus, Amphiplatins, Heterocoelus, Axis and atlas vertebrae.
f. Types of Vertebrate musculature. Flight muscles of Birds; Skeletal and muscular elements in Running and jumping; Digging and crawling without appendages; Climbing; Swimming, diving , Flying and Gliding.

UNIT IV. Adaptive radiation in Vertebrates

Origin, evolution and adaptive radiation in fishes, amphibians, reptiles, birds and mammals.

PRACTICAL: CHORDATA

1. Study of Digestive, Reproductive, Respiratory, Arterial and venous systems in different vertebrates.
2. Study of museum specimens and slides with emphasis on evolutionary and adaptive significance:
3. Protochordates – Salpa-sexual, Salpa-asexual, Botryllus, Herdmania
4. Fishes – *Rhinobatus, Chimera, Acipenser, Amia, Periopthalamus, Triacanthus, Notopterusnotopterus, Scatophagusargus, Trichiurus, Mastacembalusarmatus, Exocoetus (flying fish),Diodonhysterix, Echenesnaucrates. Zygaena, Pristis, Narcine, Trygon,*

*Rhinobatus, Chimaera.*Actinopterygii :*Polypterus, Lepidosteus, Muraena, Mystus, Catla.Hippocampus, Syngnathus, , Anabas, Diodon, Tetradon, Echeneis.*

5. Amphibians – *Icthyophis, Geganophis, Rhachophorus, Ranatigrina, Amblystoma, Uraeotyphlus, Necturus, Amphiuma, Ambystoma*and its Axolotllarva. *Triton, Salamandra, Hyla, Rhacophorus.*
6. Reptiles – *Sitana, Chameleon, Phyrnosoma, Chelonemydas, Hemidactylus, Calotes, Draco, Varanus, Phrynosoma. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera, Crocodilus. Gavialis, Chelone*and *Testudo.*
7. Birds – Indian Oriole, Indian koel - male & female, Indian tailor bird, kite, jungle fowl.
8. Mammals – Indian otter, Marmoset, Loris Bat –*Megadermalyra,* Pangolin.
9. Osteology - Skull and lower jaw of *Chelonia,* Crocodile, Bird, Carnivore mammal (dog), Herbivore mammal (horse);Types of vertebrae of Procoelus, Opisthocoelus, Amphicoelus,Amphiplatin, Heterocoelus, Axis and atlas vertebrae.

COURSE-II: REPRODUCTIVE BIOLOGY

Objectives

The major objective of this course is to provide students with a sound coverage of mammalian reproductive biology within the framework of Human Biology. This is achieved by first covering fundamentals of the structure and function of the male and female reproductive tracts, game to genesis, fertilization, early embryogenesis, fetal development and preparation for birth, and maternal adaptations to pregnancy particular emphasis is placed on the hormonal control of reproduction provides an important foundation to consider sexual differentiation and development, contraception, infertility and current reproductive technologies

Course outcome

- understand the basics of Sex differentiation and Female reproductive organs understand the details of female and male reproductive physiology
- Relate the structural characteristics to the function of each part of the tract
- Describe the major changes that occur in the female reproductive tract over the menstrual cycle
- Describe the hormonal control of ovarian and testicular function
- Describe the embryonic development of the male reproductive system and the role of hormones in its control
- Describe the major treatments available for infertility and the social and ethical issues associated with these treatments

COURSE CONTENT

UNIT – I Sex differentiation and Female reproductive organs

a. Origin and migration of primordial germ cells; genetic and hormonal control of differentiation of gonads and gonadal ducts in mammals.

b. Female Reproductive System-Functional morphology of mammalian ovary, Fallopian tube and uterus.

c. Hormonal control of follicular development – Recruitment and selection of follicles, Follicular dominance, Oocyte maturation, Ovulation, Atresia and Regulation of corpus luteum.

UNIT – II Female reproductive physiology

a. Onset of puberty in human, factors affecting onset of puberty
b. Estrous cycle and it's hormonal regulation
c. Menstrual cycle and it's hormonal regulation
d. Fertilization – Molecular Events of fertilization
e. Implantation – Process, Types and hormonal control
f. Pregnancy – length of gestation, hormonal control
g. Parturition – Process of birth and influence of hormones
h. Lactation – Hormonal control of mammary gland development and lactogenesis

UNIT – III Male reproductive physiology

a. Functional morphology of mammalian testis
b. Brief description of histomorphology and hormonal control of male accessory organs *viz.*, epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland
c. Sperm maturation – morphological and biochemical events, influence of accessory organ secretions; capacitation
d. Biochemistry of semen
e. Kinetics of spermatogenesis – wave and cycle, Stem cell renewal
f. Hormonal control of spermatogenesis
g. Ultrastructure of spermatozoa
h. Abnormalities of sperm

UNIT – IV Fertility control and assisted reproduction (ART)

a. Fertility control: Need, principles, practice and efficacy of different male and female temporary and permanent contraceptive methods- hormonal and barrier methods; intrauterine devices and sterilization.
b. Assisted Reproduction: Ovulation induction, Sperm bank, Artificial insemination, different methods of assisted reproduction – *In vitro* fertilization (IVF), gamateintrafallopian transfer (GIFT), Zygote intrafallopian transfer (ZIFT), intracytoplasmic sperm injection (ICSI), pre-implantation genetic diagnosis (PGD), Surrogacy. Ethical and legal considerations of ART and PGD.

COURSE-III: PRACTICAL: REPRODUCTIVE BIOLOGY & HISTOLOGY Objectives

-The Use of Histological Techniques to Study the Reproductive Biology -
to understand the morphology of ovary and testis in vertebrates

-to learn the basics of histopathology and histochemistry
- to study different contraceptive devices

Course outcome

- understand the estrous cycle in rat using vaginal smear -able to stain the vaginal smear in laboratory rat.
- able to identify sperm abnormalities in semen samples
- understand the pathology of Gastric ulcers, Cirrhosis of liver, Breast tumors, Cyctic follicles of ovary, Pancreas in diabetes, Cryptorchid testis and leukemia

COURSE CONTENT

I. Reproductive Biology

a. Study of estrous cycle in rat using vaginal smear.
b. Staining of vaginal smear in laboratory rat.
c. Sperm count and study of sperm abnormalities in semen samples collected from volunteers / clinical samples.
d. Study of different contraceptive devices
e. Observation of permanent slides
   i. Comparative morphology of ovary in vertebrates
   ii. Comparative morphology of testis in vertebrates

II. Histology

a. Microtomy and staining: Hematoxylin-eosin – Demonstration
b. Functional histology: Observations of permanent histology slides of mammalian organs: stomach, intestine, spleen, liver, kidney, lungs, thymus, blood vessel, lymph vessel, brain, bone and bone marrow.
c. Histopathology: Study of histopathological changes (permanent slides): Gastric ulcers, Cirrhosis of liver, Breast tumors, Cyctic follicles of ovary, Pancreas in diabetes, Cryptorchid testis and leukemia.
d. Histochemistry: Localization of proteins and (Bromophenol blue method) and PAS reaction

COURSE-IV: MOLECULAR BIOLOGY

Objectives

-to understand the chemical and molecular processes that occur in and between cells -to learn the basics behind structure of DNA and its replication
-to gain a better understanding of central dogma of molecular biology
- to learn the processes behind the gene regulation among prokaryotes and eukaryotes

Course outcome

- understand the structure of DNA and the mechanism behind the replication
- understand DNA repair mechanisms and different types of recombination methods - able to discuss the whole process of replication, transcription and translation in a detailed manner
- understand the nature of elements and regulators during gene regulation in prokaryotes and eukaryotes
- able to isolate and estimate DNA
- able to explain the principle behind PCR and karyotyping

COURSE CONTENT

UNIT I

a. **Introduction to Nucleic acids:**a) Nucleic acids store and convey genetic information, Information transfer– Central Dogma – b) Overview of structure of: DNA: The double helix Complementarity of bases
b. **Replication of DNA**:
    1. Enzyme and non enzyme components of replication machinery
    2. Replication process: i) Initiation of replication: Origin of replication, DnaA, Regulation of initiation in relation to cell division. ii) Elongation: coordinated synthesis of Leading and Lagging strands. iii) Termination: End replication problem-telomerase in eukaryotes
    3. Fidelity in replication: Selection, proof reading, mismatch repair.

UNIT II

DNA Repair i) Direct reversal of DNA damages: Photoreactivation, Alkyl transferases (ii) Excision repair: Nucleotide excision-Uvr ABC system, Base excision and AP nuclease pathway (iii) Transcription coupled repair (iv) SOS repair (v) Translesion synthesis.

a. **Recombination**: Homologous recombination: (i) Models of Recombination - Holliday model, Double strand break model, Genetic consequence of homologous recombination. (ii) Protein Machinery and mechanism of homologous recombination.

UNIT III Transcription

(a) cis components Template, promoter, (b) RNA polymerases (c) Transcription mechanism-Initiation, Elongation and Termination in Prokaryotes and Eukaryotes (d) Post transcriptional modifications of transcripts (i)Prokaryotes: mRNA, rRNA, tRNA. (ii) Eukaryotes: mRNA (G-cap, Poly-A tail, Splicing)

UNIT IV Translation

(i) Genetic code: genetic and biochemical analysis of genetic code, features of Genetic code, (ii) Enzymes of translation: AminoAcyltRNAsynthetase, Peptidyl transferase (iii) Translation process and factors: initiation, elongation (selection against incorrect Amino Acyl tRNA), and termination

UNIT V Gene Regulation in Prokaryotes

a. **Transcriptional Regulation: i)** Cis acting elements: Operator, enhancers, Silencers, Trans factors - Activators, Repressors, DNA binding motifs, helix turn helix, Zinc finger, Leucine Zipper ii)The Operons - Lactose operon (Allosteric, positive, negative control), iii)Regulation in Lambda Phage - Lytic and lysogenic cycle (Logic of lambda)
b. **Regulation beyond transcription initiation**, i) premature termination of transcription - Tryptophan operon (*trp* attenuator) ii) Ribosomal proteins as translational repressors (iii) Riboswitches (B12).

UNIT VI Gene Regulation in Eukaryotes

a. **Transcriptional Regulation i)** Basic considerations, Britten and Davidsons model ii) Transcriptional activators: Recruit transcription machinery proteins and nucleosome

modifiers (HATs & DMTs), Example: Yeast Mating type switching iii}Transcriptional repression : Mechanism - Competition, inhibition, direct repression, indirect repression,

b. **Regulation after transcription initiation:** i)Alternative mRNA splicing (Reliable recognition of splice sites, ESE & ESS sequences, SR proteins), Mechanisms (Exon skipping etc) and significance examples sxl ,tra *and* dsx in flies ii) Translational control as in Ferritin and transferrin mRNA, iii)RNA interference miRNA and siRNA with examples

Practical: MOLECULAR BIOLOGY AND EVOLUTION

1. DNA isolation by rapid method
2. Estimation of DNA concentration by Diphenylamine method
3. Demonstration of PCR
4. Karyotyping
5. Study of mitotic chromosomes of *D. melanogaster*
6. Study of sympatric species- *D. melanogaster* and *D. anannassae*
7. Study of few examples of homologous and analogous organs
8. Experiment to demonstrate Genetic drift and Natural Selection

SOFT CORE

COURSE-V: HISTOLOGY AND HISTOPATHOLOGY

Objectives

- To acquire a basic background in histology and to understand the properties of cells and their interactions with one another as components of tissues and organs
- To understand how structure and function correlate at the microscopic level

Course outcome

- The student will be able to identify the basic structure of cells, tissues and organs and describe their contribution to normal function.
- The student will be able to explain the relationship between histology and the pathogenesis of disease
- understand the Principles and methods of immunohistochemistry techniques
- able to describe the normal structure and function of various cell types, tissues, and organs, and to differentiate their histological structures from each other through examination

COURSE CONTENT

UNIT I Tissue fixation and staining

a. Histology, Histochemistry and Histopathology: Meaning, objectives and applications.
b. Tissue fixation: Objectives, methods, chemical fixatives-types and chemistry of fixation; Physical methods - freezing and microwave fixation; choice of fixatives, factors affecting fixation, fixation artifacts.

c. Dyes – Classification, Natural and Synthetic,

UNIT II Histology

a. Epithelium: Types and modifications – cilia, microvilli, stereocilia, flagella, junctional complexes.
b. Functional Morphology (mammalian): lungs, kidney, spleen, thymus, brain, bone and bone marrow, blood and lymph vessels.

UNIT III Histochemistry

a. Classical Histochemistry:
Principles and methods of application and utility of classical histochemical techniques : Examples: Localization of glycoproteins (PAS), nucleic acids (Feulgen) and steroid dehydrogenase activity.
b. Immunohistochemistry:
Principles and methods of application of Imunohistochemistry and immunofluorescence techniques. Examples: Localization of proteins in endocrine cells (Pituitary cell types or islet of Langherhans); *In situ* hybridization of nucleic acids.

UNIT IVHistopathology

a. Morphological alterations in cells due to disease, types of degeneration-clouding, hyaline, hydrophic and fatty degeneration.
b. Etiology, pathogenesis and histopathology of Liver cirrhosis and atherosclerosis, Neuropathology of alcoholism and methanol poisoning.
c. Tumors- malignant and non-malignant, types of carcinoma, histopathology of breast and prostate tumors.

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3. Pearse, A.G.E. (1980): Histochemistry, theoretical and Applied ,J& A, Churchill Ltd., London.
4. Rogers, A.W.(1983): Cells and Tissues, An introduction to Histology and Cell Biology, Academic Press, NY.
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COURSE-VI: ADVANCED GENETICS

Objectives

-to understand basics of different types of mutations and muatagens -
to understand the molecular basis of sex determination
-to gain a profound knowledge regarding chromosome, genes and genomes
-to understand the genetic basis of different syndromes and disorders in humans

Course outcome

- able to explain and discuss detailed structure of chromosomes and molecular basis of genes
- understand the molecular basis of epigenetics

- understand the techniques behind the different types of mapping the genomes - gain a brief knowledge about structural genomics, functional genomics and comparative genomics

COURSE CONTENT

UNIT I

a. **Mutations:** (i) Mutations: Types of Mutation: Synonymous, Nonsynonymous, Nonsense, missense, frameshift mutations, Transition and Transversion. (ii) Reverse mutations (iii) Intragenic suppressors (iv) Lethal mutation (v) Loss of function mutation (vi) Gain of function mutation- Amorphic, hypomorphic and isoallelic mutations.

b. **Chemical mutagens:** (i) Base analogues (ii) Nitrous acid (iii) Hydroxylamine (iv) Hydrazine (v) Alkylating agents (vi) Detection of mutations – Ames test (2) *Drosophila*: Sex-linked recessive lethals, autosomal recessive lethals, dominant lethal test

c. **Sex determination and dosage compensation**
i) Chromosomal basis of sex determination: (i) Simple systems: Eg: XX/XY, XX/XO, ZZ/ZW (ii) Parthenogenesis: Ex. Honey bees. (iii) Molecular basis of sex determination in *Drosophila* and Man (iv) Molecular basis of dosage compensation in *C. elegans*, *Drosophila* and Man.

UNIT II Epigenetics

a. Introduction to concept and definition of Epigenetics, Epigenetic Landscape (Waddington)

b. **Imprinting of Genes,Chromosomes and Genomes:** i) Discovery- Pronuclear transplantation experiments in mouse, (ii) Sex determination in Coccids iii) H19/IGF2 (reciprocal imprinting) in mammals

c. **Molecular basis of epigenetics**
   i. Histone & DNA modifications (acetylation, deacetylation, methylation, Histone phosphorylation, 'Histone Code'),
   ii. Role of Non-coding RNAs in gene regulation eg. X-chromosome inactivation in mammals,
   iii. Chromatin remodelingand differential gene regulation by Polycomb and Trithorax proteins.
   iv. Epigenetic reprogramming: Epigenome, Epigenotypes (Twins, Age related, diseases)

Unit III Genomics

a. **Mapping of genomes**: (i) Genetic mapping- (1) Cross breeding and pedigree analysis (2) DNA markers - RFLPs, SSLPs, SNPs. (ii) Physical mapping - Restriction mapping, Fluorescent *in situ* hybridization, Radiation hybrid mapping and Sequence tagged site mapping.

b. **Structural genomics:**(i) Assembly of a contiguous DNA sequence- shotgun method, clone contig method, and whole – genome shotgun sequencing. (ii) Understanding a genome sequence: locating the genes in a genome sequence, determining the functions of individual genes

c. **Functional genomics**: Study of transcriptome (By sequence analysis, and Microarray analysis) and Proteome (Interacting proteins by phage display and Yeast two hybrid system)

d. **Comparative genomics**: Bacteria (*H. influenzae*), organelles, eukaryotes (Yeast,*Caenorhabditiselegans, Drosophila*, *Arabidopsis*, Human).

UNIT IV Human Genetics

a. History, Construction and analysis of Pedigrees, Pattern of inheritance.

b. **Genetic basis of syndromes and disorders**:(1)Monogenic diseases (i) Autosomal dominant (Huntington diaease) (ii) Autosomal recessive (Cystic fibrosis) (iii) Inborn errors of

metabolism (Phenylketonuria) (iv) Genetic disorders of Haemopoietic systems (Sickle cell anemia) (v) X linked disorders (vi)Genetic disorders of eye (colour blindness) (vii) Muscle genetic disorders (Duchenne Muscular Dystrophy) (2) Genome imprinting syndromes (Prader-Willi & Angelman syndromes) (3) Chromosomal disorders (aneuploidy, structural variations) (4) Mitochondrial disorders (5) Multifactorial disorders (diabetes, Obesity) (6) Polygeneic congenital heart diseases (7) Cognitive disabilities (Schizophrenia) (8) Neurogenetic disorders (Parkinson disease) (9) Genetics of reproduction

c. **Diagnosis, Counseling, Therapy and Ethics:** (a) Prenatal diagnosis: (1)Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography (2) Invasive methods-Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy (b)Technology in reproductive assistance (c) Genetic counseling: (d) Risk assessment and counseling in Mendelian and multifactorial syndromes (e) Gene therapy (f) Genome editing (g) Eugenics, human genetics and legal, social and ethical considerations.

OPEN ELECTIVE

COURSE-VII: PRINCIPLES OF ANIMAL SCIENCE

Objectives

-this open elective paper mainly helps the students from non-zoology background to gain a basic knowledge about the Characteristics of animals ,branches of animal science and the Uniqueness of Indian Wildlife

-another aim of the paper is to understand the fundamentals of biomolecules, cells, tissues and organ systems

- to discuss the principles of animal science with presentations and tutorials

Course outcome

- understand the chemical composition of carbohydrates, lipids, proteins and nucleic acids.
- able to describe the basic structure of a cell and its organelles in a detailed manner
- understand the theories behind cell division, functional diversity and structure and function of different organ systems
- understand the fundamentals of ecology and environmental biology able to discuss the theory of inheritance and evolutionary theory

COURSE CONTENT

UNIT I. Introduction and Animal Taxonomy

a. Characteristics of animals
b. Branches of animal science
c. Uniqueness of Indian Wildlife
d. Animals as natural resource and their Conservation.
e. Animals and human welfare.
f. Variety of life (different Kingdoms)
g. Carl Linnaeus – Taxonomic hierarchy, Binomial nomenclature
h. Major and minor phyla – diagnostic features with example for each phylum

UNIT II Biomolecules, Animal cells and Tissues

a. Chemical composition
b. Examples and importance of carbohydrates, lipids, proteins, nucleic acids, enzymes and hormones
c. Sources and function of vitamins

d. Cell theory
e. Brief description of animal cell (light and ultra structure)
f. Functions of cell organelles
g. Structure and functional diversity in animal cell
h. Cell division
i. Structure and functions of basic tissues.

UNIT III Organ systems: Structure and functions

a. Nutrition: Feeding mechanisms in animals – filter feeding, biting and chewing, piercing and sucking, detritus feeding. Human alimentary canal and outlines of digestion and absorption
b. Respiration : Respiratory devices in different habitat, Human respiration – exchange of gases, cellular respiration, and ATP synthesis
c. Circulation : Blood vessels and capillaries, composition of blood, blood coagulation, immunity
d. Excretion : Nitrogenous waste productions, excretory organs in animals, mammalian kidney and urine formation
e. Movement : Locomotion in vertebrates – Swimming, walking running, flying skeletal muscle contraction
f. Co-ordination : Neural and chemical co-ordination, parts of nervous system and their functions, endocrine system and hormones as chemical messengers
g. Reproduction : Asexual and sexual reproduction, significance of sexual reproduction, outlines of human reproduction and fertility control

UNIT IV Ecology and Environmental Biology

a) Abiotic and Biotic factors b) Population ecology c) Environment and Micro organisms (microbial ecology) d) Environmental Pollution – brief account of Air, Water, Noise, Pesticide, Metal, sound and soil pollution.

UNIT V Heredity and Evolution

a) Continuity of life – Mendel's laws b) Structure of chromosomes and genes c) DNA and RNA d) Central dogma in molecular biology d)Evolution: Major theories and Evidences

UNIT VI Applied Zoology

a. Brief description, and economic importance of Vermiculture, Apiculture, Sericulture, Fishery, poultry, piggery and diary
b. Vectors and human parasites.

Course-VIII-DROSOPHILA GENETICS

Objectives

- This genetics oriented open elective paper is mainly for non biology students to help them understand the details of genetics by taking *drosophila* as a model organism
- To better understand the cytogenetics and genetics behind the development of drosophila

Course outcome

- Gain a deeper knowledge about basics of gene, genome, chromosome and the pattern of mendelian inheritance
- Understand the cytogenetic implications of chromosomal abberations
- Able to discuss the developmental genetics of *drosophila*
- Understand the genetic basis of sex determination in *drosophila*

COURSE CONTENT

UNIT I *Drosophila* as model

a) Mendelian inheritance in *Drosophila* b) sex linked inheritance c) Interaction of genes in *Drosophila* d) polytene chromosome e) concept of gene-experiments on lozenge locus in *Drosophila*

UNIT II Cytogenetics of *Drosophila*

a) Chromosomal aberrations b) Cytogenetic implications of Deletions, Duplications, Inversions, Translocations, Centric fusion and Centric fission c) Practical applications of rearrangements in *Drosophila.*

UNIT III Developmental genetics of *Drosophila*

a) Early development b) pattern formation: Antero posterior, Terminal group genes and Dorso-Ventral axis formation, Homeotic genes and body plan, c) Pattern formation in imaginal discs.

UNIT IV Mutations

Induction and detection of mutations in *Drosophila* b) Chromosomal and Molecular basis of sex determination in *Drosophila* d) Molecular basis of dosage compensation in *Drosophila*

THIRD SEMESTER

HARD CORE

COURSE-I: ETHOLOGY AND EVOLUTIONARY BIOLOGY

Objectives

-to explain both phylogenetically and physiologically the functional relationships of all factors involved in behavior

-to study the animal behaviour basically with a focus on behaviour under natural conditions, and viewing behaviour as an evolutionarily adaptive trait

-to understand the theories of evolution and to understand the Forces of Evolution that affect the allelic frequencies

Course outcome

- get a better understanding about the reflexes and complex behavior, innate and learned behaviour and different kinds of biological communications -get an idea in approaching to study the genetics of behavior
- gain a better understanding of the theories of evolution and the details of human evolutionary theories
- understand ideas and evidence that supports how life might have changed through time through speciation and molecular evolution

COURSE CONTENT

PART – A: ETHOLOGY

UNIT – I: Study of animal behavior

a. Descriptive versus experimental approaches.
b. Reflexes and complex behaviour- Latency, after discharge, summation, warm up, fatigue inhibition and feedback control;
c. Instinctive Behaviour - Fixed action pattern, Types of sign stimuli and releasers as triggers ; Genetic basis of instinctive behavior ;
d. Learning- Classical conditioning experiment, latent and insight learning. Social learning; Altruism;
e. Anti predatorbehaviour – avoiding detection through colour and Markings (Mullerian mimicry), Warning coloration. Batesian mimicry;
f. Biological communication: Forms of signals, vision, audition and chemicals; Role of pheromone-Insects social organization; pheromone effects in mammals- Lee Boot, Whitten, Bruce, Collidge and Castro-Vandenberg effect/s

UNIT-II: Approaches for studying the genetics of behavior

a. Low tech' approaches

b. Quantitative genetic approaches
c. Candidate gene approaches
d. Genomic
e. Quantitative trait locus mapping
f. Microarray approaches
g. Other whole-genome approaches
h. Behavioural Genetics: a) Inheritance of behavioral traits b) Nest cleaning behavior in honey bees d) Circadian rhythm in Drosophila c) Genetic dissection of behavior using mutations in Drosophila

PART B: EVOLUTIONARY BIOLOGY

UNIT III

a. **Theories of Evolution:** Overview of Lamarckism, Darwinism; Development of Neo-Darwinism-Mendelian Population; Gene pool, Allele and Genotype frequencies; Hardy-Weinberg genetic equilibrium.
b. **Forces of Evolution that affect the allelic frequencies**: Mutation, Migration, Selection-Stabilizing selection, Directional selection, Disruptive selection, Balancing selection, Frequency dependent selection, Density dependent selection, Group and kin selection ; Selection coefficient; Selective value; Genetic drift; Nonrandom mating.
c. **Human evolution:** Hominid evolution: Anatomical, Geographical, Cultural; Molecular phylogenetics of *Homo sapiens*; Phyletic gradualism and punctuated equilibrium

UNIT IV

a. **Isolating mechanisms and speciation:** Concepts of species; Isolating mechanisms - Geographic, Reproductive isolation - Premating isolation- Climatic, Seasonal, Habitat, temporal, Ethological; Post mating isolation- gametic mortality, zygotic mortality, Hybrid inviability, Hybrid sterility, Hybrid breakdown ; Origin of reproduction isolation- Muller's view, Dobzhansky's view; Models of speciation - sympatric, allopatric, stasipatric; speciation by hybridization
b. **Molecular Evolution:** Molecular clock - Conversion of genetic distance into divergence time, Neutral theory of molecular evolution , Emergence of Non-Darwinism, Kinds of molecular data used in phylogenetic analysis, Phylogenetic considerations based on nucleotide and amino acid data.

COURSE-II: APPLIED ZOOLOGY

Objectives

- To provide a strong foundation and motivation for applying fundamental concepts of **applied zoology** in basic research to meet global challenges
- It provides the knowledge of medicine, dentistry, Veterinary medicine, medical technology, animal farming and fisheries
-to learn about the life cycle of pests and harmful insects

Course outcome

- will gain a better knowledge about apiculture, lac culture and sericulture
- understand the ethology and life cycle of venomous insects and chemical composition of venom and its applications
- understand the advantages and limitations behind the animal farming and fisheries - get a better understanding about the aquaculture with field visits

COURSE CONTENT

UNIT I Beneficial Insects

a. Meaning and scope of Applied Zoology.
b. Apiculture: Honeybee species, Bee forage, Pollen calendar, Beekeeping, bee hive products, honeybee diseases and management.
c. Lac culture: Lac insects, host plants, Lac culture and by products.
d. Sericulture: Silkworm races, Life cycle of *Bombyx mori*, silkworm rearing, Grainage activity, Seed area, Silkworm diseases and their control. Pests and predators of silkworms.
e. Insects as tools in Forensic Science.

UNIT II Harmful insects

a. Plant insect interactions: Origin of insect pests, pest control and IPM.
b. Pests of cereals and pulses: Rice, Wheat, Jowar and Zeyamays, Green gram, Bengal gram (one pest from each category).
c. Pests of millets and commercial crops: Finger millet, Pearl millet, cotton, coffee, tea (one pest from each category).
d. Venomous insects and chemical composition of venom and its applications

UNIT III Animal Farming

a. Poultry: Poultry breeds, hatcheries, rearing, poultry diseases and their management and poultry by products.
b. Dairy: Dairy breeds, dairy farming, Dairy management and by products of dairy.
c. Laboratory animal science: General principle of breeding and maintenance of small laboratory animals – Rat, Mouse. CPCSEA Guide lines.
d. Piggery: Pig species, rearing and bi products.

UNIT IV Fisheries

a. Fisheries resources of India: coastal, deep sea and inland fisheries
b. Fresh water and marine aquaculture; culturable organisms: prawn, pearl and oyster culture.
c. Intensive freshwater fish culture: carps & cat fishes, integrated fish farming, composite and polyculture fish farming, fish by products.
d. Ornamental fish culture and sea weeds.

PRACTICAL: APPLIED ZOOLOGY

Apiculture

1. Study of honeybee species and honeybee colony members (queen, drone & worker honeybee).
   Mounting of mouth parts, sting apparatus and appendages from moribund honeybee worker.
   Analysis of honey quality: Physical and biochemical parameters.

Sericulture

2. Silkworm egg (DFL), silkworm larva, pupa and adult moths, bivoltine and multivoltine cocoons, non-mulberry silkworm cocoons, silkworm pests-Uzi fly and Dermested beetles.

3. Insect pests: Rice, wheat, Jowar, vegetables, coffee, cotton, millet and Pulses pests.
4. Venomous insects and insects of Forensic Science importance.

Poultry & Dairy

5. Study of Quality parameters of Egg and milk.

Aquaculture

6. Commercially important inland and marine fishes, prawn and ornamental Fishes.
   Fixing and presentation of dead insects by Plastination Technique.
7. **Field Visits:** Fish Farm, Sericulture, Apiculture and Lac culture Farms, Dairy and Poultry Farms and Visit to Animal House.

COURSE-II: ADVANCED DEVELOPMENTAL BIOLOGY

Objectives

- The course in Developmental Biology is an introduction to animal development and places special emphasis on mammalian development
- Students having a basic knowledge of biochemistry and cell biology, begin to study the multicellular level of biological organization.

Course outcome

-understand the mechanisms regulating developmental process
-able to dicuss the gentic basis of pattern formation among insect,amphibian and mammals
-get a better understanding of morphogenesis and neurogenesis
-able to explain the developmental mechanisms of evolutionary changes -able to dissect and mount the Imaginal discs of *Drosophila*
-will understand the homeotic genes and maternal effect mutations

COURSE CONTENT

UNIT I

a. **Introduction**: i) Issues in developmental Biology ii) Mechanisms regulating developmental process: Autonomous specification - morphogenetic determinants (Yellow Cytoplasm, gcl), Conditional specification - Cell Cell Interaction (Lens induction)
b. **Pattern Formation**: Laying down the primary body axis- i) *Drosophila* (Anterior/posterior, terminal group genes, Dorso/ventral axis) ii) Amphibians (Dorso/ventral) iii) Left –right axis in mammals. iv) Segmentation genes: Gap genes, Pairule genes, Segment polarity genes in *Drosophila*. v) Homeotic Selector genes in flies, mammals (Hox code).

Unit II

a. **Morphogenesis:a)Gastrulation:** i) Morphogenetic movements and selective affinities of cells (cadherins and differential adhesion) ii) Molecular regulators of mesodermal migration (fibronectin, lamin, integrin)
b. **Neurogenesis** i). Neuronal specification -Notch signaling- a skin/nerve regulatory switch in flies. ii). Axonal path finding: Attractants and repulsive signals – (long range and short

range- Lamin, Netrins, Semaphorins, Neurotrophins), Target selection and forming the synapse. Example:Retinal axon pathfinding

c. **Mesoderm**-vertebrate heart development (heart field specification, migration, differentiation, looping and chamber formation)

UNIT III

Limb development: i) limb bud formation & specification (FGF, Hox, Tbx, genes, retinoic acid) ii) Digit formation- A/P axis specification and ZPA, Cell death in digit formation.

a. **Metamorphosis and Regeneration**: i) Molecular mechanism of ecdysone action-cellular choice between apoptosis and differentiation. ii) Molecular responses to thyroid hormone during metamorphosis (Amphibians). iii) Blastema formation and differentiation during regeneration. (Morphollaxis in Hydra and Epimorphosis in Salamander)

b. **Developmental mechanisms of evolutionary changes** i) Genetic mechanisms- Heterotopy (loss of limbs in snakes, Turtle shell) , Heterochrony (Dolphin flippers) , Heterometry (Darwin's Finches), Heterotypy (Why insects have six legs) ii) Homologous genetic pathways of development –Deep homology

PRACTICALS: ADVANCED DEVELOPMENTAL BIOLOGY

1. Live observation of *Drosophila* embryogenesis.
2. Dissection and mounting of Imaginal discs of *Drosophila.*
3. Study of gene expression during development with lac-Z reporter gene in Embryos. (Demonstration)
4. Reporter gene Lac-Z expression in imaginal discs.
5. Study of homeotic and maternal effect mutations.
   Observation of GFP tagged reporter expression in embryos, imaginal disc and others.
6. Chick embryo mounting and study

Course-III: MOLECULAR ENDOCRINOLOGY

Objectives

-to understand the molecular structure and function of Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters

-to understand the genetic control of harmone synthesis

Course outcome

- understand the basics of endocrine system
- able to discuss the mechanism of hormone action
- get a better understanding of Hypothalamo-Hypophyseal system
- able to explain the Morphology and physiological actions of melatonin
- able to explain the Bio-chemistry of synthesis, secretion and metabolism of thyroid hormones and Parathormone

COURSE CONTENT

UNIT I

a. **Hormones**
   i) History, ii).Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters iii) An over view of Mammalian endocrine system, iv) An overview of general classes of chemical messengers-Peptide, Amino acid derivatives and Steroid hormones; v) Neurotransmitters-Neuropeptides, vi). Growth stimulating factors, Chalones, Eicosanoids and Pheromones.(3 hrs)

b. **Hormones and Homeostatsis :**
   i) Glucose, Calcium and Sodium Homeostasis, ii). Neuro-endocrine integration: milk ejection reflex and water balance. (4 hrs)

c. **Endocrine Methodologies :**
   i) Histological-Cytological, ii). Surgical and Hormone replacement Therapy, iii). Bioassay, iv). RIA, v). ELISA, vi). Recombinant DNA techniques, vii). Gene knockout animal models. (5 hrs)

UNIT II

a. **Genetic control of hormone synthesis:**
   i). Structure and expression of protein hormone encoding gene- Posttranslational modification, molecular aspects of peptide hormone secretion and delivery, ii). Transport and peripheral activation of hormones. (5 hrs)

b. **Mechanism of hormone action :**
   i). Membrane bound , cytoplasmic and nuclear hormone receptors, ii). Regulation of receptor number, iii). Non-genomic mechanism of hormone action, Signal transduction:secondary messengers - cyclic AMP, prostaglandins, DAG and calmodulin, iv). Genomic mechanism of hormone action-Steroid and thyroid hormones - regulation of gene expression v). Termination of hormone action and metabolism of hormones. (5 hrs)

c. **Invertebrate Endocrinology :** Structure, functions and molecular actions of insect and crustacean hormones with special reference to reproduction. (2 hrs)

UNIT III

a. **Hypothalamo-Hypophyseal system :**
   i). Endocrine Hypothalamus : Structure, Chemical nature and control of secretion of hypothalamic hormones-TRH, GHRH, GnRH, CRH, Somatostatin and dopamine, Control of release of these hormones and their action on target cells, ii). Pituitary- Location, Development, structure and functional cell types, Hypothalomo-hypophysial portal system, Pituitary hormone and their physiological actions with emphasis on molecular mechanisms-GH and Prolactin, FSH, LH and FSH (Glycoprotein Hormones), Pro-opiomelanocortin and Neurohypophysial Hormones, iii). Control of Hypophysial Hormones, secretion and Feed back regulation, iv). Pituitary patho-physiology :Hyperprolactinaemia, Pituitary dwarfish, Gigantism and Acromegaly.(7 hrs)

b. **Pineal gland :** Morphology and physiological actions of melatonin (1 hr)

c. **Endocrine Pancreas :**
   i). Structure and cell types of Islets of Langerhans, ii). Secretion and metabolism of Insulin, Glucagon and other pancreatic hormones, iii). Cellular and molecular actions of Insulin and Glucagon, iv). Insulin and Non Insulin Dependent Diabetes Mellitus, v). Islet cell tumor (4 hrs)

Unit IV

a. **Thyroid and Parathyroid Glands:**
   i). Position and Morphology, ii). Bio-chemistry of synthesis, secretion and metabolism of thyroid hormones and Parathormone, iii). Actions with emphasis on molecular mechanisms, iv). Patho-physiology-Goiter, Grave's disease and Cretinism. (5 hrs)

b. **Adrenal Gland.**

i). Anatomy, embryology and histology, ii). Control of synthesis, secretion and physiological roles of cortical hormones with emphasis on molecular actions, iii). Adrenal chromaffin tissue : Synthesis, and actions of catecholamines, iv). Addison's disease and Cushing's syndrome. (5 hrs)

c. **Gastro-Intestinal Hormones :**Endocrine cells, Gastrin, CCK and Secretin(2 hrs)

SOFT CORE

COURSE-IV: GENETIC ENGINEERING

Objectives

-to understand the basic principles of Genetic Engineering techniques
-to learn the principles and applications of PCR and different sequencing methods

Course outcome

- understand the principles of DNA sequencing methods and their applications -gain a better understanding of gel electrophoresis, blotting and hybridization techniques
- understand the basics of genetic recombination , gene transfer, cloningetc.
- able to isolate and estimate the amount of DNA
- learn different techniques of genetic engineering

COURSE CONTENT

UNIT I

Principles of Genetic Engineering: Nucleic acids isolation (principles of isolation, purification and quantification); DNA modifying enzymes -Restriction and modification enzymes, Other nucleases, Polymerase, Ligase, Kinases and Phosphatases; Cloning vectors - Plasmids, Phages, Cosmids, Artificial chromosomes and Expression vectors; Cloning hosts - *E. coli, Saccharomyces,* Plant and animals cells.; Gene transfer -Physical and vector mediated methods and cloning methods (Directional cloning and TA cloning methods) ; Construction of libraries -Genomic library, cDNA library and expression libraries

UNIT II

PCR: Principle, Methodology, Types - RT-PCR, AFLP, RFLP, inverse PCR and Real time PCR and their applications. DNA finger printing

DNA sequencing : DNA sequencing methods and their applications- Maxam and Gilbert's method, Sanger's method, Automated sequencing technique and Capillary gel electrophoresis, Next Generation Sequencing (NGS) methods

UNIT III

DNA Engineering techniques: Gel electrophoresis of nucleic acids and proteins (agarose,polyacrylamide) ; Blotting of macromolecules and hybridization- Probe Selection and labeling, principles of hybridization; gene screening-colony, plaque, dot, Southern & Northern blot screening, Antibody screening; Oligonucleotide synthesis ; Promoter characterization, Site directed mutagenesis; Generation of transgenic animals (*Drosophila* and Mouse)

PRACTICAL: GENETIC ENGINEERING

1. Demonstration of instruments and calculation for making of stock and working solutions .
2. Isolation of DNA by phenol chloroform method
3. Analysis of DNA by agarose gel electrophoresis
4. *In vitro*amplication of DNA by PCR.
5. Restriction digestion of DNA and analysis.
6. Ligation of DNA fragments and analysis.
7. Immunodiffusion.

COURSE-V: ADAPTATION BIOLOGY

Objectives

-to understand the adoptive nature and environmental conditions of aquatic, terrestrial, xeric and aerial habitats

-to get a better understanding of ethology and adaptations of aquatic, terrestrial and aerial life

Course outcome

- understand the adaptive nature of animals in different temperature and light condtions
- get a brief knowledge of life in extreme conditions
- learn about the biological rhythms as adaptive feature
- get a better understanding of circadian rhythms and clock genes

COURSE CONTENT

UNIT-I Introduction

Definition, Types of adaptations-Physical and behavioral, Environmental conditions of aquatic, terrestrial, xeric and aerial habitats. Nature of interaction with the environment- Tolerance, resistance, acclimation and acclimatization, Physiological Effects of temperature change in animals- Q 10 effect; Lethal temperature, causes of thermal death (high and low temperature).Light conditions - eclosion in insects.

UNIT II : Aquatic life

Adaptations of marine, intertidal, estuarine and fresh water animals (Lentic and lotic) with emphasis on morphological and physiological adaptations.

UNIT III: Terrestrial and aerial life

Adaptations for life in forest, grass land and desert

Flight adaptations-morphological and physiological in insects and birds

UNIT IV:

A) Life in extreme environments:

Adaptations for life in Deep -sea and caves; Effects of depleted oxygen availability; adaptations for deep-sea diving and high altitude conditions.

B) Biological rhythms

Rhythms as adaptive feature, Types of rhythms, Circadian rhythms – Examples in man, jet lag, health Impacts of disruption in sleep-wake rhythm, Entrainment, Phase shift, Phase response curves (PRC) and phase transition curves (PTC); Clock genes, Clock medicine.

OPEN ELECTIVE

COURSE-VI: REPRODUCTIVE HEALTH

Objectives

-to learn the structure and functions of male and female reproductive system - particular emphasis is placed on the hormonal control of reproduction
-provides an important foundation to consider sexual differentiation and development, contraception, infertility and current reproductive technologies

Course outcome

- understand the basics of reproductive health, onset of puberty and harmonal functions
- get to know the need for male and female temporary and permanent contraceptives - awareness of sexually transmitted diseases
- understand the causes, symptoms, diagnosis and treatment of Gonorrhea, Syphilis, Herpes, Chlamydia, genital warts, AIDS, Vaginitis.

COURSE CONTENT

UNIT – I

a. Male and Female reproductive system, Structure and functions of Primary and accessory reproductive organs, formation of spermatozoa and egg, .
b. Onset of puberty and its Hormonal control in male and female, Menstrual cycle and its hormonal control

UNIT – II

a. Events of fertilization
b. Process and hormonal control of pregnancy, parturition and lactation

UNIT – III

a. Fertility control: Need, Male and female temporary and permanent contraceptives.
b. Assisted Reproduction: Causes of infertility in male and female, Sperm bank, Procedure of test tube baby : collection of ova, IVF, surrogate mother, GIFT, ZIFT, ICSI,

UNIT – IV

a. Sexually transmitted diseases (STD): Meaning, Psychological aspects of STD.
b. Incidence, causes, transmission, symptoms, diagnosis and treatment of Gonorrhea, Syphilis, Herpes, Chlamydia, genital warts, AIDS, Vaginitis,

FOURTH SEMESTER

HARD CORE

COURSE-I: ENVIRONMENTAL BIOLOGY

Objectives

- to understand the importance to preserve natural landscapes and biodiversity, protect wildlife populations and reverse ecosystem degradation
- to understand the concept of habitat and ecological niche
- to learn the importance of ecology, population ecology Conservation of Natural Resources

Course outcome

- will understand the historical account, scope, basic concepts of environment and ecology
- will understand the nature of ecological models; goals of model building; basic tools in model building
- learn about the causes, effects, control measures and monitoring of environmental pollution
- learn the strategies of conservation and management of natural resources

COURSE CONTENT

UNIT - I Ecosystem

a. Historical account, scope, basic concepts, components of environment and approaches to the study of Environmental Biology.
b. Concept of habitat and ecological niche; ecotone and edge effect; food chains, Food-webs and their structure; ecological pyramids in aquatic, terrestrial and parasitic environments.
c. Brief description of biogeochemical (N,C,P) cycles.
d. Ecological productivity and its measurement.

UNIT – II Population Ecology

a. An overview of important population attributes – density, natality, growth rates - growth forms and concept of carrying capacity.
b. Mortality - life tables and survivorship curves.,
c. Sex ratio, age distribution, dispersal and dispersion, aggregation and Allee's principle, population fluctuation & cyclic oscillations and Population interactions.
d. Ecological model - nature of ecological models; goals of model building; basic tools in model building. Approaches to development of models with examples (Energy flow models).

UNIT - III Environmental pollution

a. Definition, causes, effects and control measures and monitoring of – Air Pollution - green house effect, global warming, Ozone layer depletion, photochemical smog and acid rain; Water Pollution with reference to major Indian rivers and marine pollution; Soil, Noise, Thermal, and Nuclear Pollution - with special reference to present scenario in India.
b. Pollutants and their impact on flora, fauna and humans; Solids and Biomedical wastes - causes, effects and control measures and their management.
c. Microbial Ecology: Indicator Microorganisms. Role of microorganisms in biodegrading and bioremediation of organic and metal pollution. Biodegradation, biotransformation, biomagnification and bioaccumulation of toxicants.
d. Role of Central and State Pollution Control Boards.

UNIT – IV Conservation of Natural Resources and Natural hazards

a. Conservation and management of natural resources- types, need, strategies of conservation. Significance of non - conventional energy resources: solar, wind, geo-thermal, tidal, nuclear and bio –energy.

b. Natural hazards - Earthquakes, Cyclones, Volcanoes Tsunami and their causes;
c. Environment and Social issues - Resettlement and rehabilitation of people, Wasteland reclamation and Environmental ethics.
Environmental Protection Act -1986 and related Acts

PRACTICAL: ENVIRONMENTAL BIOLOGY

1. Field visit to sewage pond, natural lake / river: Collection of water samples and study of physico-chemical parameters such as colour, pH, temperature, conductivity, total solids and turbidity.
2. Estimation of Carbon di-Oxide and dissolved Oxygen in three natural (sewage, pond and Tap) water samples.
3. To study the relationship between Dissolved oxygen and free carbon dioxide, if any, in three natural (sewage, pond and Tap) water samples.
4. Determination of COD and BOD in three natural (sewage, pond and Tap) water samples. To study the relationship between BOD and COD, if any, in three natural (sewage, pond and Tap) water samples.
5. Estimation of primary productivity of water bodies.
6. Population ecology- Population growth in Paramecium/ Drosophila
7. Estimation of Phosphate concentration in three natural (sewage, pond and Tap) water samples.
8. Estimation of Nitrate concentration in three natural (sewage, pond and Tap) water samples.
9. Determination of population density in a natural/ hypothetical community by quadrate method and calculation of Ecological indices for the same community
10. Visit to RNHM, Mysore, to study models of freshwater, marine, estuarine and terrestrial habitats.
11. Survey of Animal Population - to visit different habitats/areas in and around Mysore and collect data on some population attributes; application of Bio-statistical tests to the collected data and its interpretation.
12. C1 and C2 assessment

COURSE-II: ADVANCED CELL BIOLOGY

Objectives

- This paper will provide an deeper understanding about the eukaryotic cell cycle and its regulation
- To learn about the programmed cell death and cell signaling pathways
- To understand the genetic basis of cancer and general properties of immune responses

Course outcome

- able to discuss the cell cycle checkpoints and regulators of cell cycle pathways -a better understanding of apoptosis and necrosis will be understood -will learn the biology of neoplasm and genetic basis of cancer
- will understand the process of immune cells from its historical account to the principles of vaccination
- will understand the Principles of monoclonal antibody production and its applications

COURSE CONTENT

UNIT I Eukaryotic cell cycle & its regulation

a. Phases of cell cycle
b. Regulation: (i) Cell cycle check points (ii) cell intrinsic core regulators of checkpoints-Cyclins and Cdks, CAKs, CKIs, MPF, APC. and regulation at check points (iii) Cell intrinsic

mediators of regulation- activators (myc, Ras), inhibitors (Rb, DNA damage P53 dependent and independent inhibition) (iv) Extracellular signals – growth factors (mitogens) (v) Specific regulators at meiosis, regulation of oocyte meiosis.

UNIT II Cell death

a. **Programmed:** (i) Programmed apoptosis v/s necrosis (ii) Discovery of cell death genes in *C.elegans*& homologous pathway in mammals (iii) Caspases – action, inhibition by survival signals (Trophic factors, neurotrophins) and activation by death signals (TNF, Perforin/granzyme pathway, Mitochondrial permeability).
b. **Alternative Cell Death Mechanisms:** Autophagic, Necroptosis and their significance

UNIT III Cell signaling

a. Endocrine, synaptic, autocrine and Nitric Oxide signaling
b. Cell Surface receptors: (i) G-protein linked-structure, mechanism, Cyclic AMP mediated (ii) Enzyme linked -Receptor tyrosine kinases (iii) signaling through regulated proteolysis - Wnt-β catenin pathway, calcium signaling (iv) Synaptic signaling - Signaling at neuromuscular junction (transmitter gated ion channels, spatial and temporal summation).

UNIT IV

a. **Biology of Neoplasm:** (i) Types of tumors (Benign and Malignant), (ii) Development of cancer, metastasis and properties of cancer cells (iii) transformation of cells in culture, (iv) causes of cancer- Carcinogens (Physical, Chemical and Biological agents).
b. **Genetics of cancer:** (i) Chromosomes and cancer(Philadelphia, Burkitts lymphoma) (ii) Oncogenes: mechanism of transformation of protooncogens (iii) RNA tumor virus (Hepatitis) and DNA Tumor virus (Papilloma virus), Retroviral oncogenes, proto-oncogenes, (iv) Tumor suppressor genes: (Rb, BRCA) (v) Cancer as a multistep process, (vi) Cancer therapy: early detection and prevention, molecular diagnosis, treatment, cancer cell lines.

UNIT V

a. **Immunology:** (i) Historical account (ii) General properties of immune responses – Innate immunity and its mechanisms – cellular and molecular basis of inflammation and its importance (iii) adaptive immunity - active, passive and adoptive types (iv) Humoral and cell mediated immunity (v) Cells of the immune system: Hematopoesis, functions of NK cells, Dendritic cells, Macrophages, B Lymphocytes, T Lymphocytes (vi) Antigens and antigenicity (Epitopes, Haptene) (vii) Immunoglobulins: Classes of immunoglobulins, structure of IgG
(viii) Genetic basis of immunoglobulin diversity (xi) MHC molecules: Types, structure (x) Cytokines (xi) Antigen recognition by cytosolic pathway, endocytic pathway
b. **Clinical immunology**: (i) Vaccines – principles of vaccination, Recombinant vaccines, DNA vaccines (ii) Principles of monoclonal antibody production and its applications (iii) Deficiencies in the immune system – AIDS, autoimmune diseases, Hypersensitivity.

COURSE-III: MAJOR PROJECT

COURSE OUTCOMES

apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.

demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.

use effectively oral, written and visual communication.

identify, analyze, and solve problems creatively through sustained critical investigation.

SOFT CORE

COURSE-IV: RESEARCH METHODOLOGY

Objectives

- to discover answers to questions through the application of scientific procedures.
- Formulating research aim and objectives in an appropriate manner is one of the most important aspects of this paper
- To learn and practice the literature survey aspects of projects
-to understand the importance of Biostatistics and computer applications

Course outcome

- understand the Purpose and importance of scientific research
- understand the basics of biostatistics and various computer applications
- understand the importance of Significance of disseminating research results, IPR, Patenting -learn the Importance of peer review in paper publication and limitations of Plagiarism

COURSE CONTENT

UNIT I. Introduction to Research

a. Purpose and importance of scientific research
b. Sampling Techniques: Random and non-random sampling methods.
c. Survey methods: Line Transect, Variable Width Line Transect, All out Search Methods,
d. Planning and designing a research study: Literature survey and critical review; Identifying the gaps, Defining the problem, Statement of objectives, Selection of methods to achieve objectives, Collection, compilation and Presentation of data.

UNIT II. Animals models in research and Cell culture

a. Introduction to laboratory animals – Drosophila, rat, mice, guinea pigs, rabbits. Breeding and management of laboratory animals, bioethics. CPCSEA Guide lines, RRR
b. Introduction to cell lines; *in-vitro* cell culture systems, primary and secondary Culture systems, applications of cell culture.
c. Cryopreservation: Scope, principles, Methods and applications, cryoprotectants, cryopreservation of tissue, organs and embryos.
d. Good laboratory practices, Waste disposal, Maintenance of sanitation & hygiene,

UNIT III. Biostatistics and computer application

a. Arithmetic mean, mode, median, range, variance, standard deviation and standard error, coefficient of variation
b. Testing of hypothesis: Statement for testing the hypothesis, statistical validation using student's "t" test, 'z' test, chi square test, simple and multiple correlation, regression analysis, ANOVA., Meaning of level of significance.
c. Computer applications: MS word, EXCEL, Power point, SPSS uses,

UNIT IV.

Preparation of Research paper, Thesis and Research Project Proposal preparation.

a. Significance of disseminating research results, IPR, Patenting,

b. Research paper: Preparation of research paper, Importance of peer review in paper publication.
c. Dissertation/thesis: Collection and compilation of data, organizing a thesis, bibliography.
d. Research Project Proposal: Indentifying a problem, reviewing national and international status, objectives, methodology, budget.
e. Plagiarism,

COURSE-V: MEDICAL AND ENVIRONMENTAL IMPACT OF DEVELOPMENTAL GENETICS

Objectives

-this paper will help in knowing the importance of studies of inheritance, mapping disease genes, diagnosis and treatment
-to a better understanding of developmental anomalies and the function of stem cells

Course outcome

- will understand the interaction of environment and development of an organism - understand the physiology of stem cells and its functions at different stages -will be able to discuss regarding the teratogenesis and teratogenic agents
- understand the Theories of Aging, Organism aging and Cellular changes during aging

COURSE CONTENT

UNIT I

Development and Environment: (a) Developmental symbiosis (Parasitism, Mutualism, mammalian gut microbes) (b) Embryonic diapause (insects and mammals). (c) Phenotypic plasticity (*Bicyclusanynana*): Polyphenism – nutritional (Dung beetle), seasonal (*Araschinalevana*), Diet and DNA methylation (folic acid), predator-induced polyphenism (Daphnia), Environment dependent sexual phenotype (sex peptides and reversal in fishes) d) Learning – Adaptive nervous system (neuro physiology of song learning).

UNIT II

a)Teratogenesis: (i) Teratogenic agents and their assault on human development- (a)Alcohol, b)Retinoic acid, c) thalidomide d) endocrine disruptors - DES, BPA (Reproductive, Cancer susceptibility), e) DDT, f)Heavy metals g) pathogens h) Transgeneration inheritance of developmental disorders.
b) Cancer as disease of development: Developmental therapies and differentiation

therapy. **UNIT III**

a) **Developmental anomalies**: (a) Anencephaly - Spina bifida (Folic acid) (b) Cyclopia-Shh mutants (c) Blindness-Rx mutants (d) Deafness
b) **Aging**: Concept of aging: Theories of Aging, Organism aging, a) Cellular changes during aging (DNA damages, shortened telomere, mitochondrial mutation, oxidative stress). b) Aging disease (Progeria) c) Genes and Aging (DNA repair enzymes, Telomerase, p53, Insulin growth factor pathways) d) Epigenetic changes during aging

Unit IV

Stem cells: i) Embryonic stem cells, Multipotent adult stem cells (Neuronal stem cell, Hematopoietic Stem cell) ii) Application of stem cells: **a)** Stem cell therapy: transgenic stem cells: Regeneration Therapy, Therapeutic cloning. b) IPS cells and its application, hematopoietic stem cells from cord blood (Eg. Fanconi's anemia). c) Treatment of diseases: Neuro-degeneration and muscular dystrophy d) Organoid derivation from stem cells

COURSE-VI: BIODIVERSITY AND WILDLIFE BIOLOGY

Objectives

-to learn the scope of biodiversity
-to understand the importance of conservation of biodiversity -to learn the scope of wildlife biology

Course outcome

- will learn the Concept of biodiversity, levels of biodiversity and general theories of biodiversity
- will understand the values of wildlife including endangered, threatened, vulnerable, rare and extinct species
- understand the importance of Wildlife Conservation

COURSE CONTENT

UNIT I. Scope of Biodiversity

a. Concept of biodiversity, levels of biodiversity: general theories (biotic and abiotic) of biodiversity.
b. Biodiversity profile of World, India and Karnataka.
c. Biodiversity depletion: threatened biodiversity, impact of development, effect of pollution, global warming and climate change.
d. Mega biodiversity centeres in the world, biodiversity hot spots in India and Ramsar wetlands.

UNIT II. Conservation of Biodiversity

a. Convention on Biological Diversity, Biodiversity Act, 2002, Biodiversity Board.
b. Bioethics, IPR, Earth summits, Man and biosphere program (MAB).
c. Biodiversity mapping, methods of assessment, prospecting, bioremediation, Biodiversity index and techniques.
d. Management of biodiversity hotspots, biodiversity sustainable development and biodiversity heritage sites in Karnataka.

UNIT III. Scope of Wildlife Biology

a. Values of wildlife, wildlife categories: endangered, threatened, vulnerable, rare and extinct species, Red data book, green data book.
b. Causes of wildlife depletion: degradation and destruction of wildlife habitats, exploitation for commercial purposes, deforestation, urbanization and industrialization, hunting, forest fire and agricultural expansion.
c. Wildlife corridors, human-wildlife conflicts: Elephant, Tiger, Panther.
d. Wildlife and tribal welfare, tribes in India and role of tribes in wildlife management.

UNIT IV. Wildlife Conservation

a. Wildlife legislation: IBWL, Wildlife Protection Act, 1972.

b. Wildlife conservation strategies: NGO's - BNHS, WWF, IUCN; ZSI, BSI. Protected area network and wildlife projects.
c. In-situ conservation: Wildlife sanctuaries, national parks and bioreservers and their management. *Ex-situ* conservation: Zoo garden and its management, Zoo Authority of India, captive breeding, artificial insemination, cryopreservation, germplasm banks.
d. Wildlife census, techniques and survey methods.

OPEN ELECTIVE

Course-VII: ECONOMIC ZOOLOGY

Objectives

-to understand the Economic importance of Invertebrates and Vertebrates -to learn the Commercial importance of Insects
-to gain better knowledge regarding Pests, Parasites and Vectors

Course outcome

- will learn the culture and management of important invertebrates including apiculture, Corals, Lac culture, Mariculture
- a basic knowledge about invertebrate products and byproducts
- understand the usefulness of insects as tools in Forensic Science and in crime detection
- a better understanding of Insect culture, collection, preservation and the importance of Bioethics

COURSE CONTENT

Unit 1. Introduction and scope of Economic Zoology

a. Economic importance of Invertebrates; culture and management of important invertebrates – Apiculture, Corals, Lac culture, Mariculture, Prawn culture, Pearl culture, Sericulture and Vermiculture.
b. Invertebrate products and byproducts.

Unit 2. Economic importance of Vertebrates

a. Rearing and management of important vertebrates – Dairy, Fisher culture, Poultry, Piggery, Pigeonery, Rabbit and snakes.
b. Usefulness of vertebrate products and by products: Animal oriented Medicine, leather, wool, fur industry.

Unit 3. Pests, Parasites and Vectors

a. Insects as pests – on food and vegetable crops.
b. Parasitic protozoa, nematodes, helminthes and their human diseases.
c. Vectors: Mosquites, ticks, mites, cockroaches, rat and their human diseases.

Unit. 4. Commercial importance of Insects

a. Entomophagy: Entomophagic species and their usage in different parts of the world and economics.
b. Insects as tools in Forensic Science, usefulness of insects in crime detection.
c. Insect culture, collection, preservation and Bioethics.
d. Insects as biological controlling agents. Venomous insects and their venom application to treat various ailments and diseases, Apitherapy.