

DEPARTMENT OF ZOOLOGY
KARNATAK UNIVERSITY, DHARWAD

Syllabus

For

ZOOLOGY

Under Choice Based Credit System

I Semester (w.e.f 2019-20 onwards)

ZCT-1.1 Biosystematics
ZCT-1.2 Biology of non-chordates
ZCT-1.3 Biology of chordates
ZCT-1.4 Environmental Biology

II Semester (w.e.f 2019-20 onwards)

ZCT-2.1 Molecular Genetics
ZCT-2.2 Molecular Cell Biology
ZCT-2.3 Animal Physiology

III Semester (w.e.f 2020-21 onwards)

ZCT-3.1 Developmental Biology
ZCT-3.2 Evolutionary Biology
ZCT-3.3 Animal Biotechnology

IV Semester (w.e.f 2020-21 onwards)

ZCT-4.1 General and Comparative
Endocrinology
ZCT-4.2 Biology of Reproduction
ZCT-4.3 Applied Zoology

ZCT 1.1: BIOSYSTEMATICS

48 hrs

Unit I: Science of Biosystematics

(04)

Concept of Biosystematics, Terms used in systematic biology, Historical review of taxonomic philosophies, Future of taxonomic studies, Stages in taxonomy, Tasks of taxonomist, Systematics as a profession, Significance of taxonomy.

Unit II: Species concept

(06)

Historical perspective of species concept (typological, nominalist, biological), kinds of species-sibling, sympatric, allopatric, syntopic, ring species, polytypic and monotypic species. Intraspecific groups (variety, morphs, subspecies, temporal subspecies, race and clines).

Unit III: Taxonomic Collection, Preservation and Identification

(10)

Collection - Purpose, value, scope of collection, content of collection, significance of museum collections, legal aspects of collecting animals, post collection processes. Preparation and packaging of specimen for posting.

Preservation - Methods, taxidermy, plastination, factors responsible for the deterioration of museum specimens. Curating of collections - museum collection policy, preparation of material for study, housing and cataloging, exchangeable and expendable materials and loans.

Identification - Systematic process of sorting and labelling, procedure of identification; identification services.

Unit IV: Trends and Approaches in Taxonomy

(08)

Morphological - General external structures, anatomy, special structures, Embryological and Cytogenetic, Ecological – Habitats and hosts, food, parasitism, seasonal variations. Behavioural – Ethological isolating mechanisms, courtship and behavioural patterns, Biochemical - Serological proteins, metabolic factors. Molecular – Major rRNA genes, Cytochrome B, Cytochrome C, Cytochrome C oxidase and other conserved sequences; Numerical approaches.

Unit V: Classification and Phylogenetic Analysis

(10)

Components of classification; Procedure of classification (phenetic and cladistic), presentation of classification - Linnaean/Taxonomic hierarchy, ways of constructing a phylogenetic tree. Phylogenetic analysis - Purpose, terminology, methods of phylogenetic analysis (Phenetic method, dendrogram method, pairwise distance; Cladistics method, parsimony, maximum likelihood); phylogenetic lineages.

Unit VI: Application of Zoological Nomenclature

(10)

Taxonomic keys and their significance, taxonomic publications, International rules of nomenclature – Historical and contemporary situation; International Code of Zoological Nomenclature (ICZN); DNA bar coding, the taxonomic bottle neck, digitization of taxonomic data/ Bioinformatics.

ZCT 1.2: BIOLOGY OF NON- CHORDATES

48 hrs

Unit I: Coelom, Body plan and Phylogeny

(8)

Symmetry and evolution of bilateria; Evolution and significance of coelom; evolution and significance of metamerism; Protostomia and Deuterostomia.

Phylogeny and systematic position of Ctenophora, Entoprocta, Sipunculida and Ectoprocta.

Unit II: Locomotion and Nutrition

(12)

Amoeboid, Ciliary and Flagellar movements in Protozoa; Ultrastructural aspects of flagella; Principle of hydrostatic skeleton; hydrostatic movement in Annelida; Flight movement in insect. Nutrition in Protozoa and lower Metazoan; Filter feeding in Polychaeta, Mollusca, Crustacea and Echinodermata; Feeding patterns in insects.

Unit III: Respiration and Circulation

(10)

Respiratory organs in invertebrates – gills, lungs and trachea; Respiratory pigments - hemoglobin, hemocyanin, hemerythrin and chlorocruorin

Circulation – Patterns (open and closed types) with suitable examples

Unit IV: Excretion

(6)

Excretory organs – Flame cells, coelomoducts, nephridia and Malphigian tubules – Morphology and mechanisms.

Unit V: Nervous System

(7)

Trends in neural evolution: Primitive nervous system in Cnidaria and Echinodermata; Advanced nervous system in Annelida, Arthropoda and Mollusca; Brief review of sense organs in different phyla.

Unit VI: Reproduction

(5)

Asexual, sexual and parthenogenetic modes of reproduction and their significance; Larval forms and their significance.

ZCT 1.3: BIOLOGY OF CHORDATES

48 hrs

UNIT I: Phylogeny, systematic position and organization of Protochordates (6)

Phylogeny and systematic position of Urochordata and Cephalochordata. General organization in urochordates-ascidians, thaliaceans and larvaceans; General organization in amphioxus. Retrogressive metamorphosis.

UNIT II: Origin, evolution and adaptive radiations in early vertebrates (6)

Origin of chordate; origin, evolution and adaptive radiations in cyclostomata; origin, evolution and adaptive radiations in Pisces – ostracoderms; placoderms; chondrichthyans; acanthodians; actinopterygians and sarcopterygians.

UNIT III: Origin, evolution and adaptive radiations in Amphibia, Reptilia and Aves (8)

Origin, evolution and adaptive radiations in Amphibia – Early labyrinthodonts – stegocephalians, temnospondyls and lepospondyls; Lissamphibians. Origin, evolution and adaptive radiations in Reptilia – stem reptiles, pelicosaur and therapsids. Origin, evolution and adaptive radiations in Aves.

UNIT IV: Zoogeography, Adaptive radiations and Endoskeleton of Mammals (12)

Zoogeography, origin and evolution of monotremes, marsupials and placentals, adaptive radiations in marsupials; dentition in mammals.

Overview of skull - cranium, jaws and hyoid apparatus; Axial skeleton – vertebrae, centra and ribs. Appendicular skeleton – pectoral girdle, pelvic girdle and organization of limb bones.

UNIT V: Comparative anatomy (10)

Comparative anatomy of integument and its derivatives – organization of dermis and epidermis in vertebrates; teeth, feathers, hair, scales, mammary glands, nails, claws and hooves. Heart and aortic arches in anamniotes and amniotes; Anatomy of Brain in different vertebrates. Kidney in vertebrates – archinephric, pronephric, mesonephric and metanephric kidneys and their ducts.

UNIT VI: Adaptations (6)

Aquatic, aerial and terrestrial adaptations; Aerodynamics and mechanism of flight in birds (wing as flight surface).

ZCT 1.4: ENVIRONMENTAL BIOLOGY

48 hrs

Unit I: Introduction to Environmental Biology (10)

History, definition, importance, scope, divisions and awareness of environmental biology. Ecosystem: Concept, types, structure, components and productivity and functions of different ecosystems; Biogeochemical cycles. Ecological Succession: Definition, primary and secondary succession, influence of anthropogenic activities on succession.

Unit II: Population Growth and Regulation (4)

Types of population growth, physical and biological factors regulating population, population pyramids, population explosion.

Unit III: Natural Resources (6)

Concept and classification of natural resources; Non-renewable resources- land, soil and mineral resources; Renewable resources- water, forest, wildlife, range lands, agriculture, livestock, aquaculture; Energy resources (renewable and non-renewable); Resource management and conservation.

Unit IV: Animal biodiversity (12)

Global and Indian biodiversity; Levels of biodiversity- genetic, species, ecosystem diversity; Endangered species; Values of biodiversity- consumptive, productive, social, ethical, aesthetic (ecotourism) and health values; Conservation of biodiversity- *ex-situ* and *in-situ*; Mega-biodiversity centers- National parks, sanctuaries and biosphere reserves, biodiversity hotspots; Threats to biodiversity; Human-wildlife conflicts; Organizations associated with biodiversity management.

Unit V: Climate change (6)

Composition and structure of atmosphere; Climate- catastrophes and driving forces; Human caused climate change- ozone layer depletion, greenhouse gases and global warming, acid rain; Strategies for dealing with global warming.

Unit VI: Environment and human health (10)

Types of environmental health hazards- infectious organisms, Toxicants- chemicals, natural and synthetic toxins, heavy metals; Bioaccumulation and bio-magnification; Toxicity measurement- animal testing; environmental legislation and protection.

ZCP 1.5 - BIOSYSTEMATICS PRACTICALS

48 rs

- 1-3 Biosystematic position of specimens:
 - a. Phylum Protozoa to Phylum Echinodermata
 - b. Minor Phyla and Protochordates
 - c. Cyclostomata to Mammals
4. Morphometric measurements of some locally available fishes
5. Identification of venomous and non-venomous snakes
6. Identification and grouping of animals by using identification keys
7. Scat Analysis
8. Cluster analysis by using suitable example
9. Construction of different types of Taxonomic key for the identification of animals
10. Construction of phylogenetic trees by taking suitable examples
11. Animal preservation techniques (Physical and chemical methods)
12. Statistical Applications in Biosystematics
13. Any other practical depending on feasibility.

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ZCP 1.6 - BIOLOGY OF NON- CHORDATES PRACTICALS

48 hrs

1. Observation of microorganisms in given water sample.
- 2-4. Study of Earthworm:
 - a. Digestive system
 - b. Nervous system
 - c. Mounting of ovary
 - d. Mounting of setae
 - e. Mounting of Nephridia
- 5-6. Study of Starfish:
 - a. Digestive system
 - b. Water vascular system
 - c. Mounting of tube feet
7. Locomotion:
 - a. Setae of earthworm
 - b. Tube feet of starfish
 - c. Leg of cockroach
8. Nutrition:
 - a. Tubular feeding in Hydra
 - b. Eversible pharynx in Planaria
 - c. Filter feeding in Sponge, Terebella, Sabella and Unio
9. Respiratory organs
 - a. Branchial cone in Terebella
 - b. Ctenidia in Unio
 - c. Rectal gills in Naids
 - d. Tracheae in Cockroach

10. Excretion
 a. Nephridium in earthworm
 b. Malpighian tubules in cockroach
11. Reproduction
 a. Conjugation in *Paramecium*
 b. Ovary of earthworm
12. Invertebrate larvae
 a. Coelenterate larva – Ephyra
 b. Platyhelminthes larvae – Redia, Cercaria, Echinococcus
 c. Annelida larva – Polychaete larva
 d. Arthropod larvae – Nauplius, Mysis, Zoea, Phyllosoma, Mosquito larva, Megalopa
 e. Mollusca larvae – Veliger, Glochidium
 f. Echinoderm larvae – Bipinnaria, Brachiolaria, Pluteus
13. Any other practical depending on feasibility.

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ZCP 1.7-BIOLOGY OF CHORDATES PRACTICALS

48 hrs

1. Study of digestive system in Shark/Chick
2. Study of male reproductive system in Shark/Chick
3. Study of female reproductive system in Shark/Chick
4. Study of cranial nerves of Shark
5. Study of digestive system in Rat
6. Study of male reproductive system in Rat
7. Study of female reproductive system in Rat
8. Study of cranial nerves in Rat
9. Mounting:
 - a. Membranous labyrinth of shark
 - b. Ampullae of Lorenzini of shark
 - c. Placoid scales of shark
10. Mounting:
 - a. Brain of shark
 - b. Brain of rat
11. Identification

Protochordates:

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|-------------------------|---------------------|----------------------|
| 1. <i>Balanoglossus</i> | 2. <i>Botryllus</i> | 3. <i>Amphioxus</i> |
| 4. <i>Doliolum</i> | 5. <i>Ascidia</i> | 6. <i>Petromyzon</i> |

Pisces:

| | | |
|---------------------|-------------------|----------------------------------|
| 1. <i>Myxine</i> | 2. <i>Clarius</i> | 3. <i>Echeneis (Sucker fish)</i> |
| 4. <i>Scoliodon</i> | 5. Hippocampus | 6. Sting ray |

Amphians:

| | | |
|--------------------------|------------------------|---------------------|
| 1. <i>Ichthyophis</i> | 2. <i>Siren</i> | 3. <i>Bufo</i> |
| 4. <i>Axolotal larva</i> | 5. <i>Rana tigrina</i> | 6. <i>Ambystoma</i> |
| 7. <i>Rhacophorus</i> | | |

12. Identification

Reptiles:

- | | | |
|---------------------------------|---------------|-------------------|
| 1. Tortoise | 2. Phrynosoma | 3. Krait |
| 4. <i>Draco</i> (flying lizard) | 5. Varanus | 6. Russel's viper |
| 7. Typhlops | 8. Chameleon | |

Birds:

- | | | |
|-----------------------------|------------------|--|
| 1. Cuckoo (male and female) | 2. Bhraminy kite | 3. <i>Gallus gallus</i> (Hen and Cock) |
| 4. Indian roller | 5. Horn bill | 6. Owl |

Mammals:

- | | | |
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| 1. Pangolin (Ant eater) | 2. Loris | 3. Hystrix |
| 4. Hedge hog | 5. Flying squirrel | |

13. Any other practical depending on feasibility.

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ZCP 1.8 - ENVIRONMENTAL BIOLOGY PRACTICALS

48 hrs

1. Estimation of pH of different water and soil samples using digital pH meter
2. Estimation of dissolved oxygen (DO) in different water samples
3. Estimation of free carbon dioxide in different water samples
4. Estimation of chlorides in different water samples
5. Estimation of total hardness of different water samples
6. Determination of Biological Oxygen Demand (BOD) in different water samples
7. Estimation of total alkalinity of different water samples
8. Estimation of total dissolved solids in different water samples
9. Estimation of dissolved sulphates in water by turbidometric method
10. Estimation of dissolved phosphates in different water samples by colorimetric method
11. Estimation of organic carbon content of different soil samples
12. Estimation of Chemical Oxygen Demand (COD) in water
13. Any other practical depending on feasibility.

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ZCT 2.1: MOLECULAR GENETICS

48 hrs

Unit I: Mendelian and Modern Genetics (12)

Overview of Mendelian principles and Post-Mendelian Genetics. Concept of alleles, complementation test, cistron, muton and recon. Linkage and crossing over. Non-Mendelian inheritance.

DNA structure and functions: DNA as hereditary material – experiments; Watson and Crick model and alternate models of DNA, semi-conservative replication of DNA; DNA repair mechanisms; organization of prokaryotic and eukaryotic genomes. Replication: Enzymology of replication, initiation, elongation and termination; models of replication. Protein synthesis: Genetic code, colinearity hypothesis. Transcription, post-transcriptional modification. Translation: post-translational modification.

Unit II: Bacterial Genetics (6)

Genetics of bacterium and bacteriophage: Transformation, transduction and conjugation in bacteria; F- mediated sexduction, mechanism of recombination in bacteria, Life cycles of bacteriophage, plasmids and episomes.

Unit III: Gene Regulation in prokaryotes and Eukaryotes (8)

Gene regulation: Prokaryotes- operon model- positive and negative regulation; Eukaryotes - model of gene regulation, transcription factors, Cis and trans acting elements in eukaryotes. Dosage compensation in human, *Drosophila* and *Caenorhabditis elegans*. Genome imprinting.

Unit IV: Chromosome abnormalities (6)

Variation in chromosome structure: cytogenetic implications of duplication, deletion, inversion, translocation and position effect. Transposons- transposable elements in bacteria and in eukaryotes. Mutations- spontaneous and induced mutations; Molecular basis of mutation, effect of mutations.

Unit V: Genetic Diseases (12)

Genetic diseases: Single gene inheritance; cystic fibrosis, sickle cell anemia, Marfan syndrome, Huntington's disease, and, hemochromatosis. Multifactorial inheritance: heart disease, high blood pressure, Alzheimer disease, arthritis, diabetes, cancer, and obesity. Chromosome abnormalities: Turner syndrome, Klinefelter syndrome, Down syndrome and Cri-du-chat syndrome. Mitochondrial inheritance: Leber's hereditary optic atrophy, epilepsy, myoclonic epilepsy and dementia.

Unit VI: Genomics and Proteomics (4)

Salient features of yeast, *Drosophila* and Human genomes; Evolutionary genomics; Proteomics.

ZCT 2.2. MOLECULAR CELL BIOLOGY

48 hrs

Unit I: Introduction and Microscopy

(04)

Scope of modern cell biology, Microscopy: Magnification, Limit of resolution, Resolution power. Types of microscopes: Phase contrast, Fluorescence, Transmission Electron, Laser Confocal microscopes- principle, structure and applications.

Unit II: Molecular organization of biomembranes

(08)

Organization and composition of plasma membrane, Fluid mosaic model. Membrane fluidity- role of cholesterol. Membrane asymmetry. Transport across membranes (solutes, gases, ions and water); Passive and active transport, Cell junctions: types, structure and functions .

Unit III: Molecular organization and functions of cell organelles

(08)

Endoplasmic reticulum; Ribosomes – Structure, translation and translocation, nascent polypeptide chain, protein folding and processing. Golgi apparatus- signal hypothesis, protein glycosylation, protein sorting and transport, endocytosis and lysosome formation. Mitochondria – bioenergetics, oxidative phosphorylation, protein import and transport metabolites; Peroxisomes. Cytoskeleton- Molecular organization of microfilaments, Intermediate filaments and microtubules and their role in cell architecture and functioning

Unit IV: Biomolecules

(08)

Amino acids- structure and classification, Peptide bond formation. Proteins - primary, secondary and tertiary structures. Polypeptide folding: Random coiling, Alpha helix and Beta sheet. Protein modifications - Glycoproteins, Proteoglycans and Lipoproteins. Carbohydrates - Complex polysaccharides. Lipids – Triglycerides and compound lipids

Unit V: Nucleus and Chromatin Biology

(07)

Ultra structure of nucleus and functions. Molecular structure of chromosomes: Euchromatin and Heterochromatin; Role of histones in Packaging DNA; Nonhistone proteins; C- Value Paradox. Nucleolus – organization and functions.

Unit VI: Cell Cycle, Apoptosis, Cancer biology and Immunology

(13)

Cell Cycle- Molecular events; Role of Cyclins and Cyclin Dependent Kinases (CDK) in cell cycle. Apoptosis - Mechanism and significance
Cancer Biology - Benign and Malignant tumors; Characteristics and properties of cancer; Development and causes of cancer; Carcinogens; Oncogenes; Oncoviruses; Tumor suppressor genes; Diagnosis and treatment of cancer.
Immunology: Cells and tissues of immune system, types of immunity, T and B lymphocytes; Cytokines, MHC molecules. Immunoglobulins: types, structure and functions of immunoglobulins.

ZCT 2.3: ANIMAL PHYSIOLOGY

48 hrs

Unit I: Introduction to Physiology and Physiology of Respiration and Blood (12)

History and central themes of Animal Physiology and its sub-disciplines

Respiration: The atmosphere, solubility of gases, respiratory organs in the vertebrates; Respiratory mechanisms in aquatic and air breathing fishes, birds and mammals; respiration in eggs; Exchange of O₂ and CO₂ and transport. Oxygen dissociation curve.

Blood - components and functions; acid-base balance regulation.

Circulation: General principle, vertebrate circulation, the physics of flow in tubes, Hemostasis.

Unit II: Water and Osmoregulation (06)

Properties of water molecules; Osmoregulation, osmoregulators and conformers; Obligatory exchanges of ion and water; Osmoregulatory organs; Osmoregulation in aqueous and terrestrial animals

Unit III: Temperature (06)

Classification of animals based on thermal biology, Temperature relations of ectotherms, heterotherms and endotherms, specialized metabolic states – torpor, hibernation, and aestivation.

Unit IV: Feeding, Digestion and Energy metabolism (12)

Feeding methods and mobility of the alimentary canal; Physiology of digestion and absorption, gastrointestinal secretions; nutritional requirements (micro and macro).

Enzymes and metabolism: General properties, Regulation of metabolic reactions, Metabolic production of ATP; Efficiency of energy metabolism.

Unit V: Movement (06)

Structural organization of contractile proteins of muscle-actin and myosin; Mechanism of muscle contraction; Adaptations of muscle for various activities – jumping, swimming, sound and flight.

Unit VI: Nervous system (06)

Structural organization and functions of nervous system; Electrochemical, resting and action potential; Transmission of information within neuron, synaptic transmission (electrical and chemical); Neurotransmitters.

ZCP 2.4 - MOLECULAR GENETICS PRACTICALS

48 rs

- 1-2. Study of polytene chromosomes in: a. *Chironomous* larva
b. *Drosophila* larva
3. Study of genetics of blood group in Man
4. Study of X-chromatin or Barr body in buccal cell of Human
5. Human Karyotype analysis: a. Normal male
b. Normal female
6. Human Karyotype analysis: a. Down syndrome
b. Cri-du-chat syndrome
c. Klinefelter syndrome
d. Turner syndrome
e. Translocation
7. Study of *Drosophila* mutants
 - a. Normal male
 - b. Normal female
 - c. Yellow body
 - d. Bar eye
 - e. White eye
 - f. Vestigial wing
 - g. Ebony body
 - h. Sepia eye
8. Study of sex comb and genital plate of different *Drosophila* species
9. Study of karyotype of different *Drosophila* species
10. Study of Sternopleural and Acrostical bristles and statistical analysis of *Drosophila*
11. Study of eye pigments of *Drosophila* by paper chromatography.
12. Study of inversions of *Drosophila*.
13. Any other practical depending on feasibility.

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ZCP 2.5 - MOLECULAR CELL BIOLOGY PRACTICALS

48 hrs

- 1) Study of epithelial tissues: ciliated, columnar and squamous, etc.
- 2) Study of nervous tissue: Myelinated and unmyelinated nerve cells
- 3) Study of Muscular tissue : Smooth muscles, striated muscles and cardiac muscle
- 4) Study of connective tissues ; Bone and cartilage; Blood cells – Neutrophils, Basophils, Eosinophils, Lymphocytes and Monocytes
- 5) Estimation of DNA by Diphenylamine (DPA) method
- 6) Estimation of RNA by Orcinol method
- 7) Study of mitosis - observation of permanent slides
- 8) Study of stages of Mitosis in onion root tips

- 9) Study of meiosis – observation of permanent slides
- 10) Study of stages of meiosis in grasshopper testis
- 11) Histopathological examination (HPE) of normal and malignant cells.
- 12) Preparation of stains and fixatives
- 13) Observation of Lactobacillus from the curd sample
- 14) Study of eukaryotes from rectal parasite of frog.
- 15) Any other practical depending on feasibility.

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ZCP 2.6 - ANIMAL PHYSIOLOGY PRACTICALS

1. Qualitative analysis of carbohydrates
2. Qualitative analysis of polysaccharides
3. Qualitative analysis of proteins
4. Qualitative analysis of lipids
5. Total count of blood corpuscles
6. Differential count of WBCs
7. Estimation of blood clotting time
8. Estimation of protein and hemoglobin
9. Estimation of cholesterol and triglycerides
10. Analysis of pathological contents of urine
11. Estimation of glucose
12. Identification of adulterants
13. Any other practical depending on feasibility.

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ZCT 3.1: DEVELOPMENTAL BIOLOGY

48 hrs

Unit I: Introduction (6)

Overview of development, Anatomical and experimental approach to developmental Biology: embryological origin of gene theory, Evidence for genomic equivalence. Nuclear transplantation experiments in frog and mammal- the concept of totipotency. Nucleo-cytoplasmic interactions during early development in Ameoba and Frog.

Unit II: Fertilization and early development (5)

Fertilization- Cellular and biochemical processes during early fertilization; Strategies for monospermy and prevention of polyspermy in conservation of species; Signal transduction and egg activation.

Unit III: Development in *Drosophila* (8)

Genetic and molecular analysis of axis formation in *Drosophila*: Development of larva; Establishment of anterior, posterior, dorsal and ventral polarity; Role of maternal effect genes, segmentation genes and homeotic selector genes.

Unit IV: Development in Amphibians (9)

Genetic and molecular analysis of axes formation in amphibia: Mechanism of progressive determination of amphibian axes – the origin and molecular biology of Nieuwkoop centre, primary embryonic and regional specificity of induction: Organizer functions and its diffusible proteins.

Unit V: Cell differentiation and organogenesis (10)

Development of somites and differential cell proliferation in shaping organ primordia – Myogenesis – Determination of myotome, specification and differentiation by myogenic bHLH proteins, muscle cell fusion. Differentiation of neural tube - Primary and secondary neurulation, Differentiation of neural tube- Anterior-posterior axis, dorsoventral axis; Differentiation of erythrocytes - Hematopoiesis.

Unit VI: Post-embryonic development and Teratology (10)

Metamorphosis in Amphibia- Morphological, biochemical changes and molecular mechanism of hormonal regulation; Regeneration in Hydra, Planaria and Salamander.

Growth- concept, isometric and allometric.

Teratology: Causation of abnormal development, experimental studies; Teratogens.

ZCT 3.2: EVOLUTIONARY BIOLOGY

48 hrs

Unit I: Introduction to evolution and Theories of evolution (14)

Evolution of evolutionary thoughts. Lamarckism; Natural Selection (Darwinism), Contributions of Charles Darwin, Alfred Russel Wallace, Thomas Malthus and Hugo de Vries; Postulates of Natural Selection and evidences; Natural Selection in action- Industrial melanism; Darwin's finches, Experimental evidences of Natural selection- Endler's guppies ; Concepts of inclusive fitness – altruism and kin selection.

Unit II: Neo-Darwinism (10)

Hardy-Weinberg Law of genetic equilibrium; Genes and genotype frequencies, Concept of Mendelian Population and gene pool; Factors operating against Hardy-Weinberg Law; Selection - types of selection- balancing selection, frequency dependent selection, directional selection, disruptive selection, artificial selection; Random Genetic drift (Bottle neck effect, Founder's effect); Migration.

Unit III: Non-Darwinism (4)

Molecular polymorphism: Nucleic acids and proteins; Molecular clock; Neutral theory of evolution and evolution random walk; Forces in evolution- stochastic vs deterministic.

Unit IV: Speciation and origin of higher categories (6)

Reproductive isolation mechanisms – pre- and post-zygotic. An overview of speciation - allopatric, sympatric, peripatric and parapatric modes of speciation; Phyletic gradualism and punctuated equilibrium; micro and macroevolution

Unit V: The Evolution of Life histories (10)

Basic questions in life history evolution; Life history trade-offs: Optimality arguments, age and size at maturation; clutch size and reproductive investment, empirical evidences of life-history trade-offs; Life span and aging; evolutionary theories for aging.

Unit VI: Impact of Darwin's thoughts in understanding human health and diseases (4)

Darwinian medicine; Proximate versus ultimate causes of diseases; Design defects; Defense Mechanisms; Allergy; Evolution of antibiotic / Pesticide resistance; Evolution of behaviors such as anxiety, fear and depression.

ZCT 3.3: ANIMAL BIOTECHNOLOGY

48 hrs

Unit I: Introduction

(02)

Concept, scope, development, current status and future of animal biotechnology

Unit II: Animal cell culture and Stem cell technology:

(10)

Animal cell culture: Cell culture techniques; Cell lines and storage. Equipments, Culture media, Applications of animal cell culture.

Stem cell technology: Types and properties of stem cells, Differentiation of stem cells, Advantages and disadvantages of stem cell technology.

Unit III: Gene and Animal cloning

(12)

Gene cloning: Method of gene cloning; Molecular tools; Restriction enzymes, ligases and other enzymes, cloning vectors; Selection and screening of transformed cells. Cloning strategies: Construction of genomic and cDNA library. Application of gene cloning.

Gene transfer techniques- Transformation; Microinjection; Electroporation; Polycations; Lipofection and Retroviral infection.

Animal cloning: Cloning in different animals with special reference to Dolly; Somatic cell nuclear transfer (SCNT).

Unit IV: Transgenic Animals and Gene therapy

(08)

Transgenic animals: Importance of rDNA technology; Genetically Modified Organisms (GMOs), gene targeting, gene knock-out and knock-in technology, gene-silencing; Advantages and disadvantages of transgenic animals – ethical concerns.

Gene therapy: Methods; somatic and germ line therapy, gene therapy in animals and embryos.

Unit V: Application of Animal Biotechnology

(08)

Production of regulatory proteins (insulin, somatostatin); Whole blood; RBC; Platelet concentration, Albumin; Clotting factors, Hemoglobin. Anticoagulants (heparin, vitamins, plasminogen activator). Hybridoma technology- Production and applications of monoclonal antibody.

Recombinant vaccines; DNA vaccines, DNA probes, Biochips.

Unit VI: Techniques in Biotechnology and Nanobiotechnology

(08)

Electrophoresis and Electrofocussing; Blotting techniques; DNA finger printing. Polymerase Chain Reaction–Methods and applications.

Nanoparticles: Properties, synthesis, characterization and applications of nanotechnology

ZCP 3.4 - DEVELOPMENTAL BIOLOGY PRACTICALS

48 hrs

1. Study of different developmental stages of chick embryo in whole mounts.
2. Study of transverse sections (T. S.) of chick embryos
3. Temporary mounting of chick blastoderms, embryos of different developmental stages and study of morpho-anatomical features of these embryos.
4. Observation of development of *In vivo* cultured chick embryo by 'window method'.
5. Study of transverse sections (T. S.) of frog embryos and tadpoles.
6. Study of morpho-anatomical changes during metamorphosis in frog.
7. Study of development and life cycle of *Drosophila*:
8. a) Egg b) I Instar
c) II Instar d) III Instar and c) Pupal stage
9. Temporary mounting of cellular blastoderm, sex comb and halteres in *Drosophila melanogaster*.
10. Study of development and life cycle of mosquito.
11. Study of rat spermatozoa and ova
12. Study of pre-implantation stages in mouse, *Mus musculus*
 - a). Zygote b). 2 cell embryo
 - c). 4 cell embryos. d). 8 cell embryo
 - e). Morula f). Blastocyst with intact zona pellucida
 - g). Hatched blastocyst
13. Any other practical depending on feasibility.

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ZCP 3.5 - EVOLUTIONARY BIOLOGY PRACTICALS

48 hrs

- 1-2. Evidence for Principle of Evolution: a. Homologous structures.
b. Serial homology.
- 3-4. Evidence for Principle of Evolution: a. Analogous organs.
b. Vestigial organs.
5. Embryological evidence for evolution: Descent with modification.
6. Fossils and Living fossils.

- 7-8. Application of Hardy-Weinberg principle to determine allelic frequency of:
 - a. PTC trait in man
 - b. blood group trait in man
9. Experiment to elucidate the principle of overproduction that leads to struggle for existence.
10. Study to elucidate that every individual is unique and variations are universal.
- 11-12. Experiment to demonstrate how natural selection works:
 - a) alphabet analogy.
 - b) beetle survival.
13. Modification of structures for new function that have lost their original role.
14. Any other practical depending on feasibility.

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ZCP 3.6 - ANIMAL BIOTECHNOLOGY PRACTICALS

48 hrs

1. General requirements of animal biotechnology laboratory
2. Sterilization Techniques – Physical, Chemical & Radiation
3. Separation of Amino acids by paper chromatography
4. Identification of bacteria's through Graham's staining method
5. Cell viability test by using trypan blue
6. Extraction of DNA and RNA from animal tissues
7. Isolation of Casein, Lactose, and Albumin from Milk
8. Preparation of buffers used in animal biotechnology
9. Preparation of different types of media.
10. Protozoan's culture in laboratory as a model for cell culture
11. Demonstration of Agarose Gel Electrophoresis
12. Demonstration of PolyAcrylamide Gel Electrophoresis (PAGE)
13. Demonstration of Instruments used in animal Biotechnology
14. Cell Death during development (Apoptosis).
15. Any other practical depending on feasibility.

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ZCT 4.1: GENERAL AND COMPARATIVE ENDOCRINOLOGY

48 hrs

Unit I: Aim and scope of Endocrinology

(5)

Pioneers in Endocrinology - Discovery of hormones; Techniques in endocrinology; Hormones as chemical messengers - Classification of hormones.

Unit II: Comparative anatomy of Endocrine glands

(5)

Endocrine hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas; Neurovascular hypothesis.

Unit III: Hormones – Homeostasis and Biological actions

(14)

Positive and negative feedback of hormone action. Calcium and glucose homeostasis; hormonal regulation of intermediary metabolism: carbohydrate, protein and lipid. Hormones and behaviour. Biological actions of hormones of hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal and pancreas.

Unit IV: Mechanism of hormone action, Biosynthesis and secretion of hormones

(13)

Hormone receptors- types and structure, regulation; Mechanism of hormone action- peptide hormone, receptor signal transduction, G proteins, Cyclic AMP, other membrane messengers - Protein kinase C; Phospholipase C. Mechanism of action of steroid hormones; Termination of hormone action.

Biosynthesis and secretion of steroid hormones - corticosteroids and sex-steroids, Catecholamines, thyroid hormones, Peptide hormones- insulin; Hormonal inactivation.

Unit V: Growth factors

(5)

Insulin, Prolactin, placental lactogen and IGFs; Neurotrophic growth factors; Hematopoietic growth factors; Epidermal growth factors; Transforming growth factors; Fibroblast growth factors; Cytokines, chalone.

Unit VI: Immunoendocrinology

(6)

An overview of organization and function of immune system, effect of endocrine ablation and replacement on immune response; Sexual dimorphic immune response and its mechanism; Effect of pregnancy on immune response; Hormonal regulation of immune responses; Immuno-endocrine interactions involved in the immune response.

ZCT 4.2: BIOLOGY OF REPRODUCTION

48 hrs

Unit I: An overview of Reproduction

(04)

Sex determination and differentiation of gonads, gonadal ducts and their hormonal regulation

Unit II: Male Reproductive system

(10)

Anatomy of male reproductive system, Histo-architecture of testis, Spermatogenesis, Functions of Sertoli and Leydig cells; Seminiferous epithelial cycle and wave, Stem cell renewal. Hormonal control of spermatogenesis. Patterns of spermatogenesis and testicular cycles in non-mammalian vertebrates.

Unit III: Male accessory reproductive organs

(10)

Functional morphology and hormonal regulation of epididymis, Vas deferens, Prostate gland, Seminal vesicle, Coagulating and Cowper's glands; Biology of spermatozoa, and Biochemistry of semen; Biological actions of androgens.

Unit IV: Female Reproductive system

(10)

Anatomy of female reproductive system; Histo-architecture of ovary, Folliculogenesis, Follicular atresia, ovulation, Corpus luteum; Hormonal regulation of estrous and menstrual cycle; Biological actions of estrogens. Structure of ovary and ovarian cycles in non-mammalian vertebrates.

Unit V: Implantation, Gestation, Parturition and Lactation

(08)

Types of implantation, sequential events and hormonal regulation, delayed implantation; Placenta – histophysiology and endocrine function, Endocrine regulation of pregnancy and parturition; Lactation– Development of mammary glands, Hormonal control of lactation.

Unit VI: Fertility and Infertility

(06)

Fertility control in male and females – Natural methods, barrier methods, intrauterine devices, hormonal contraceptives, surgical and immunological approaches; Amniocentesis; ARTs – Induction of ovulation, Artificial insemination, IVF, GIFT, ZIFT, Surrogate pregnancy, Gestational carrier.

ZCT-4.3: APPLIED ZOOLOGY

48 hrs

Unit I: Vermiculture (6)

Life cycle of earthworm; Establishment of vermiculture unit; Earthworm as a tool for conversion of waste material into vermicompost; Types of earthworm; Earthworm as Fish and Poultry feed; Vermiwash.

Unit II: Apiculture and Sericulture (12)

Apiculture: Life cycle, foraging and colony organization in different species; Bee keeping practices in India. Composition and uses of honey; Bee products; Lac insect- life cycle, cultivation and uses of Lac.

Sericulture: Classification of silkworms based on moultinism, voltinism and geographical distribution; Popular silkworm breeds and hybrids. Life cycle of *Bombyx mori*; Diseases and pests of silkworm: protozoan, bacterial, viral and fungal diseases (mode of infection, transmission, prevention and control measures).

Unit III: Insect Pest Management (6)

Crop pests: Life cycle and damaged caused by pests of cotton, sorghum, pulses and fruits. Household pests; Integrated Pest Management. Mass multiplication of bio-control agents.

Unit IV: Parasitology (6)

Kinds of vectors and blood sucking dipterans; Important humans and veterinary parasites (Protozoan and Helminthes), Host- parasite interactions.

Unit V: Fisheries (8)

Freshwater, brackish water and marine fisheries resources of India and its importance. Culture of Exotic fishes; Composite fish culture; Induced breeding. Cold water fisheries, Shell fisheries. Preservation and processing of fish and fish by-products.

Unit VI: Poultry and Dairy science (10)

Poultry: Indigenous and Exotic Poultry Breeds. Techniques and methods of breeding; Poultry products; Nutritive value of egg and meat. Poultry diseases: Viral, bacterial, fungal, protozoan and Helminth diseases and their control, vaccines for infections.

Dairy science: Indigenous and Exotic breeds. Principles and methods of breeding. Modern trends in breeding dairy animals. Dairy products: Processing, preservation and marketing of milk and milk products. Nutritive value of milk. Dairy pathology: Viral, bacterial and parasitic (Endo-Ecto) infections. Vaccination and control of diseases.

ZCP 4.4 -GENERAL AND COMPARATIVE ENDOCRINOLOGY PRACTICALS

48 hrs

1. Display of endocrine glands in rat.
2. Study of pituitary and pineal glands in rat.
3. Study of pituitary and pineal glands in fish.
4. Preparation of fixatives and stains, fixation of all endocrine glands as per the protocol.
- 5-6. Processing of following endocrine glands for histology:
 - a) Ovary
 - b) Testis
 - c) Adrenal
 - d) Thyroid with Parathyroid
 - e) Pancreas – Islets of Langerhans
- 7-8. Comparative histoarchitecture of following endocrine glands (fish to mammals):
 - a. Pituitary gland.
 - b. Thyroid and parathyroid
 - c. Pancreas
 - d. Adrenal and inter-renal glands
- 9-10. Enzyme histochemistry - localization of steroid dehydrogenase enzyme activity (Δ^5 -3 β -HSDH and 17-3 β -HSDH) in the adrenal, ovary and testis of rat.
11. Estimation of Acetylcholinesterase enzyme (AChE) activity.
12. ELISA- Quantitative measurement of sex steroid hormones in serum of rat.
13. Any other practical depending on feasibility.

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ZCP - 4.5: BIOLOGY OF REPRODUCTION PRACTICALS

48 hrs

1. Study of estrous cycle in rat
2. Study of mammalian ovary- Primordial follicle, primary follicle, antral follicle, Graafian follicle, corpus luteum, corpus albicans and atretic follicles.
3. Study of female accessory reproductive organs in rat
 - T. S. of Fallopian tube
 - T.S. of Uterus
4. Induction of pseudopregnancy in rat.
5. Histology of testis and male accessory reproductive organs in rat
 - Epididymis
 - Seminal vesicles
 - Coagulating glands
 - Ventral prostate and
 - Cowper's glands / Bulbourethral gland.
6. Androgen bioassay in rat.
7. Study of abnormal spermatozoa in rat.
8. Quantification of number of sperms in rat epididymal fluid.

9. Comparative anatomy of the ovary in non- mammalian vertebrates
 - T. S. of Fish ovary
 - T. S. of Amphibian ovary
 - T. S. of Reptilian ovary
 - T. S. of Bird ovary
10. Comparative anatomy of the testis in non- mammalian vertebrates
 - T. S. of Fish ovary
 - T. S. of Amphibian ovary
 - T. S. of Reptilian ovary
 - T. S. of Bird ovary
11. Pathology of Reproductive system
 - Cryptorchid testis, Prostate cancer
 - Polycystic ovary, Endometriosis
12. Contraceptive methods
 - Intra-uterine device
 - Hormonal contraception
13. Any other practical depending on feasibility.

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ZCP 4.6 - APPLIED ZOOLOGY

48 hrs

- 1 Vermitechnology: Study of Digestive system in Earthworm.
- 2 Vermitechnology: Mounting of setae, blood glands, nephridia and ovary of Earthworm.
- 3 Apiculture: Bee keeping appliances: Study of digestive system in Honey bee.
- 4 Apiculture: Mounting of poison apparatus, pollen basket, pollen brush, wax glands and mouth parts of Honey bee.
- 5 Insect pest management: Study of agricultural and horticultural pests and bio control agents.
- 6 Parasitology: Study of pathogenic parasites.
- 7 Fisheries: Economically important freshwater fishes: (*Catla catla*, *Labio rohita*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Wallago attu*, *Clarius batrachus*, *Mystus seengala* and *Channa punctatus*).
- 8 Fisheries: Marine fishes: Sardine, Mackerel, Trygon, Scoliodon, Bombay duck and Pomfret). Shell fishes: Prawn, Pearl oyster and Sepia.
9. Silkworm Biology: Life cycle of *Bombyx mori*. Study of digestive system of larva. Mounting of silk gland and spiracles.
10. Study of Silkworm pathogens.
11. Dairy Science: Study of Different breeds: Study of Ecto and endo parasites (Mode of infection, prevention and control measures).
12. Poultry: Study of Different breeds: Study of Ecto and endo parasites. (Mode of infection, prevention and control measures).

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REFERENCE BOOKS

- Abbas, A. K., Lichtman, A. H., and Pober, J. S. *Cellular and Molecular Immunology*. IV Ed. W. B. Saunders Company, 2000
- Albert, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., and Walter, P. *Molecular Biology of the Cell*. Garland Science Publishing, New York, 2002
- Alberts, B., Bray, D., Johnson, A., Lewis, I., Raff, M., Roberts, K., and Walter, P. *Essential Cell Biology: An Introduction to the Molecular Biology of the Cell*. Garland Publishing, Inc, New York and London, 1998
- Arora, R. K. *Air Pollution: Causes and effective control*. Mangal Deep Publications, Jaipur (India), 1999.
- Arthur, R and William, H. A. *Farming for pleasure and profit: Dairy farming Management of cows*. Kessinger Publishing Company, 2010
- Atherly, A. G., Girton, J.R., and McDonald, J. F. *The Science of Genetics*. Saunders College, 1999
- Avatar Singh, Joshi and Singh, B K. *Dairy farming*. ICAR publishers, 2010
- Bailey, N. T. J. *Statistical methods in Biology* – III Ed. Cambridge Univ. Press, 1994
- Barrington, E. J. W. *Structure and Function of Invertebrates*. ELBS 1971
- Bentley, P. J. *Comparative Vertebrate Endocrinology* – III Ed. Cambridge Univ Press, 1998
- Botkin, D. B., and Keller, E. A. *Environmental Science: Earth as a living planet*. John Wiley and Sons, Inc, 1995
- Bumie, D. (Ed). *Animal: The Definitive Visual Guide to the Worlds Wildlife*. D. K. Publications, 2001
- Campbell, R. C. *Statistics for Biologists*. III Ed. Cambridge Univ Press, 1989
- Celis, J. E. (Ed). *Cell Biology: A Laboratory Handbook* – Vol – I and II. Academic Press, 1998
- Chapman, R. F. *The Insects: structure and function* – IV Ed. Cambridge Univ. Press. 1998
- Chirikjian, J. G. *Biotechnology: Theory and Techniques*- Vol. – I and II. Jones and Barlett, 1995
- Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. *Standard methods for the examination of water and waste water* – XX Ed. American Public Health Association, 1998
- Clive, A. Edwards., Norman, Q. Arancon and Rhonda Sherman. *Vermiculture Technology*. CRC Press, 2011.
- Cooper, G. M. *The Cell: A Molecular Approach* II Ed. ASM Press Washington, 2000
- Cunningham, W. P. *Environmental Science* – V Ed. WCB McGraw – Hill, 1999
- David, D. V. and Kumaraswami, T. *Elements of Economic Entomology*. Popular Book Depot. Madras. 1988
- Darwin C. *The Descent of Man*. John Murray (1979) Penguin Classics
- Daniel Prater: *Book of Indian Animals*, Bombay Natural History Society
- Degroot, L. J., and Neill, J. D. (Ed). *Endocrinology*- IV Ed, Vol. I-III. W.B. Saunders Company, 2001
- De Robertis, EDP and De Robertis, EMI. *Cell and Molecular Biology*. VIII Ed BI Waverly Ltd. 1995
- Dent, D. *Insect Pest Management*- II Ed. CABI, 2000
- Dhaliwal, G. S., and Heinrichs E. A. *Critical issues in Insect Pest Management*. Commonwealth Publishers, New Delhi, 1998
- Dingle, H. *Migration: The Biology of Life on the Move*. Oxford Univ Press, 1996
- Dokuhon, Z.S. *Illustrated text book of Sericulture*. Oxford and IBH publishing Co., New Delhi, 1998.
- Duncan, F. N. (eds). *Bee-keeping for Profit and Pleasure*, Agrobios (India), 2004.
- Dutta Munshi and Srivastava. *Natural history of fishes and systematic of freshwater fishes of India* Narendra publishing house, New Delhi, 1988.

- Forthofer, R. N., and Lee, E. S. *Introduction to Biostatistics*. Academic Press, New York, 1995.
- Futuyma, D. J. *Evolutionary Biology*. III Ed. Sinauer Associates Inc Massachusetts, 1998
- Gadagkar, R. *Survival strategies*, University press. 1997.
- Gerhart, J., and Kirchner, M. *Cells, Embryos and Evolution*. Blackwell Science Publisher, 1997
- Gilbert, S. F. *Developmental Biology* -VII Ed, Sinauer Associates Inc, Publishers. Massachusetts, 2003.
- Glick, B. R., and Pasternak, J. J. *Molecular Biotechnology: Principles and Applications of Recombinant DNA* – II Ed. A. S. M. Press, 1998
- Gullan, P. J., and Cranston, P. S. *The Insects: An Outline of Entomology*- II Ed. Blackwell Science, 2000
- Gupta, P. K. *Vermicomposting for sustainable Agriculture*. Agrobios (India) 2003
- Hadley, Mc. E. *Endocrinology* – Ed. Prentice Hall Inc, 2000
- Hawksworth, D. L. (Ed). *Biodiversity: Measurement and Estimation*. Chapman and Hall, 1995
- Higgins, D., and Taylor, W. (Eds). *Bioinformatics Sequence, Structure and Databanks*. Oxford Univ Press, 2000
- Howse, P., Stevans, I., and Jones, O. *Insect Pheromones and their Use in Pest Management*. Chapman and Hall, 1998
- Imms, A. D., *General Textbook of Entomology*, Vol. 1 and 2 Chapman and Hall, London, 1977
- Jadhav and Sidiqi. *Handbook of poultry production and management*. Jaypee publishers, 2010.
- Jairajpuri, M. S. (Ed). *Collection and Preservation of Animals*. Zoological Survey of India, 1990
- Jawaid Ahsan and Sinha, S. P. *A hand book on Economic Zoology*, S. Chand and Co. Ltd. New Delhi. 2000.
- Jhingran, V. G. *Fish and Fisheries of India*. Hindustan Publishing Corporation (India) New Delhi. 1983
- Kalthoff, K. *Analysis of Biological Development*. McGraw-Hill, Inc. New York, 1996
- Kapoor, V. C. *Theory and Practice of Animal Taxonomy*. Oxford IBH Co. Pvt. Ltd., New Delhi, 1998
- Kerkut, S. A., and Gilbert, L. I. (Eds.) *Comparative Insect Physiology, Biochemistry and Pharmacology*. Vol. 13, Pergaman Press, New York, 1985
- Keynes, R. *Charles Darwin's Zoology notes and Specimen Lists From H M. S. Beagle*. Cambridge Univ Press, 2000
- Knobil, E., and Neil, J. D. (Eds.). *Encyclopedia of Reproduction*. Vol. I-IV. Academic Press, 1998
- Knobil, E., and Neil, J. D. (Eds.) *The Physiology of Reproduction*. II Ed, Vol-I and II. Raven Press Ltd, 1994
- Kormondy, E. J. *Concept of Ecology*. III Ed, Prentice Hall of India Publishers, 1994
- Kotwal. P. C., and Banerjee, S. *Biodiversity Conservation: In Managed Forests and Protected Area*. Agro Botanica, 1998
- Krebs, J. R., and Davies, N. B. *An Introduction to Behavioral Ecology*. III Ed. Blackwell Science Ltd. 1993
- Kumar, and Asija. *Biodiversity: Principles and Conservation*. Agrobios (India), 2000
- Kumar, H. D. *Plant and Animal Interactions*. East-West Press, Pvt Ltd, New Delhi, 2000
- Lodish, H., Berk, A., Zipuosky, L. S., Matsudaira, P., Baltimore, D. and Darnell, L. *Molecular Cell Biology* – IV Ed. W. H. Freeman and company, 2001
- Malacinski, G. M., and Freifelder, D. *Essentials of Molecular Biology*. III Ed. Jones and Barlett Publishers, 1998
- Mandal, A. *Handbook of Neuroendocrinology*. EMKAY Publications, 1994
- Manning, A., and Dawkins, M. S. *An Introduction to Animal Behavior*- IV Ed., Cambridge Univ Press, 1997
- Marshall, A. J., and Williams, W. D. (Eds.). *Text book of Zoology Invertebrates*. VII Ed., Vol. I.AI. T. B. S Publishers and Distributors, 1995

- Mayr, E. and Ashlock P. D. *Principles of Systematic Zoology*, 2nd Edition, McGraw-Hill, Inc. 1991
- McKinney, M. L., and Schoch, R. M. *Environmental Science: Systems and Solutions*. Jones and Barlett Publishers, 1998
- Mishra, R. C. *Perspectives in Indian Apiculture*. Allied Scientific Publ. Bikaner, India 1999
- Moore, J. *An Introduction to the Invertebrates: Studies in Biology*. Cambridge Univ Press, 2001
- Neilsen, K. S. *Animal Physiology: Adaptation and Environment*. IV Ed. Cambridge Univ Press, 1995
- Nelson, R. J. *An Introduction to Behavioral Endocrinology*. Sinauer Associates, Inc, 1995
- Norris, D. O. *Vertebrates Endocrinology* III Ed. Academic Press, 1996.
- Pablo De, Scanes, C. G., and Weintraub, B. D. *Hand book of Endocrine Research Techniques*. Academic Press, Inc. 1993
- Price, P. W. *Biological Evolution*. Saunders College Publishing, 1996
- Primrose, S. B. *Molecular Biotechnology*. II Ed. Blackwell Scientific Publications, London, UK, 1991
- Pedigo, L. P. *Entomology and Pest Management*. IV ed. Prentice- Hall of India, Pvt. Ltd. New Delhi. 2002.
- Prasad, D and Goutam, R. D. *Potential IPM tactics*. Westvill Publishing House, New Delhi, 1998
- Rajan, R.K., Hemanth Raju. *Text Book on silkworm rearing*. Central Silk Board, Bangalore, 2005.
- Rao, K. V. *Developmental Biology: A Modern Synthesis*. Oxford and IBH Publishing Company Pvt. Ltd. 1993
- Rao, M. N., and Rao, H. V. N. *Air Pollution*. Tata Mc Graw-Hill Publishing Company Ltd, 1999
- Ratnabir Singh., Shomorendra Singh., Devashish Kar. *Parasite Fauna in the wetland fishes of India. Today and tomorrow*. Printers and Publishers, New Delhi, 2014.
- Salim Ali: *Book of Indian Birds*. Bombay Natural History Society / Oxford University Press, Mumbai, 1997
- Sarker, Dilip. *The Silkworm: Biology, genetics and Breeding*. UBS publishers, 1998.
- Saidapur, S. K. (Ed) *Reproductive Cycles of Indian Vertebrates*. Allied Publishers Ltd, New Delhi, 1989
- Samuel, M. L. *Statistics for Life Sciences*. Dellen Publishing Co. San Francisco, 1991
- Sathe, T. V. *Vermiculture and Organic Farming*. Daya Publishing House. Delhi. 2004
- Sharma, P. D. *Environmental Biology*. Ed – I and II. Rastogi Publications, 21XX
- Simpson, G. C. *Principles of Animal Taxonomy*. Clumbia Univ Press, New York, 1961
- Slater, P. J. B. *Essentials of Animal Behavior*. Cambridge Univ Press 1999
- Sasidhara R. *Animal Biotechnology*. MJP publishers, Chennai, 2006
- Smith, J. M. *Evolutionary Genetics*. Oxford Univ Press, 1998
- Smith, J. E. *Biotechnology*. III ed. Cambridge University Press. 1996
- Smyth, J. D. *Animal Parasitology*. Cambridge Univ Press, 1996
- Snedecor, G. W., and Cochran, W. G. *Statistical methods*. VI Ed. Oxford and IBH Publishing Co., New Delhi, 1967
- Snustad, D. P., and Simmons, M. J. *Principles of Genetics*. John Wiley and Sons, Inc, 2003
- Srivastava, K. P. *Text Book of Applied Entomology- Vol.-I –II*. Kalyani Publishers, 1996
- Steel, R. G. D., and Torrie, J. H. *Principles and Procedures of Statistics: A Biometrical Approach – II Ed*. McGraw-Hill Book Company, 1980
- Strickberger, M. W. *Evolution*. Jone and Barlett Publishers, Boston, London, 2000
- Subramoniam, T. *Developmental Biology*. Narosa Publishing House, 2002
- Sunder Rao, P. S. S., and Richard, J. *An Introduction to Biostatistics*. III Ed. Prentice Hall, India, New Delhi, 1997
- Srivastava, K. P. *A text book of Applied Entomology*. Vol. I and II, Kalyani Publishers. New Delhi. 1993
- Tamarin, R. H. *Principles of Genetics*. V Ed. Wm. C Brown Publishers 1996

- Tembhore, D. B. *Modern Entomology, Ecology and Management*. SID Publ. Dehradun, India, 1999
- Tribhuvan Singh., Promod Kumar Singh and Khursheed Ahmad Sahaf. *Silkworm Rearing Technology*, Discovery Publishing house.
- Turner C.D. and Bugnara, J.T. *General Endocrinology*. W. B. Saunders 1976
- Twyman, R. M. *Instant Notes: Developmental Biology* Bios Scientific Publishers Ltd, 2001
- Upadhy, R. K., Mukerji, K. G. and Rajak, R. L. *IPM system in Agriculture*. Vol. I and II. Aditya Books Private Ltd. New Delhi
- Van Emden, H. F. *Pest Control*. II Ed. Cambridge Univ Press, 1989.
- Willmer, P., Stone, G., and Johnston, I. *Environmental Physiology of Animals*. Blackwell Science Ltd. 2000
- Wolpert, L., Beddington, R., Brockes, J., Jessen, T., Lawrence, P., and Meyerowitz, E. *Principles of Development*. Oxford Univ Press, 1998
- Young, J. Z. *The Life of Vertebrates* –III Ed. (Indian Ed) Oxford Univ Press, 1981
- Young, S. S. *Computerized data acquisition and analysis for the life sciences: A Hands-on guide*. Cambridge Univ Press, 2001

DEPARTMENT OF ZOOLOGY
KARNATAK UNIVERSITY, DHARWAD

Syllabus

For

Elective Papers

Offered by

ZOOLOGY

For students of other Departments

Choice Based Credit System

2019-20 onwards

SEMESTER II

ZET 2.7: ANIMAL BEHAVIOR

48 hrs

Unit I: Introduction to Animal Behavior (4)

Animal Behavior: Introduction, definition and history (Lorenz, Tinbergen, von Frisch); Questions about animal behavior

Unit II: Development of Behavior (8)

Behavior and genes; Innate behavior; Parent-offspring interaction; Imprinting- Filial Imprinting and Sexual imprinting; Instinct- Interaction between instinct and learning

Unit III: Learning (8)

Definition and forms learning: Habituation; Associative learning/ conditioning (Classical conditioning- Pavlov; Operant conditioning, instrumental learning, Skinner), Spatial learning; Insight learning; Social learning; Cognitive maps; Observational learning/imitation; Insight learning; Social learning

Unit IV: Communication (10)

Sign and normal stimuli; Channels of communication; Pheromones and acoustic signals; Evolution of display and mimicry, aposematic coloration, deception and honesty; communication in social groups, alarm calls, alarm pheromones, trail pheromones; Dance language in honey bee; Primate language

Unit V: Evolution of Social system (10)

Society, benefits and costs of sociality; Social interactions of groups- Altruism – concept of inclusive fitness, (Kin selection, parental care); Reciprocal Altruism, selfish, spite, conflict and infanticide; Insect eusociality: a case of altruism and cooperation (honey bee); Vertebrate societies; Human sociobiology; Biological and cultural evolution

Unit VI: Cooperation and conflict (8)

Fine balance between Cooperation and conflict : Queen-worker conflict in ants; Worker-worker conflict in honey bees; disease as an enhanced social conflict; Chimpanzee politics, Parental harassment of sons in bee eaters; communal nursing; Mutiny in ant colony; mother – offspring conflict.

SEMESTER III

ZET 3.7: ECONOMIC ZOOLOGY

48 hrs

Unit I Introduction (1)

Importance of Economic Zoology

Unit II: Vermiculture (6)

Establishment of vermiculture unit; Earthworm as a tool for the conversion of biodegradable waste into vermicompost; Earthworms as poultry and fish feed; Vermiwash.

Unit III: Beekeeping and Sericulture (11)

Beekeeping practices in India; Foraging and colony organization in honeybees; Composition and uses of honey and bee products. Lac culture: Cultivation and uses of lac.

Importance of sericulture as a rural industry; Life cycle of *Bombyx mori*; Modern rearing methods, reeling, grading and marketing.

Unit IV: Pest management and Parasitology (16)

Pests of economically important crops; Household pests; Damages caused by pests; Integrated Pest Management (IPM)- Different components and general idea about the biocontrol agents; Vertebrate (birds and rodents) pest management.

Definition and types of parasites and vectors; Blood sucking dipterans; Important human and veterinary parasites (protozoans and helminthes); Host-parasite interactions.

Unit V: Fisheries (10)

Culture of major carps and exotic carps; Off-shore fisheries- Sardin; Composite fish culture; Ornamental fishes; Pearl culture; Fish by-products.

Unit VI: Poultry keeping (4)

Different breeds of chicken and different breeding systems; Egg production and economics.

Note: The figure in the parantheses indicates approximate number of lecture hours to reflect the weightage to be given to respective topics.

References

- David, D. V. and Kumarswami, T. *Elements of Economic Entomology*. Popular Book Depot. Madras. 1988
- Dent, D. *Insect Pest Management*- II Ed. CABI, 2000
- Dhaliwal, G. S., and Heinrichs E. A. *Critical issues in Insect Pest Management*. Commonwealth Publishers, New Delhi, 1998
- Duncan, F. N. (eds). *Beekeeping for profit and pleasure*. Agrobios (India) 2004.
- David, D. V. and Kumarswami, T. *Elements of Economic Entomology*. Popular Book Depot. Madras. 1988.
- Gadagkar, R. 1997. *Survival strategies*. University press
- Gupta, P. K. *Vermicomposting for sustainable Agriculture*. Agrobios (India) 2003
- Jawaid Ahsan and Sinha, S. P. *A hand book on Economic Zoology*, S. Chand and Co. Ltd. New Delhi. 2000.
- Jhingran, V. G. *Fish and Fisheries of India*. Hindustan Publishing Corporation (India) New Delhi. 1983
- Krebs, J. R., and Davies, N. B. *An Introduction to Behavioral Ecology* – III Ed. Blackwell Science Ltd. 1993
- Manning, A., and Dawkins, M. S. *An Introduction to Animal Behavior*- IV Ed., Cambridge Univ Press, 1997
- Mishra, R. C. *Perspectives in Indian Apiculture*. Allied Scientific Publ. Bikaner, India 1999
- Rao, M. N., and Rao, H. V. N. *Air Pollution*. Tata Mc Graw-Hill Publishing Company Ltd, 1999
- Sathe, T. V. *Vermiculture and Organic Farming*. Daya Publishing House. Delhi. 2004
- Slater, P. J. B. *Essentials of Animal Behavior* Cambridge Univ Press 1999
- Upadhyaya, R. K., Mukerji, K. G. and Rajak, R. L. *IPM system in Agriculture*. Vol. I and II. Aditya Books Private Ltd. New Delhi
- Van Emden, H. F. *Pest Control*-II Ed. Cambridge Univ Press, 1989

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