


KUVEMPU UNIVERSITY
DEPARTMENT OF APPLIED ZOOLOGY, SHANKARAGHATTA

P.G. Course: M.Sc. ZOOLOGY

CBCS Scheme (Effective from 2015-16 July onwards)

I SEMESTER

| Paper Code | Theory Papers | Teaching / week | IA | Exam | Total | Credits |
|------------------|---|-----------------|----|--------------|------------|-----------|
| HC-1.1 | Biosystematics, Non Chordata and Chordata | 4 hrs. | 25 | 75 | 100 | 4 |
| HC-1.2 | Animal Physiology and Endocrinology | 4 hrs. | 25 | 75 | 100 | 4 |
| HC- 1.3 | Fundamental Genetics | 4 hrs. | 25 | 75 | 100 | 4 |
| SC-1.4(a) | Economic Zoology | 4 hrs. | 25 | 75 | 100 | 4 |
| SC-1.4(b) | Biological Chemistry and Biostatistics | 4 hrs. | 25 | 75 | 100 | 4 |
| | Practical papers | | | | | |
| Practical –1.5 | Based on theory paper HC – 1.1 | 4 hrs | - | 50 | 50 | 2 |
| Practical –1.6 | Based on theory paper HC – 1.2 | 4 hrs | - | 50 | 50 | 2 |
| Practical –1.7 | Based on theory paper HC- 1.3 | 4 hrs | - | 50 | 50 | 2 |
| Practical-1.8(a) | Based on theory paper SC 1.4(a) | 4 hrs | - | 50 | 50 | 2 |
| Practical-1.8(b) | Based on theory paper SC-1.4(b) | 4 hrs | - | 50 | 50 | 2 |
| | | | | Total | 600 | 24 |

II SEMESTER

| Paper Code | Theory Papers | Teaching / week | IA | Exam | Total | Credits |
|--------------------|--------------------------------------|-----------------|----|--------------|------------|-----------|
| HC-2.1 | Cell Biology | 4 hrs. | 25 | 75 | 100 | 4 |
| HC-2.2 | Animal Behavior and Wildlife Studies | 4 hrs. | 25 | 75 | 100 | 4 |
| SC-2.3(a) | Developmental Biology | 4 hrs. | 25 | 75 | 100 | 4 |
| SC-2.3(b) | Ecology and Evolution | 4 hrs. | 25 | 75 | 100 | 4 |
| EL- 2.4 | | 2 hrs. | 10 | 40 | 50 | 2 |
| | Practical papers | | | | | |
| Practical –2.5 | Based on theory paper HC – 2.1 | 4 hrs | - | 50 | 50 | 2 |
| Practical –2.6 | Based on theory paper HC – 2.2 | 4 hrs | - | 50 | 50 | 2 |
| Practical –2.7(a) | Based on theory paper HC- 2.3(a) | 4 hrs | - | 50 | 50 | 2 |
| Practical – 2.7(b) | Based on theory paper SC – 2.4(b) | 4 hrs | - | 50 | 50 | 2 |
| | | | | Total | 500 | 20 |

III SEMESTER

| Paper Code | Theory Papers | Teaching / week | IA | Exam | Total | Credits |
|-------------------|--|-----------------|----|--------------|------------|-----------|
| HC-3.1 | Molecular Biology and Biotechnology | 4 hrs. | 25 | 75 | 100 | 4 |
| HC-3.2 | Basic and Applied Entomology | 4 hrs. | 25 | 75 | 100 | 4 |
| SC 3.3 (a) | Microbiology and Immunology | 4 hrs. | 25 | 75 | 100 | 4 |
| SC 3.3 (b) | Parasitology and Nematology | 4 hrs. | 25 | 75 | 100 | 4 |
| EL-3.4 | | 2 hrs. | 10 | 40 | 50 | 2 |
| | Practical papers | | | | | |
| Practical -3.5 | Practical – I: Based on theory paper HC – 3.1 | 4 hrs | - | 50 | 50 | 2 |
| Practical -3.6 | Practical – II: Based on theory paper HC – 3.2 | 4 hrs | - | 50 | 50 | 2 |
| Practical -3.7(a) | Practical – III: Based on theory paper SC 3.3(a) | 4 hrs | - | 50 | 50 | 2 |
| Practical -3.7(b) | Practical – III: Based on theory paper SC 3.3(b) | 4 hrs | - | 50 | 50 | 2 |
| | | | | Total | 500 | 20 |

IV SEMESTER

| Paper Code | Theory Papers | Teaching / week | IA | Exam | Total | Credits |
|----------------|--|-----------------|----|--------------|------------|-----------|
| HC-4.1 | Advanced Genetics and Computational Biology | 4hrs. | 25 | 75 | 100 | 4 |
| HC-4.2 | Environmental Pollution and Eco-toxicology | 4 hrs. | 25 | 75 | 100 | 4 |
| HC-4.3 | Project work | 4 hrs | 25 | 75 | 100 | 4 |
| | Practical papers | | | | | |
| Practical -4.5 | Practical I: Based on theory paper HC – 4.1 | 4 hrs | - | 50 | 50 | 2 |
| Practical -4.6 | Practical II: Based on theory paper HC – 4.2 | 4 hrs | - | 50 | 50 | 2 |
| | | | | Total | 400 | 16 |

1. Total Marks for the Course : 2000

2. Total Credits for the Course : 80 + 3 (Soft Skills) = 83

- Dissertation (Major and minor project work) should be based on experimental / review work and valued by two examiners (one external and one internal).
- Educational tour is compulsory in the III Semester. Tour report should be submitted for internal assessment.
- Each candidate shall have to complete 1Credits each in Communication Skill, Computer applications and Personality development within first two semester.

Internal Assessment for papers

- Two session tests : 10 marks
- Seminar/Tutorial/Group discussions/Tour Report : 05 marks
- Assignment/Fieldwork : 05 marks
- Regularity and attendance : 05 Marks

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## **SEMESTER - I**

**Paper HC 1.1: Biosystematics, Non Chordata and Chordata** 64 hrs

**A– BIOSYSTEMATICS** 22 hrs

**Unit 1. Principles of animal taxonomy:**

- a) Brief account of species concept, Classification, Taxonomy and Systematics.
- b) Zoological nomenclature – ICZN. c) Taxonomic procedures, Monophyly, Polyphyly. d) Grades and Clades. e) Vertical and horizontal relationships.
- f) Ranks of characters. g) New trends in taxonomy. 10 hrs

**Unit 2: Taxonomic categories:**

Classification of Invertebrates up to class and vertebrates up to order with suitable examples. Species as a category 3 hrs

**Unit 3. Systematic position of peripatus:**

Organization and phylogenetic relationships of protochordates. Systematic position of Agnatha. 5 hrs

**Unit 4: Phylum Chordata:** Origin and diversity of Chordates,

General characters. Advancements of chordate over other phyla. Comparison (differences) of chordates with non-chordates. 4 hrs

**References:**

1. Agerstein. G. 1972. Evolution of Metazoan life cycle, Academic Press. N.Y & London.
2. Barnes, R.D. 1974. Invertebrate Zoology. III edition. W.B.Saunders Co., Philadelphia.
3. Barrington. E.J.W.1976. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
4. Simpson. G.C. Principles of Animal Taxonomy.

**B -Non Chordata** 22 hrs

**Unit 5: Major and Minor Phyla;** Lower and Higher Invertebrates;

General Characteristics of Invertebrates. 3 hrs

**Unit 6: Locomotion in Invertebrates:** Muscle filaments and myonemes, Flagella and cilia. Amoeboid movement, 3 hrs

**Unit 7: Nutrition in Protozoa:** Filter feeding in polychaetes, Filter feeding and digestion in Deuterostomia and mollusks, 3 hrs

**Unit 8: Respiratory organs:** Gills and tracheae in arthropods, physical factors, Respiratory pigments, Gills and lophophores, Gills and lungs in mollusks. 4 hrs

**Unit 9: Excretory organs:** Excretory organs, Excretion of nitrogen, Osmotic and 4 hrs

Ionic regulation in marine animals, Protozoa and freshwater life.

- Unit 10 :** (a) **Primitive Nervous Systems:** Components of behaviour, nerve net in Coelenterates, Echinoderms.  
(b) **Advanced Nervous Systems :** Trends in neural evolution, Metameric nervous system in annelids, Aspects of arthropod behaviour, Giant nerve fibres and molluscan nervous system. 5 hrs

**References:**

1. Barnes, R.D.1974. Barnes, R.D.1974. Invertebrate Zoology, III Ed. W.B. Saunders Co., Philadelphia.
2. Barrington, E.J.W.1976. Invertebrate Structure and Function. Thomas Nelson and Sons Ltd., London.
3. Kapoor, V.C. 1998.Theory and Practice of Animal Taxonomy. Oxford IBH Co. Pvt. Ltd., New Delhi, 1998.
4. Parker, T.J. Haswell, W.A. 1961. Textbook of Zoology, Vol. I, II Ed. Macmillon Co.,
5. Russel-Hunter, W.D. 1969. Biology of Higher Invertebrates, The Macmillan, Co., Ltd., London.
6. Sedgwick, A 1966. A Student Text Book of Zoology. Vol. I, II and III. Central Book Depot, Allahabad.
7. Simpson, G.G. 1965. Principles of Animal Taxonomy. Oxford Book Co., New Delhi.
8. Jordon, E.L. and P.S. Verma 2009. Invertebrates Zoology, S. Chand Publishers, New Delhi – 110055.

**C - CHORDATA** 20 hrs

- Unit 11 : Protochordata :**General and Comparative study:  
Comparision of three Protochordates, Subphyla in terms of General comparision, Habits and habitats, Alimentary canals and associated glands, Pharynx, Food and feeding and Excretory system. 5 hrs

- Unit 12: Integument and its Derivatives:** Comparative Anatomy, Epidermal Integument or Skin Functions, Structure its Derivatives (Glands, Scales and scutes, digital cornifications, horns, feathers, hairs), Integument in different classes of Chordates. 5 hrs

- Unit 13:Endoskeleton in Vertebrates:** Introduction to Skeleton, Meaning, Types, Functions, Subdivisions Skull : Types of Bones. Morphogenesis (History and Development). Skull in Different Vertebrates. Suspensoria or Jaw Suspensions. Vertebral column structure and types of vertebrae. 4 hrs

- Unit 14: Digestive System** : Introduction Embryonic Digestive Tract  
Alimentary Canal : Divisions, Digestive Glands. 3 hrs
- Unit 15: Respiratory System:** Introduction Respiratory organs: Gills  
(Internal or true gills, External or Larval gills). Lungs and Ducts,  
Accessory Respiratory organs and Swim Bladders. 3 hrs

**References:**

9. Barrington, E.J.W.1965. **The Biology of Hemichordata and Protectorate-**  
Oliverand Boyd, Edinburgh.
2. Goodrich, E.S. 1958. **Studies on the Structure and Development of Vertebrates.**  
Vol. I and II, Dever Publications Inc., New York.
3. Weichert, C.K. and Presch. W. 1975. **Elements of Chordate Anatomy, IV**  
Ed. McGraw Hill Book Co., New York.
4. Jordan, E.L. and P. S. Verma. 2009. **Chordata Zoology**, S. Chand and Company  
New Delhi.

**A- Biosystematics and B- Non Chordata**

**Practicals:**

1. Study of external and internal morphology with the help of audio-visual CD/Charts-
  - a. Nervous system: Crab, Sepia/ Loligo
  - b. Respiratory system: Gills, Trachea, Book lungs
  - c. Reproductive system: Earth worm, Cockroach
  - d. Excretory System: Nephridium of earthworm and leech, malphigian tubules

**2. Slides and museum specimens:**

**1. PROTOZOA:**

Slides: 1. Gregarines, 2.Monocystis, 3. Ceratium, 4. Euplotes, 5. Didinium, 6.Nictiluca,  
7. Radiolaria, 8. Stentor, 9. Foraminifera, 10. Opalina.

**2. PORIFERA:**

a. Slides: 1. T.S of Sycon, 2. L. S. Sycon.  
b. Specimens: 1. Sycon, 2. Gratia, 3. Euspongia.

**3. CNIDARIA:**

a. Slides: 1. Obelia colony 2. Obelia polyp and medusa, 3. Planaria,  
4. Aurelia – tentaculocyst b. Specimens: 1.1. Physalia 2.Virgularia 3. Spongodus 4. Zoanthus  
5. Favia

**4.HELMINTHS:**

a. Slides. 1. Temnocephala.

b. Specimens: 1. Planaria, 2. Male and female Ascaris lubricoides, 2. Teania solium.

### **5. ANNELIDA:**

a. Slides: 1. Ozobranthus, 2. Glossiphonia

b. Specimens: 1. Eunice, 2. Chloea flava, 3. Polynoe. 4. Terebella, 5. Eurythoe

### **6. ARTHROPODA:**

a. Slides: 1. Cyclopes 2. Daphnia 3. Chelifer 4. T.S of Peripatus.

b. Specimens: 1. Balanus 2. Lepas, 3. Palinurus 4. Uca 5. Pycna 6. Hippa 7. Gongylus 8. Belostoma, 9. Limulus 10. Squilla 11. Eupagarus 12. Cicada- female and male

**7. Minor phyla-** 1. Bugula 2. Plumatella 3. Cristella 4. Pectinella 5. Lingula 6. Phoronis 7. Dendrostoma.

**8. Larval forms-** 1. Aurelia- Planula 2. Redia 3. Cerceria 4. Trochophore 5. Nauplius, 6. Zoea, 7. Mysis 8. Phyllosoma. 9. Limulus 10. Veliger 11. Glochidium. 12. Bipinnaria. 13. Auricularia, 14. Tornaria.

## **C - Chordata**

### **1. Study of external and internal morphology with the help of audio- visual CD/ charts:**

A: Pigeon: Flight muscles, Digestive, Reproductive, arterial, Venous, Respiratory, Nervous and skeletal systems

B: Rat: Digestive, Reproductive, Arterial, venous and Nervous system

### **2. Specimens and slides of-**

1. Protochordates- 1. Asexual and sexual forms of Salpa 2. Botryllus 3. Herdmania

2. Pisces- Rhinobatus 2. Chimeara 3. Acipenser 4. Periophthalmus 5. Tracanthus

6. Notopterus 8. Trichurus 8 Exocoetus 9. Diodon hyserix 10. Echinensis

3. Amphibians- 1. Ichthyophis 2. Rhacophorus 3. Rana tigrina 4. Amblystoma

4. Reptiles- 1. Sitana 2. Chameleon 3. Phrynosoma 4. Chelone mydus

5. Aves- Psittacula columboides( parakeet) 2. Kite 3. Jungle fowl 4. King fisher  
5. Koel(male/ female)

6. Mammals- 1. Indian Otter 2. Marmoset 3. Loris 4. Megaderma iyra ( bat) 5. Pangolin.

**3. Osteology:** 1. Skull- study of dorsal, ventral and lateral views of chelonian, Crocodile, Bird, mammal- dog( carnivore) and horse (herbivore)

2. Vertebra- a. Axis and Atlas b. Procoelous c. Opisthocoelous d. Amphicoelous  
e. Amphiplatan f. Heterocoelous

## **HC-1.2 Animal Physiology and Endocrinology** **64 hrs**

### **A. ANIMAL PHYSIOLOGY** 32 hrs

#### **Unit 1. Bioenergetics and cellular respiration:** 2 hrs

Energy – Concepts and definition, Redox potentials, Stepwise energy release through cytochrome and production of ATP uncouplers of oxidative phosphorylation, inhibitors.

#### **Unit 2. Digestive and excretory system:** 7 hrs

Digestive tract and associated glands & their secretions, Digestive enzymes.

Mechanism and stages of Digestion, Absorption of Carbohydrates, Proteins and Lipids and Energy balance and BMR

Comparative physiology of excretion in animals- Nitrogenous wastes and waste elimination. Mammalian kidney- Structure and physiology of urine formation.

#### **Unit 3. Blood and circulation:** 5 hrs

Components of Blood, and their functions, Haemopoiesis and formed elements, Hemoglobin.

Blood volume and its regulation, blood groups,

Circulatory system in animals- Types and functional anatomy,

Types of hearts, comparative anatomy of vertebrate heart,

Pace makers, Heartbeat, Blood pressure and their regulation and

ECG- Principle and significance.

#### **Unit 4. Respiratory system:** 4 hrs

Respiratory organs in animals- Trachea, Gills and lungs, anatomical considerations.

External and internal respiration, Respiratory membrane and exchange of gases, Transport of O<sub>2</sub> and CO<sub>2</sub>. Neural and chemical regulation of respiration.

#### **Unit 5. Nervous system and sense organs:** 5 hrs

Central and peripheral nervous system,

Structure of neuron, types and functions.

Impulse generation and conduction, molecular mechanisms of Synaptic transmission. Neurotransmitters, types & functions and their degeneration.

Visual, auditory and tactile reflexes.

#### **Unit 6. Muscle Physiology:** 4 hrs

Types of muscles, ultra structure and their functions.

Theories of muscle contraction, Chemistry and molecular



mechanism of muscle contraction, Neural control of muscle tone and posture and Insect flight muscles and tymbal muscles.

**Unit 7. Environmental Physiology:** 5 hrs

Concept of homeostasis, tolerance, resistance, acclimation and acclimatization. Osmoconformers and regulators, adaptations to aqueous and terrestrial environments, Temperature and biokinetic zone, Physiological adaptations of homeotherms and poikilotherms for temperature fluctuation, Physiology of stress: physiological responses to stress- metabolic hormonal and immune response.

**B- ENDOCRINOLOGY** 32 hrs

**Unit 8. Basic Concepts of Endocrinology** 3 hrs

**Chemical messengers:**

Autocrine, Paracrine and endocrine secretions,  
Types of hormones, an overview of human endocrine system

**Hormone synthesis:** Peptide and steroid hormones.

Role of Hormones in homeostasis- Glucose and Water balance

**Unit 9. Physiology of Endocrine glands:** 9 hrs

Structure and function of endocrine hypothalamus, pituitary gland, chemical structure and control of hypothalamic hormones. Pituitary hormones and their physiological actions. Feedback regulation. Pathophysiology. Hypothalamo - hypophysial portal system  
Pineal –Structure and function.  
Structure and biosynthesis and actions of hormones of Thyroid and adrenal gland.  
Endocrine pancreas- structure and secretions of hormones and Diabetes mellitus,  
Gastro intestinal hormones.

**Unit 10. Hormones and Male Reproduction:** 7 hrs

Functional morphology of mammalian testis, Kinetics of spermatogenesis – wave and cycle, Hormonal control of spermatogenesis, Brief description of histomorphology and hormonal control of male accessory organs viz., epididymis, vas deferens, seminal vesicles, ventral prostate, bulbourethral gland and preputial gland, Sperm maturation, morphological and biochemical events, influence of accessory organ secretions, hormonal control of Male secondary sexual characters. Ultrastructure of spermatozoa, abnormalities of sperm, Biochemistry of semen and capacitation, Male fertility problems and contraception.

**Unit 11. Hormones and female Reproduction:** 9 hrs

Mammalian ovary- Structure, folliculogenesis and its hormonal control, atresia, ovulation and regulation of corpus luteum.

Hormonal control of female reproductive organs.  
Onset of puberty, Reproductive cycles-estrous and Menstrous  
hormonal control of menstrual cycle.  
Implantation – Types and hormonal regulation.  
Pregnancy – hormonal regulation  
Parturition –hormonal regulation.  
Lactation – Hormonal control of mammary gland, development and  
Lactogenesis. Female fertility problems and contraception.

**Unit 12. Molecular Endocrinology:**

4 hrs

Hormone receptors: Types, Structure and regulation of their numbers  
Signal transduction- mechanism of action of peptide hormones  
Second messengers concept- cAMP, DAG, IP3, prostaglandins and calmodulin,  
Mechanism of action of steroid hormones.

**References:**

1. Barrington, E. J. W (1976) An introduction to general and comparative endocrinology, Oxford University press, London.
2. Bolander .Jr F.F. (2004) Molecular Endocrinology Third Edition. Academic press. SanDiego.
3. Chester-Jones, I. Ingleton, P. M. and Philips, J. G. (1987) Fundamentals of comparative vertebrate endocrinology. Plenum press, N. Y
4. Eckert, R and Randall, D. 2002, Animal physiology, 2<sup>nd</sup> Edn, W.H..Freman
5. Ganong. W.F. 1987. Review of medical physiology, 13<sup>th</sup> Edn., Appleton and Lange. U.S.A.
6. Guyton. A.G. 1986, Text book of Medical Physiology, 7<sup>th</sup> Edn., Saunders Publication
7. Hoganth, P. J. (1978) Biology of Reproduction, Blakie Glasgow, U. K
8. Knobil, E and Neil J. D (1994) The physiology of reproduction, Vol. I & II. Raven press, N. Y.
9. Negi. C.S. (2009). Introduction to Endocrinology. PHI learning Pvt Ltd. New Delhi.
10. Norris. D.O. (2006). Vertebrate Endocrinology. Third Edition. Academic press. SanDiego.
11. Prosser, C.L. and Brown.F.A 1961 Comparative animal physiology, W.B.Saunders Co. London.

**Practicals:**

**4x16=64 Hrs**

1. Determination of serum cholesterol.
2. Determination of glucose content by Folin-Wu method in normal and diabetic blood samples.
3. Estimation of liver and skeletal muscle glycogen in normal and starved mice.
4. Estimation of proteins in the liver/ skeletal muscle of mice by Lowry's method.
5. Determination of serum/ blood urea by DAMO method.
6. Estimation of creatinine in the urine sample - method.
7. Estimation of chlorides in the urine sample - method.
8. Estimation of serum phosphotases (Acid and alkaline) - method.
9. Total count of RBC and WBC.

10. Differential count of WBC.
11. Study of estrous cycle in rat using vaginal smear.
12. Staining of vaginal smear.
13. Study of Counting of spermatozoa and study of sperm abnormalities.
14. Study of different contraceptive devices.
15. Observation of permanent slides for comparative histomorphology of pituitary, Ovary, Testis, Oviduct, Uterus, Fallopian tube, Epididymis, Thyroid gland, Adrenal gland and Pancreas in vertebrates. Pregnancy detection test.

**HC 1.3: FUNDAMENTAL GENETICS** **64 hrs**

**Unit 1: Mendelian principles:** 6 hrs

Dominance, segregation, independent assortment, Allele, multiple alleles, pseudoallele.

**Unit 2. Extensions of Mendelian principles:** 9 hrs

Co-dominance, incomplete dominance, gene interactions, pleiotropy, Genomic imprinting, penetrance and expressivity, phenocopy.

**Unit 3. Gene mapping:** 9 hrs

Linkage maps, crossing over and recombination, Coupling and repulsion phases, mapping with molecular markers, mapping by using somatic cell hybrids.

**Unit 4. Extra chromosomal inheritance:** 7 hrs

Mitochondrial and cytoplasmic inheritance, maternal inheritance. Examples: Chlamydomonas, Neurospora, Paramoecium, Yeast and Drosophila.

**Unit 5. Sex linked inheritance:** 7 hrs

Sex determination and Sex linked inheritance, Sex determination in humans, Drosophila and other animals, Sex linked genes and dosage compensation of X linked genes.

**Unit 6. Fine Structure of the gene:** 6 hrs

Classical concept. Studies in bar eye and Lozenge loci in Drosophila, Pseudoallelism. Benzer's work on rII locus in T-4 phages. The concept of cistron, recon and muton.

**Unit 7. Chromosomal and Gene mutations:** 14 hrs

**Chromosomal mutations:** Deletion, Duplication, Inversion, Translocation

and their genetic implications.

**Genes mutations:** Types and Molecular mechanisms of mutations.

Structural mutations: Point mutations – Silent, missense, and nonsense mutations. Functional mutations: Loss-of-function and Gain-of-function mutations. Causes of mutations.

Mutational analysis in vitro and in vivo.

### **Unit 8. Bacterial Genetics:**

6 hrs

Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating.

### **References:**

1. Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart. 2004. Introduction to Genetic Analysis, 7th Edition. W. H. Freeman and Company. New York.
2. Griffiths, Anthony J.F.; Gelbart, William M.; Miller, Jeffrey H.; Lewontin, Richard C. 1999. Modern Genetic Analysis.. W. H. Freeman and Company. New York.
3. Atherley A.G, Girton J.R and J.F.McDonald (1999). The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, N.Y.
4. Brooker R.J (1999) Genetics : Analysis and Principles. Benjamin/Cummings, Longman Inc.
5. Gardner EJ, Simmons M.J and D.P.Snustad (1991) Principles of Genetics. John Wiley and Sons. Inc. N.Y.
6. Goodenough U (1985) Genetics. W.H. Feeman and Co.N.Y.
7. Hartle D.L and E.W.Jones (1998) Genetics: Principles and analysis. Jones and Bartlett Publishers.
8. Jinks J.A. (1972) Extrachromosomal inheritance, Prentice Hall Inc. N.J
9. Brown T A (1989) Genetics. A molecular approach. Van Nostrand Co. N.Y
10. Snustad D.P and M.J.Simmons. 1997. Principles of Genetics. John Wiley and Sons, Inc. NY.

### **Practicals:**

- 1) Study of morphology of *Drosophila melanogaster* – Wing, Sex comb, and Bristles.
- 2) Study of mutants of *Drosophila melanogaster*
- 3) Preparation of genital plate of *D. melanogaster*
- 4) Study of Multiple alleles - Blood typing.
- 5) Analysis of F1, F2 and Test cross progeny in *Drosophila melanogaster* to understand pattern of inheritance of different characters and to demonstrate
  - a) Law of segregation
  - b) Law of Independent assortment
  - c) Sex-linked inheritance

## SC 1.4(a): ECONOMIC ZOOLOGY

64 hrs

### A-AQUACULTURE

22 hrs.

**Unit 1: Introduction:** Definition, scope and status of aquaculture.

Techniques of culturing fishes: Carps (Indian major & minor carps),  
Trouts, Catfishes, Ornamental fishes, Shell fishes (Prawns, Pearl oysters). 9 hrs

**Unit 2: Fish seed technology:** natural collection, bundh breeding, induced breeding, seed transportation. Aquaculture systems: Inland farms, tanks, pens and cages 7 hrs

**Unit 3: Nutrition and Feeds:** Feeding habits and food utilization, energy requirements, sources and metabolism, live foods, artificial feeds. 3 hrs

**Unit 4: Fishes diseases and their control:** Protozoa, fungal, bacterial, viral, environmental and nutritional, algal toxins, vitamin deficiency diseases. Fishing, control of weeds, pests and predators. 8 hrs

**Unit 5: Biotechnology in Aquaculture:** Genetic engineering, transgenic fish, super males, cryopreservation of gametes. 2 hrs

**Unit 6: Farm management and economics:** Concepts, economic principles of farm, management of Hatcheries, Nurseries, Rearing ponds, and Stocking ponds. 3 hrs

### B - APICULTURE

20 hrs

**Unit 1: Introduction to Apiculture:** Scope and its importance.

Classification and morphology of honey bees, species and races of honey bees, tribal life and bee hunting. sex separation, comb building, orientation of comb, communication, collection of propolis and water. 6 hrs

**Unit 2. Entomophily:** Bee plants, floral design, colour, smell, pollen and nectar production and composition. Pollen calendar. Relationship between floral design and mouth parts of honey bees. Pollen and nectar collection. Honey and its chemical composition, medicinal importance. 6 hrs

**Unit 3. Beekeeping and management:** Rearing of honey bees, equipments, comb foundation, queen rearing(rearing techniques, feed contents, feeding and economics of queen rearing, requeening, bee nursing, honey and

wax extraction. economic importance of honey, wax, bee pollination, pollen and Venom. 6 hrs

**C – SERICULTURE** 22 hrs

**Unit 4. Sericulture:** Components, origin and development of the art and science of sericulture. Global silk production, quality and quantity of silk produced in India, economics of silk production, foreign exchange. 5 hrs

**Unit 5. Classification, systematic position of sericigenous insects.** Salient features of Saturniidae and Bombycidae. Races of mulberry silkworms, classification based on voltinism, moulting and geographic origin. 5 hrs

**Unit 6. Morphology and life cycle of *Bombyx mori*. Structure and functions of Silk glands.** 3 hrs

**Unit 7. Silkworm rearing:** Building, equipments, disinfection, environmental factors, spacing, feeding and bed cleaning. 2 hrs

**Unit 8. Modern rearing technology:** Seed cocoons, preservation, grainage activity, LSPs, egg production, incubation, artificial hatching, seed organisation and seed area and bivoltine rearing. 5 hrs

**Unit 9. Silkworm Pathology:** Protozoan, Fungal, Viral and Bacterial diseases and their control measures.  
Silkworm pests and Predators: Uzi fly, Dermestid beetle, ants, lizard, birds and monkey.  
Lac insects: external morphology, culture, economic importance. 10 hrs

**References:**

1. Hickling, C.E. 1962. Fish and fish culture. Faber and Faber, London.
2. Jhingran, V.G. 1977. Fish and Fisheries of India. Hindustan Publ., New Delhi.
3. Scnmitz, R.J. 1996. Introduction to Freshwater Biology. Gulf Publishing Company, New Delhi.
4. T.V.R. Pillay 'Principles and practice of Aquaculture. 2nd edition, Fishing News books.
5. R.K.Rath. 'Fresh water aquaculture'. 2nd Edition. Scientific Publishers. Handbook of Fisheries and Aquaculture, Indian Council of Agricultural Research, ICAR, (2006), DIPA, New Delhi, INDIA.
6. Srivastava., 1979. Applied Entomology. Vol II.
7. Singh .S., 1962. Beekeeping in India. ICAR. New Delhi.India.
8. Snodgrass,R.E. 1956. Anatomy of the Honeybee. Cornell Univ. Press. Ithaca. New York.
9. Winston, M. 1984. The Biology of the Honeybee. Harvard. Uni. Press. London. UK.

10. Tazima. Y. 1958. Silkworm egg. CSB Publication, Bombay.
11. Yashimoro Tanaka. 1964. Sericology, CSB Publication, Bombay.
12. Tanaka, Y. 1953. "Genetics of the silkworm, Bombyx mori" – advances in genetics, Demerec.M. (Ed), Vol.5, Academic press, New York.
13. Tazima, Y. 1964. "The genetics of the Silkworm". Logos Press Ltd., London.
14. Tazima, Y. 1978. The silkworm an important laboratory tool. Kodnasha Ltd., Tokyo.
15. Govindan, R., Narayanswamy, T.K. and Devaiah,M.C. 1998. Principles of silkworm pathology. Ser scientific Publishers, Bangalore.

## **PRACTICALS**

### **AQUACULTURE**

1. Physico- chemical parameters of freshwater bodies.
2. Study of morphometric characters of Indian major carps.
  - a) Diversity of fishes.
  - b) Biological analysis of water and estimation of primary productivity.
  - c) Collection of phytoplankton and zooplankton from natural resources and their identification.
5. Length-weight relationship and condition factor determination.
6. Experiments on chemoreception using different attractants and repellents.
7. Toxicity testing with zooplankton/fish.
8. Study of feeding habits of fishes by gut content analysis.
9. Visit to freshwater/ marine fish farms.

### **APICULTURE AND SERICULTURE**

1. Study of morphology of honey bee and cast system.
2. Mounting of mouth parts, stinging apparatus of honey bee.
3. Study of digestive system of honeybee.
4. Study of structure of honey comb.
5. Study of bee plants.
6. Estimation of leaf protein by Lowry's method.
7. Study of morphology of lifecycle of B.mori
8. Study of digestive and silk gland of B. mori
9. Study of cocoons and food plants of silkworm.

**SC-1.4(b): Biochemistry and Biostatistics****64 hrs****A. Biochemistry**

32 hrs

**Unit 1. Introduction:**

4 hrs

Scope, structure of atoms, molecules and chemical bonds (covalent, coordinate, ionic and hydrogen bonds); stabilizing interactions (Vander-Waals, electrostatic, hydrogen bonding, hydrophobic interaction); principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties); normality and molarity of solutions.

**Unit 2. Nucleic acids:**

3 hrs

Composition, functions; synthesis and metabolism, salvage pathways, its regulation and diseases.

**Unit 3. Carbohydrates:**

10 hrs

Composition, structure, functions and metabolism: Glycolysis, Citric acid cycle, Oxidative phosphorylation; Gluconeogenesis, Glycogenolysis, Regulation of blood sugar, Impaired Glucose Tolerance, Glycosuria, Insulin, Glucagons, Diabetes mellitus, Lactic acidosis, Glycated hemoglobin. Inborn errors associated with carbohydrate metabolism.

**Unit 4. Proteins:**

5 hrs

Composition, conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds) functions and metabolism: Transamination, Deamination, oxidative deamination, Urea cycle and Transmethylation.

**Unit 5. Lipids:**

4 hrs

Introduction, metabolism: Oxidation of fatty acids (alpha and beta oxidation), Prostaglandins, Cholesterol, Hypercholesterolemia, Lipoproteins, Atherosclerosis. Disorders of lipid metabolism.

**Unit 6. Vitamins:** composition, structure, functions, metabolism

2 hrs

**Unit 7. Enzymes:**

5 hrs

Principles and mechanism of enzyme catalysis, enzyme and enzyme kinetics, isozymes, factors affecting enzyme activities, feedback and allosteric inhibition enzyme regulation, role of C-AMP in regulation, Clinical and industrial applications of enzymes.



## **References:**

1. Conn E.E, Stumpt P.K, Bruencing G and Dol. R.G. 1995. Outlines of Biochemistry. John Wiley, Singapore.
2. David L.Nelson and M.M.Cox. 2000.Principles of Biochemistry. 3<sup>rd</sup> Edn. Worth Publishers, 41, Madison Avenue, NY.
3. Harper H.A. 1993.A Review of Physiological Chemistry, Lange Medical Publication, 2<sup>nd</sup> Edn.
4. Kapoor, V.C.1998. Theory and Practice of Animal Taxonomy. Oxford IBH Co. Pvt. Ltd., New Delhi, 1998.
5. Lehninger A.L, Nelson D.L and Cox M.M, 2nd Edn. 1993. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
6. Lubert Stryer. 1995. Biochemistry 4<sup>th</sup> Edn W.H.Freeman & Co.
7. Plummer, D.T. 1993. Practical Biochemistry, 3<sup>rd</sup> Edn. Tata McGraw Hill Publishing Co., Ltd. New Delhi.

## **Practicals:**

1. Qualitative analysis of carbohydrates (Starch, Glycogen, Sucrose, Lactose, Maltose, Glucose, Fructose).
2. Qualitative analysis of proteins (Egg albumin, Casein, Gelatin, Peptone)
3. Precipitation reaction of proteins (Egg albumin, Peptone)
4. Estimation of amino acids by Sorenson's Formal titration (Arginine, Alanine, Leucine, lysine *etc.*,)
5. Demonstration of Beer Lambert's law (Methylene blue, Safranin *etc.*,).
6. Determination of concentration of Glucose and Maltose by calibration curve.
7. Determination of amylase activity.
8. Determination of effect of temperature, pH and incubation period on amylase activity.

## **B. BIOSTATISTICS**

**32 hrs.**

**Unit 7. Introduction:** Statistical terms, notations and classification of data (population, sample); variables (continuous, discrete); presentation of data (geographical, chronological, qualitative, quantitative); frequency and frequency distributions (overlapping, non-overlapping).

2 hrs

**Unit 8. Sampling methods:** Selection of sample, qualitative and quantitative samples, sampling methods (random, systemic, stratified, cluster and non-random).

3 hrs

**Unit 9. Collection & representation of biometric data:**

Frequency distribution: Class interval, relative frequency, percentage frequency, cumulative frequency.  
Graphic representation: Introduction, histogram, frequency polygon, frequency curve, ogive, scatter or dot diagram, line diagram, bar diagram, sector or pie-diagram.

8 hrs

### **Unit 10. Measures of Central tendency and Dispersion:**

Arithmetic mean, geometric mean, median, mode,  
relation between mean, median and mode.

Measures of Dispersion:

Definition, range, mean deviation, standard deviation, coefficient  
of variability, standard error, degree of freedom, confidence limit

6 hrs

### **Unit 10. Probability distribution patterns:**

Normal, Binomial, Poisson distribution; skewness and Kurtosis

Tests of Significance:

Parametric tests (Analysis of Variance, Student's 't'-test, z-test);  
nonparametric tests (Chi-square test)

7 hrs

### **Unit 11. Regression and Correlation:**

**Regression:** Introduction, regression line, regression equation,  
procedure of regression test, partial, curvi linear and multiple regression.

**Correlation:** Types of correlation, correlation and reserves,  
methods of studying correlation, coefficient of determination,  
significance test for 'r', coefficient of non-determination, coefficient  
of alienation, partial correlation, multiple correlation.

6 hrs

### **References:**

1. Snedecor D.W. and Cochran W.G. 1967. Statistical Methods. Ed. VI. Oxford and IBH Publishing Co., New Delhi.
2. Prasad, S. 2004. Elements of Biostatistics. Rastogi publications. Meerut, India.
3. Robert R. Sokal & James F. Rohlf. 1994. Biometry- The Principles and Practice of Statistics in Biological Research. 3<sup>rd</sup> ed. W. H. Freeman & Company publishers.
4. ZAR, J. H. 1999. Biostatistical analysis, 4<sup>th</sup> ed. Prentice-Hall publications
5. Bailey, N.T.J. 2000. Statistical Methods in Biology. 3<sup>rd</sup> ed. Cambridge University Press. U.K.

### **Practical syllabus**

1. Preparation of frequency distribution tables.
2. Measures of central tendency: calculation of mean, median and mode for ungrouped and grouped series.
3. Measures of dispersion: calculation of standard deviation and standard error.
4. Graphical representation of biometric data: preparation of histogram, frequency polygon and frequency curve, cumulative frequency or ogive and scatter; line, bar and pie-diagram.
5. Tests of significance (problems for Student's 't' test, analysis of variance, z-test, Chi-square test)
6. Problem on Karl Pearson's Coefficient of correlation.

## **Semester II**

## HC-2.1. Cell Biology

64 Hrs

### Unit 1. Introduction to the Cell:

2 hrs

The origin and evolution of the cell, From molecules to first cell, from Prokaryotes to eukaryotes, from single cell to multicellular organisms.

### Unit 2. Membrane Structure and Function:

8 hrs

Structure of model membrane, The Lipid bilayer, Membrane proteins, Membrane carbohydrates, Membrane transport of small molecules, Membrane transport of macromolecules. Electrical properties of membrane.

### Unit 3. Structural organization and functions of intracellular organelles:

4 hrs

The nucleus, Mitochondria, Lysosomes, Peroxisomes, Golgi apparatus, and endoplasmic reticulum.

### Unit 4. Molecular organization of the eukaryotic chromosome:

4 hrs

Chromosomal DNA and its packaging and organization, Polytene chromosomes, Lampbrush Chromosomes, heterochromatin, centromeres.

### Unit 5. The cytoskeleton:

6 hrs

The nature of cytoskeleton, Intermediate filaments, Microtubules, Actin filaments, Cilia and Centrioles, Organization of the cytoskeleton.

### Unit 6. Protein sorting:

8 hrs

Organelle biogenesis and protein secretion, synthesis and targeting of mitochondria, peroxisomal proteins, translational modification in the ER. Intracellular traffic, vesicular traffic in the secretory pathway, protein sorting in the Golgi, traffic in the endocytic pathway, exocytosis.

### Unit 7. Cell division and Cell Cycle:

6 hrs

Overview of the Cell cycle and its control, The molecular mechanisms for regulating mitotic events, Cell cycle control in mammalian cells, Checkpoints in cell cycle regulation.

### Unit 8. Cell Communication:

8 hrs

General principles of cell communication, I gap junctions, extracellular matrix, Collagen and Noncollagen component of the extracellular matrix, integrins.

### Unit 9. Cell Signaling:

6 hrs

Overview of the extracellular signaling, Cell surface receptor, Signaling through G-protein coupled receptors, signal transduction pathways, second messengers, Interaction and regulation of signaling pathways.

### Unit 10. Programmed Cell Death and Aging:

6 hrs

**Programmed Cell Death** a) Apoptosis v/s necrosis b) Discovery of cell death genes in *C.elegans* & homologous pathway in mammals.

**Aging :** a) Concept of aging-organismal b) cellular changes during aging (DNA damages, shortened telomere, mitochondrial mutations, Oxidative stress)  
c) Theories of aging.

**Unit 11. Methods in Cell biology:**

6 hrs

Microscopy: light microscopy; fluorescence microscopy;  
Phase contrast microscopy; Electron microscopy, Purification of cells and their parts, Cell separation and culture, flow cytometry, Fractionation of cell contents, Tracing cellular and imaging molecules with radioactive isotopes and antibodies.

**References:**

- 1) Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter 2008. Molecular Biology of the cell. V Ed. Garland Science, New York.
- 2) Brachet, J. 1985. Molecular Cytology, Academic Press, N. Y.
- 3) Furukawa, R., and M. Fechheimer. 1997. The structure, function and assembly of actin filament bundles. Int. Rev. Cytol. 175: 29-90.
- 4) Lodish, H., A. Berk, C.A Kaiser, M.P. Scott, A Bretscher, H. Ploegh, P. Matsudaira. 2008. Sixth Edition, Molecular Cell Biology. W. H. Freeman and Co., N. Y.
- 5) Pollard, T. D. and W. C. Earnshaw. 2002. Cell Biology. Saunders
- 6) Wolfe, A. 1995. Chromatin: Structure and function. Academic Press, N. Y.

**PRACTICALS:**

- 1) Study of meiotic chromosomes of grass hopper by Heidenhains iron hematoxylin stain and calculation of chiasma frequency.
- 2) Study of mitotic chromosomes in apical meristem of *Alium cepa*
- 3) Staining and study of cell Organelles.
- 4) Study of mammalian mitotic chromosomes using bone marrow cells
- 5) Study of Polytene chromosomes of :  
(a) *Drosophila melanogaster*  
(b) *Drosophila nasuta*  
(c) *Drosophila annanassae*
- 6) Study of Barr body using buccal smear

## HC 2.2 ANIMAL BEHAVIOR AND WILDLIFE STUDIES

64 hrs

### A. ANIMAL BEHAVIOR

32 hrs

**Unit 1: Introduction:** Approaches and methods in study of behavior; proximate and ultimate causation, ethograms. Reflexes and complex behaviours : Latency, after discharge, summation, warm up, fatigue, Inhibition and feedback control.

4 hrs

**Unit 2: Instinctive behaviour:** Fixed action patterns, sign stimuli and release, types of sign stimuli. Learning and imprinting : Definition, categories of learning, habituation, conditioning, latent learning, insight learning, social learning. Imprinting: Types of imprinting, imprinting as learning, functional aspects of imprinting.

6 hrs

**Unit 3: Development and behaviour:** Causes of behavioural changes during development, Development of bird song, Importance of early experience-critical period.

4 hrs

**Unit 4: Foraging and anti-predator behaviour:** feeding strategies – search and selection of food, Anti predator behaviour – avoiding detection through colour and markings (Mullarian mimicry), Warning colouration, Batesian mimicry

4 hrs

**Unit 5: Biological communications:** Nature and functions, forms and signals- Visual, auditory, chemical

4hrs

**Unit 6 :Sexual behaviour:** Seasonality, isolation and territories with suitable examples, Sexual behaviour – Courtship behaviour, Pheromones in Insects and Mammals, Lee -Boot's effect, Whitten effect, Bruce effect, Coolidge effect, Castro Vandenberg effect. courtship signals, selected examples of courtship and mating behaviour, courtship as conflict behaviour.

4 hrs

**Unit 7: Social organisation:** Introduction, advantages of grouping, social organization in insects with special reference to ants and honeybees, Quasi social, semi social and eusocial, social organisation in sub human primates. Altruism

4 hrs

**Unit 8: Biological Rhythms:** Types of rhythms, biological clocks and their significance.

2 hrs

## **References:**

1. Manning A and Dawkins M. 1997. An Introduction to Animal Behaviour- IV Ed., Cambridge Univ. Press.
2. Harjindra Singh, 1990. A text book of Animal Behaviour, 1<sup>st</sup> Edition, Anmol publications.
3. Krebs, J.R. and Davies, N.B. An introduction to Behavioural Ecology, 3<sup>rd</sup> Edition, Blackmell scientific Publications.
4. Reena Mathur., 1996. Animal Behaviour, 1<sup>st</sup> Edition, Vivek Rostogi for Rostogi and company.
5. Ranga, M.M. 1994. Animal Behaviour, 1<sup>st</sup> Edition, Agro Botanical publishers.
6. Vinod Kumar., 1996. Animal Behaviour, 1<sup>st</sup> Edition. Himalaya Publishing House.

## **B - WILD LIFE STUDIES**

**32 hrs**

### **Unit 9. Introduction, History and Scope:**

Importance and values of wild life.

Wild life categories: Endangered , Threatened, Vulnerable, rare; data

Deficient categories, Red data book. Causes of wildlife depletion:

Degradation and destruction of natural habitats, Exploitation

for commercial purposes, Deforestation, Agricultural expansion

and grazing, Urbanization and industrialization, Forest fires.

**8 hrs**

### **Unit 10: Concept of biodiversity:**

Types of biodiversity and biodiversity profile of India. Ramsar Wetlands.

General theories of biodiversity: biotic and abiotic theories.

**6 hrs**

### **Unit 11. Wildlife Conservation:**

Conservation strategies, Role of NGO's in

Conservation, Global and Indian bodies concerned with wildlife

conservation, Wildlife conservation projects in India – Project tiger,

Lion, elephant, Musk deer, Thiamin Deer and Crocodile.

**4 hrs**

### **Unit 12: In situ and ex situ conservation:**

Biodiversity and Biodiversity hotspots,

Bioreserves, National Parks and Wildlife sanctuaries – their characteristics. Ex situ

Conservation: Zoos and their significance – Captive breeding of animals– Zoos, Cryo –

preservation, Modern methods of ex situ conservation, Artificial insemination for

conservation.

**3 hrs**

### **Unit 13: Wild Life census and Management:**

General methods Census Methods for vertebrate species (mammals and birds)

**Wild life management:** Range lands: status, types and management.

Case studies (Gudavi and Mandagadde bird sanctuary, Bhadra wild life

sanctuary). Wild life-Human conflicts: Elephant, wolf and tiger.

**6 hrs**

## Unit 14: Bird migration:

Exploratory migration, seasonal and ontogenetic migration, Orientation and navigation, map models, physiological preparation for migration, environmental factors. Nesting and roosting: Types of nests, construction of nests and nesting in weaverbird. Wild life protection act 1972 and its amendments Wildlife schedules and Biodiversity Act, 2002.

5 hrs

### References:

1. Ali, S. and Ripley S.D. 1969. **Handbook of Birds of India and Pakistan**, Oxford University.
2. Chatrath, K.J.S. 1992. **Wetlands of India**, Ashish Publishing House, New Delhi.
3. Heywood, V.H. (Eds) 1995. **Global Biodiversity**, Published for UN Environmental Programme, Cambridge University Press.
4. Hosetti, B.B. 1996. **Concepts in Wildlife Management**, Daya Publishing House, Delhi.
5. Hosetti, B.B. and Venkateshwarlu M. 2001. **Wildlife Trends in Biodiversity Conservation and Management**, Daya publishing House, Delhi-35, India.
6. Hosetti, B.B. 2002. **Glimpses of Biodiversity**, Daya Publishing House, Delhi-35, India.
7. Stiling, P, 2002. **Ecology: Theories and Applications IV** Ed. Prentice Hall of India Pvt. Ltd., New Delhi-110 001.
8. Khanna, D.R. and P.R.Yadav, 2005. **Biology of Birds**, Discovery Publishing House, New Delhi 110 002.
9. Sharma, B.B. 1994. **High altitude Wildlife of India**, IBH Publ. House New Delhi.
10. Ganguly, G. Sinclair and R.E. Anthony, 1994. **Wildlife Ecology and Management**, Blackwell Scientific Publ. Boston.
11. Negi, S.S. 2002. **Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India**. Indus Publ., New Delhi.

### Practicals:

1. Sexual behaviour in *Drosophila*
2. Pupation behaviour in *Drosophila*
3. Behaviour experiments in Rat/Captive Mice/Bruce mice and foraging experiments in honeybees
4. Trailing behaviour in Ants
5. Determination of species diversity by Shannon-Weiner Index
6. Determination of species diversity by Simpson's index
7. Critical studies on endangered, endemic, vulnerable, exotic species of India.
8. Visit to a wildlife sanctuary, Zoo/Natural history Museum and submission of a report.
9. Field visit to wildlife sanctuary
10. Audio-visual programmes.



## **SC-2.3(a): Developmental Biology**

**64 hrs**

### **Unit 1: Introduction, Scope and Principles of Developmental biology:**

5 hrs

The anatomical tradition,, The Questions of Developmental Biology, methods to study embryology, Basic concepts of Development: potency, commitment, specification, competence, determination and differentiation, morphogenetic gradients. Developmental Patterns among the Metazoa.

### **Unit 2. Early embryonic development:**

10hrs

Gametogenesis and fertilization: Oogenesis and spermatogenesis, molecular events during fertilization, cell surface molecules in sperm-egg recognition in animals. Creation of multicellularity- Celavage – types and Regulatory Mechanisms, embryonic fields. Blastulation, Gastrulation and formation of germ layers in *C. elegans*, Sea urchin, *Drosophila*, amphibians, birds, mammals.

### **Unit 3. Organizer phenomenon:**

4 hrs

Primary organizer- Spemann and Mangold experiment, Regional specificity of induction, Functions of organizer.

### **Unit 4. Morphogenesis and organogenesis:**

12 hrs

Morphogenetic determinants and their role in development: Axes and Pattern formation during early development- Determination of embryonic axes in *Drosophila*- Anterior-Posterior (maternal effect genes) & Dorso/ventral; Amphibians (cell-cell interaction) & Mammals (HOX genes). Morphogenetic movements and regulatory mechanisms in amphibian and mammalian embryo. Neurulation, mesodermal and endodermal derivatives. Role of cell Adhesion molecules in morphogenesis: Cadherins and Fibronectins Proximo-distal axis specification in developing limb.

### **Unit 5. Model systems in Development:**

7 hrs

Cell aggregation and differentiation in *Dictyostelium*  
Organogenesis – vulva formation in *C.elegans*.  
Early embryogenesis in *Drosophila*: regional specification by  
Segmentation genes: Gap genes, pair rule genes, segment polarity genes and Homeotic genes.

### **Unit 6. Nucleo-cytoplasmic interactions:**

3 hrs

Nuclear transplantation experiments in *Acetabularia*  
An overview of nuclear transplantation experiments in amphibians and mammals.

### **Unit 7. Post embryonic development:**

4 hrs

Metamorphosis: Endocrine and molecular regulation of metamorphosis in amphibians. Regeneration: Blastema formation, Determination of polarity in regeneration, Source of cells for regeneration.

**Unit 8. Stem cell biology:**

15 hrs

Introduction to concepts in stem cell biology, definition of terms (renewal, potency etc), properties of stem cells, stem cell niche.

Molecular mechanisms of self-renewal, pluripotency, multipotency and lineage differentiation, stem cell niche.

Embryonic stem cells: Generation and manipulation of embryonic (Mouse and human) stem cells. Adult stem cells- Neural stem cells, Hematopoietic stem cells, Epithelial stem cells (skin, intestine, breast), Cancer stem cells. Stem cells and regeneration. Stem cell therapy and Ethical issues associated with stem cell biology.

**Unit 9. Medical implications of developmental biology:**

4 hrs

History and causes of abnormal development.

Teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

**References:**

1. Balinsky, B.I., 1965. An introduction to embryology, W.B.Saunders company.
2. George, M. Malacinski (ed) 1988, Developmental genetics of higher organisms, Macmillan Publishing Co.,
3. Gilbert, S. F. 2006, Developmental Biology, 8th Ed. Sinauer Associates Inc.,
4. Kalthoff, 2000, Analysis of Biological Development, 2nd Ed., McGraw-Hill Science, New Delhi, INDIA. Massachusetts, USA.
5. Rao, V. 1994. Developmental Biology. A Modern Synthesis. Oxford and IBH Delhi.
6. Tamarin, R., 1991, Principles of Genetics, 3<sup>rd</sup> Edition.
7. Vasudeva Rao, 1994. Developmental Biology: A modern synthesis, Oxford & IBH, New Delhi.
8. Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006) Principles of Development, , Oxford University Press, New Delhi, INDIA.
9. Wolpert, L, Beddington, R, Jessell, T, Lawrence P, Meyerowitz, E, Smith J., 2001, Principles of Development Oxford University Press Oxford.
10. Daniel R. Marshak, Richard L. Gardner and David Gottlieb , Stem Cell Biology , 2001. Cold Spring Harbor Laboratory Press, Cold Spring Harbor NY, USA
11. Kursad Turksen, Adult Stem Cells, 2004, Humana Press, Totowa NJ, USA
12. Ann Kiessling and Scott C. Anderson, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, 2003. Jones and Bartlett Publishers, Boston MA, USA

**Practicals:**

1. Study of life cycle of *Drosophila melanogaster*.
2. Study of different stages of embryos of *Drosophila*
3. Study of larval and prepupal wing, leg and eye antennal imaginal discs of *Drosophila*.
4. Slides of internal changes during early development of frog
5. Slides of internal changes during early development of chick
6. Chick embryo development: Live observation (Window technique)
7. Chick embryo development: Slide observation
8. Mounting of Chick embryo
9. Demonstration of effect of thyroxine on frog tadpole development.

10. Differential gene expression during development: Puff formation in salivary gland chromosomes.
11. Influence of temperature and teratogens on animal development

**SC 2.3 (b): ECOLOGY AND EVOLUTION 64 hrs**

**A. ECOLOGY 32 hrs**

- Unit 1: Basic concepts of Ecology:** Definition, branches of ecology, structure of ecosystem, Functioning of ecosystem, energy flow and nutrient cycles, food chains, food webs, trophic levels. 6 hrs
- Unit 2: Habitat and niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. 2 hrs
- Unit 3: Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax. 4 hrs
- Unit 4: Community ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. 4 hrs
- Unit 5: Population ecology:** Characteristics of a population; Population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. 6 hrs
- Unit 6: Species interactions:** Types of interactions, intraspecific competition, herbivory, carnivory, symbiosis and Mutualism. 4 hrs
- Unit 7: Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. 6hrs

## References:

1. Trivedi, P.R and Gurudeep Raj. 1992. Environmental Ecology. Akashdeep public.House, New Delhi.
2. Agarwal S.K. 1991, Pollution Ecology, Himalayan Pub. Udaipur.
3. Dash, M.C. 1993, Fundamentals of Ecology, Mc-Graw hill co., New Delhi.
4. Hosetti, B.B. 2003. Wetlands conservation and management, Pointer publishers, Jaipur, India.
5. Kormondy, E.J. 1992. Concepts of Ecology, Prentice hall of India Pvt. Ltd., New Delhi.
6. Paul Colinvaux, 1986, Ecology. John Wiley and Sons, New York.

## B. EVOLUTION

32 hrs

### **Unit 8: Emergence of evolutionary thoughts:** Lamarck;

Darwin—concepts of variation, adaptation, struggle, fitness and natural selection;

4 hrs

### **Unit 9: Origin of cells and unicellular evolution:**

Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers; concept of Oparin and Haldane; experiment of Miller (1953); the first cell; evolution of prokaryotes; origin of eukaryotic cells; evolution of unicellular eukaryotes.

7 hrs

### **Unit 10: Paleontology and evolutionary history:** The evolutionary time

scale; areas, periods and epoch; major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of animals; stages in primate evolution including Homo-sapiens.

7 hrs

### **Unit 11: Molecular Evolution:** Concepts of neutral evolution,

molecular divergence and molecular clocks; molecular tools in phylogeny, classification and identification; protein and nucleotide sequence analysis; origin of new genes and proteins; gene duplication and divergence.

7 hrs

### **Unit 12: The Mechanisms of Speciation:** Population genetics –

populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; Isolating mechanisms; speciation; allopatricity and sympatricity; convergent evolution; sexual selection; co-evolution.

7 hrs

## **References:**

1. Dobzhansky, Th. 1951. Genetics and Origin of species. 3<sup>rd</sup> Ed. Columbia Univ. press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M Valentine. 1976 Evolution. Surjeet Publicatiuon, New Delhi.
3. Jha, A.P. 1992 Genes and Evolution. Jhon Willey Publication, New Delhi.
4. Merrill, D.J. 1962. Evolution and Genetics, Holt, Rinehart and Winston, Inc.
5. Smith, J.M 1998. Evolutionary Genetics. Oxford University Press, Oxford, Newyork.
6. Strickberger, M.W. 1990. Evolution. Jones and Bartett Publishers, Boston, London.

## **Practicals:**

1. Determination of species diversity of streams, lakes, river and forest communities.
2. Determination of density and abundance of species by quadrate method of different type of habitats.
3. Collection and observation of plankton from polluted and non-polluted water bodies.
4. Physical and chemical characteristics of soil.
5. Insect diversity in soil.
6. Ecological tools.

## **Landscape studies:**

1. Principles of GIS, GPS and RS technology.
2. Interpretation (visual and automated) of remote sensing information for landscape differentiation.

## **Semester III**

|                                                                                                                                                                                                                                                                                                                                                                     |               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| <b>HC-3.1: Molecular Biology and Biotechnology</b>                                                                                                                                                                                                                                                                                                                  | <b>64 hrs</b> |
| <b>A - <u>Molecular Biology</u></b>                                                                                                                                                                                                                                                                                                                                 | 32 hrs        |
| <b>Unit 1: Central dogma of molecular biology:</b>                                                                                                                                                                                                                                                                                                                  | 3 hrs         |
| C-Value paradox. Macromolecules and Organization: DNA, RNA: Structure, Conformation (models), Denaturation, Renaturation.                                                                                                                                                                                                                                           |               |
| <b>Unit 2: Fundamental Processes:</b>                                                                                                                                                                                                                                                                                                                               |               |
| <b>DNA Replication:</b> Unit of replication, enzymes components involved in replication, replication origin and replication fork, fidelity of replication, Prokaryotic and eukaryotic DNA Replication mechanism.                                                                                                                                                    | 4 hrs         |
| <b>DNA Transcription:</b> Transcription factors and machinery. RNA polymerases. Mechanism of prokaryotic and eukaryotic transcription. Post – transcriptional modifications in RNA: 5’Cap formation, 3’end processing and polydenylation, Splicing, editing, Nuclear export of mRNA, mRNA stability.                                                                | 5 hrs         |
| <b>Translation:</b> Genetic code, Ribosome, Enzymes, factors and the process (formation of initiation complex, initiation factors, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase), translational proof-reading, translational inhibitors. Co-and post – translational modifications of proteins. | 6 hrs         |
| <b>Unit 3: Regulation of gene expression:</b>                                                                                                                                                                                                                                                                                                                       | 9 hrs         |
| Transcriptional regulation in prokaryotes(+ve and –ve control) and eukaryotes. Translational regulation, Epigenetic regulation, RNA interference.                                                                                                                                                                                                                   |               |
| <b>Unit 4: Genetic Repair mechanisms:</b>                                                                                                                                                                                                                                                                                                                           | 5 hrs         |
| Introduction, Types of DNA damage; Types of DNA repair mechanisms: Photoreactivation, excision repair, SOS repair, adaptive response, post-replication repair.                                                                                                                                                                                                      |               |
| <b>Unit 5 : Gene silencing technology (RNA Interference):</b>                                                                                                                                                                                                                                                                                                       | 3 hrs         |
| Principle of gene silencing, siRNA, siRNA technology, MicroRNA. Construction of siRNA vectors. Applications of RNA interference.                                                                                                                                                                                                                                    |               |

## **References:**

1. Molecular Cell Biology. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. New York: W.H. Freeman & Co. 1999
2. Modern Genetic Analysis. Griffiths, Anthony J.F. Gelbart, William M, Miller Jeffrey H, Lewontin, Richard C. New York: W.H. Freeman & Co. 1999
3. Molecular Biology of the Cell. Alberts, Bruce; Johnson, Alexander; Lewis, Julian, Raff, Martin; Roberts, Keith; Walter, Peter. New York and London: Garland Science 2002
4. The Cell – A Molecular Approach. Cooper, Geoffrey M. Sunderland (MA): Sinauer Associates, Inc. 2007
5. Introduction to Genetic Analysis. Griffiths, Anthony J.F.; Miller, Jeffrey H.; Suzuki David T.; Lewontin, Richard C, Gelbart, William M. New York: W.H. Freeman & Co. 1999
6. Principles of Genetics. Gardner, E.J., Simmon, S. and Snustad, 8<sup>th</sup> Edition, John Wiley and sons inc. Publication, New York. 1991
7. Genes IX, Lewin, 2008, 9<sup>th</sup> Edition, Jones and Bartlett Publishers, Boston, USA

## **B – Biotechnology**

**32 hrs**

**Unit 6:** Introduction, History and Scope of biotechnology.

1 hrs

**Unit 7: Genetic engineering:**

8hrs

Definition, objectives and outline of recombinant DNA technology procedure.

**Enzymes:** Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase.

**Cloning vectors:** Plasmids, Phages, M13 mp vectors, Cosmids, Phagemids, Bluescript vefctors. Cosmids, Artificial chromosomes (YAC, BAC, HAC), Animal Virus derived vectors-SV-40, vaccinia/baculovirus & retroviral vectors, Expression vectors; pMal; GST; pET.

**Unit 8: Cloning:**

8 hrs

Construction of Genomic and cDNA libraries.

Indetification of Recombinants: Genetic selection, Use of chromogenic substrates, Insertional activation.

Analysis of recombinant DNA clones: Characterization of clones, Restriction. Mapping, Southern hybridization.

Polymerase chain reaction and DNA sequencing: PCR – Principle, Methodology, Types - RT-PCR, inverse PCR and Real time PCR and their applications.

DNA sequencing methods - Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing.



- Unit 9: Recombinant DNA techniques and their applications** 3 hrs  
Gel electrophoresis – DNA separation, Chromosome walking,  
Blotting of macromolecules (Southern and Northern blotting), DNA fingerprinting.
- Unit 10: Hybridoma Technology:** 2 hrs  
Scope of the technique, production of Monoclonal antibodies.  
Applications of monoclonal antibodies.
- Unit 11: Transgenic Technology:** 4 hrs  
Introduction, genetically modified organisms; gene knockouts and mouse disease models  
Transgenic animals; *Drosophila*, fish, and mouse.
- Unit 12: Animal cell and Tissue culture:** 4hrs  
Principles of cell culture, cell and tissue types, cell lines, transformation.  
Cell and tissue culture media: Natural and defined, role and components of serum in culture.  
Applications of tissue culture: Tissue culture in biomedical research  
karyological studies, amniocentesis, mutagenesis, Cytotoxicity assays.
- Unit 13: Applications of Biotechnology:** 2hrs  
Production of medicinally important products – vaccines, Gene therapy,  
AIDS therapy, Biofertilizers, biopesticides, medicine and human health.

### **References:**

1. Brown, T. A. 1995. Gene Cloning: An introduction. Chapman and Hall, London.
2. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
3. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
4. Primrose, S. B., and R. M. Twyman . 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
5. Kreuzer, H. and A. Massey. 2001. Recombinant DNA and Biotechnology. ASM Press, Washington D.C.
6. Sandy B. Primrose, Richard M. Twyman, and Robert W. Old. 2002. Principles of Gene Manipulation. Blackwell Publishers,.
7. J.D. Watson, A.A. caudy, R.M. Myss, J.A. Witkowski, Recombinant DNA: Genes and genomes. 3<sup>rd</sup> Edition, W.H. Freeman & Co. Ltd. 2007.

**Practicals:**

1. Isolation of cellular DNA by rapid method / standard method
2. Restriction digestion and electrophoresis
3. Isolation of plasmid DNA from bacteria.
4. Estimation of DNA concentration by Diphenylamine method.
5. Qualitative analysis of isolated DNA for proteins and carbohydrates
6. Molecular biology problems
7. Localization of DNA in prefixed paramecium slides by Feulgen staining
8. Localization of nucleic acids in prefixed paramecium slides by Toluidine blue staining.

**H C 3.2 Basic and Applied Entomology****64 hrs**

|                                                                                                                                                                                               |        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| <b>Unit 1: General Entomology:</b> Classification of insects up to orders with suitable examples; Integument, Head and its appendages, Thorax and its appendages, abdomen and its appendages. | 11 hrs |
| <b>Unit 2: Digestive system:</b> General structure and functions                                                                                                                              | 3 hrs  |
| <b>Unit 3: Excretory and Respiratory system:</b> General structure and functions                                                                                                              | 3hrs   |
| <b>Unit 4: Nervous system:</b> Sense organs, sound producing organs<br>Photoreceptor and photogenic organs                                                                                    | 4 hrs  |
| <b>Unit 5: Endocrine system:</b> Hormones and their regulation; pheromones.                                                                                                                   | 3 hrs  |
| <b>Unit 6: Reproductive system:</b> Development, Metamorphosis and diapause in insects.                                                                                                       | 3 hrs  |
| <b>Unit 7 : Agricultural Entomology:</b>                                                                                                                                                      |        |
| <b>Insect pests:</b>                                                                                                                                                                          | 5 hrs  |
| Pest - definition and its ecology, features responsible for evolutionary success of insect species, factors responsible for achieving the status of pest.                                     |        |
| <b>Insect pests of major crops:</b>                                                                                                                                                           | 12 hrs |
| Damage, life and seasonal history and status and control of major pests of important crops such as:                                                                                           |        |
| Cereals: Rice, Sorghum, Maize, Wheat.                                                                                                                                                         |        |
| Oil seeds: Sun flower, Saff flower & Groundnut.                                                                                                                                               |        |
| Vegetable crops: Brinjal, Ladies finger, Cabbage and Beans.                                                                                                                                   |        |
| Miscellaneous: Sugarcane, cotton, Coconut, Coffee, Areca nut and Cardemom.                                                                                                                    |        |

**Unit 8: Veterinary and forest entomology:** 12 hrs  
Common insects attacking humans and domestic animals; their life history, mode of attack, type of injury or infection, treatment and control especially with reference to house fly, blow flies, blood sucking insects. Insect pests of timber and forest products, Control of locust and termites. Culture of commercial insects (Lac, Bee, Silk).

**Unit 9: Integrated pest management:** 6 hrs  
History, different phases of pest control, Quarantine, Physical, Cultural, Chemical, Biological control and, genetic and biotechnological methods of control. Pheromones- production, and their use in pest surveillance and management.

**Unit 10: Bioluminescence in insects:** 2 hrs  
Light producing organ & biochemistry of Light production.

### **References:**

1. Awasti V.B. 2009 **Introduction to general entomology** 3<sup>rd</sup> Ed. Scientific publication (India), Jodhpur
2. Awasti V.B. 2007, **Agricultural Insect Pests and their control**. Scientific publishers (India) Jodhpur
3. Trigunayat M.M. 2009, **A Manual of practical entomology**, scientific publishers, Jodhpur, India.
4. Dhaliwal G.S. Ramsingh and B.S. Chillar 2006, **Essentials of Agricultural entomology**. Kalyani Publishers, New Delhi.
5. L . K Jha. **Applied Agricultural Entomology**. New central book agency. Culcutta
6. Rajendra singh. 2007. **Elements of Entomology**. Published by Rakesh kumar. Rastogi and Rastogi Publications. Gangotri, Shivaji Road. Meerut.

### **Practicals:**

1. Insect collection and preservation
2. Classification of Insects
3. Type study and identification of insects from various taxonomic groups.
4. Common insects and their significance.
5. Applied Entomology.
6. Demonstration of aceto Carmine fluid by Malphigian tubules.
7. Insect Dissection.
8. Field report.

**SC-3.3(a) Microbiology and Immunology** **64 hrs**

**A. Microbiology** **32 hrs**

**Unit 1:Introduction:** History of Microbiology, biodiversity, distribution, general classification and distinguishing features of various groups of microorganisms. **6 hrs**

**Unit 2:Isolation and culture of microorganisms:** Principle and technique of isolation; microbial nutrition (types of microbial culture and microbial media), microbial growth, enumeration of microbes and microbial biomass **8 hrs**

**Unit 3:Sterilization techniques:** Physical methods (Dry and wet), Radiation (ionizing and non ionizing), Filtration (porcelain, sintered glass and membrane filters), Chemical methods (Asepsis, disinfection); phenol alcohols: halogens and phenol coefficient). **4 hrs**

**Unit 4:Viruses:** Structure and classification, replication, bacteriophages, life cycle of phage typing, Viroids and prions. **4 hrs**

**Unit 5:Mycoplasma:** Chlamydiae, Rickettsia, their Properties, classification and their role in animal and human diseases. **3 hrs**

**Unit 6:Yeast:** Structure, classification, culture and economic importance. **2 hrs**

**Unit 7:Industrial microbiology:** Importance of bacteria and Yeasts; production of alcohol, microbial pesticides, microbial antibiotics and microbial enzymes **5 hrs**

**References:**

1. Alexander N. Glazer, Hiroshi Nikaido 1998. Microbial biotechnology. Fundamentals of Applied biotechnology, W.H. Freeman and Company, NY.
2. Edward. 1996, Fundamentals of microbiology, 4<sup>th</sup> edition. The Benjamin/Cumming Publication Corp.
3. Lancing M. Prescott, John P. Harley and Donald A. Klein. 2002. Microbiology. 5<sup>th</sup> edition. McGraw Hill publication. New Delhi.

**Practical syllabus**

1. Study of microbial equipments (microscope, auto clave, hot air oven, laminar air flow, incubator, inoculation loop and inoculation needle).
2. Preparation of stains: Crystal violet, Gram's iodine, lactophenol cotton blue, safranin, malachite green, methylene blue, carbol fuchsin.
3. Simple staining technique for the study of bacteria
  - a. Positive staining and
  - b. Negative staining
4. Differential staining technique of bacteria
  - a. Gram's staining
  - b. Acid fast staining
  - c. Bacterial endospore staining.
5. Hanging drop technique to observe the motility of bacteria.
6. Observation of bacteria in root nodules.
7. Preparation of culture media
  - a. Nutrient Agar media and
  - b. Potato Dextrose Agar media.
8. Isolation of bacteria and fungi from different sources.
9. Pure culture techniques
  - a. Streak plate method (continuous, discontinuous, radiant, quadrant, T-streak),
  - b. Spread plate method
  - c. Pour plate method
10. Counting of cells/spores in a given suspension using haemocytometer.

## **B. IMMUNOLOGY**

**32 hrs.**

**Unit 8. Introduction to immunity:** History; types of immunity –  
Innate and acquired immunity.

**Cells and Organs of immune system:** Cells: Lymphocytes (T & B cells), monocytes, macrophage; eosinophills, basophills, neutrophills and mast cells.

**Primary and secondary lymphoid organs:** Bone marrow, Thymus, Spleen, Lymph nodes

7 hrs

**Unit 9. Antigens and Immunoglobulins:**

**Antigens:** Antigens, factors influencing immunogenicity, adjuvant, epitope, hapten;

**Immunoglobulins:** Basic structure of the immunoglobulin; types and functions of immunoglobulins, monoclonal antibodies.

5 hrs

**Unit 10. Antigen-antibody reactions and Immunotechniques:**

Agglutination; Precipitation; Immunofluorescence;

RIA; ELISA, Immuno-electrophoresis and Western blotting.

4 hrs

**Unit 11. Immune response:** Humoral and cell mediated immune responses,

Primary and secondary immune modulation; Cytokines; role of complement system in immune response (Classical pathway, Alternate pathway); Immune response against bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections; congenital and acquired immunodeficiencies;  
Autoimmune disorders. 10 hrs

**Unit 12. Major histocompatibility complex and Hypersensitivity:**

Transplantation and graft rejection, Genetic organization of H2 and HLA complexes, HLA typing; Immediate and delayed hypersensitivity. 4 hrs

**Unit 13. Vaccines and Vaccination:** Types of Vaccines and their significance; Vaccine delivery systems. 2 hrs

**References:**

1. Austyn, J.M. and Kathym, J. Wood. 1993. Principles of cellular and molecular Immunology. Oxford University Press. Oxford.
2. Benjamin, Elisunshine, Geoffrey Leskowitz.1996. Immunology: A short course. 3<sup>rd</sup> Edition. New York.
3. Kubey, J.M. 1990. Essential Immunology. 6<sup>th</sup> Edition. Blackwell Scientific Publication, New York.
4. Rao, C.V. 2002. An introduction to Immunology. Narona Publishing House, New Delhi.
5. Rotti, I. 1994. Essential Immunology. Blackwell, London.
6. Stibes, D.P. and Terr, A.I. 1991. Basic and Clinical Immunology. 7<sup>th</sup> Edition. Appleton and Large. California.

**Practical syllabus**

1. Study of cells and organs of the immune system.
2. Haemagglutination test for blood group determination.
3. Determination of differential count of WBC.
4. Determination of total count of WBC using haemocytometer.
5. Estimation of the haemoglobin content by cyanmethaemoglobin method.
6. Separation of serum from the blood
7. Separation of plasma from the blood.
8. Purification of IgG from the serum.
9. Determination of antibody titre.
10. Electrophoretic separation of serum/plasma proteins.
11. Immunochromatography technique to detect
  - a. Hepatitis-B virus
  - b. HCG in urine sample for pregnancy
  - c. HIV (tri-dot assay)
12. Radial immunodiffusion test to detect the concentration of unknown antigen.
13. Ouchterlony double diffusion test to detect the concentration of unknown antigen.
14. Demonstration of ELISA

## PAPER-3.3(b): PARASITOLOGY AND NEMATOLOGY

### A. PARASITOLOGY

32 hrs

**Unit 1: Introduction:** Concepts of Parasitism, Classification, Distribution and types of parasites. Origin and evolution of parasites. 3 hrs

**Unit 2: Parasitic diseases of human importance:** Structure, Life cycle, mode of transmission, pathogenicity and control of;  
**Protozoan** parasites : Trichomonas, Leishmania, Trypanosoma, Plasmodium, Toxoplasma.  
**Nematoda:** Ascaris, Ancylostoma, Strongyloides, Trichuris, Enterobius, Waucheraria, Loa.  
**Trematoda :** Schistosoma, Fasciola.  
**Cestoda :** Taenia, Echinococcus, Hymenopilis. 12 hrs

**Unit 3: Ectoparasites :** Habitat, Life cycle, Pathogenicity and Prevention of :  
(a) Fleas, (b) Mites, (c) Ticks, (d) Lice. (e) Mosquitoes, (f) Houseflies. 5 hrs

**Unit 4: Host- Parasitic Relationship:** Cellular, Physiological, Immunological, Molecular, Social, Behavioural aspects, Larval migrants. 6 hrs

**Unit 5: Parasitoids:** Types, ecobiology, Chemical cues with suitable examples. 3 hrs

**Unit 6: Bacterial Infection:** Cholera, Tuberculosis. Diphtheria, anthrax, Typhoid, Tetanus, Leprosy. Viral Infection: Rabies, Dengue fever, Japanese encephalitis, KFD, Hepatitis, Poliomyelitis. 3 hrs

### **Practicals on A: PARASITOLOGY**

1. Culturing an insect parasitoid and studying their infection on an insect host.
2. Staining blood films for the study of protozoa (especially malarial parasite).
3. Collection of the specimen for the study of parasites.
4. Preparation of permanent slides of the hard parts of insects.
5. Study of vectors of diseases and mouth parts:  
a) Mosquitos b) Flea c) Ticks d) Housefly
6. Slides and specimens: pathogens of human Malaria, Filariasis, Leishmaniasis, Trypanosoma, Ascaris etc.
7. Preparation of human blood film and study of different types of cells  
a) Counting the RBCs. b) Counting the WBCs. c) Differential count of WBCs

## References:

1. Smyth, J.D 2000. Animal Parasitology, Cambridge low Edition.U.K.
2. Arira, D.R. And Arora,B. 2001. Medical parasitology. 1<sup>st</sup> Edition. Satish kumar jain for CBS Publisher ad Distributors, New Delhi.
3. Chatterjee, K.D. 2001. Parasitology (Protozoology and Helminthology). 12<sup>th</sup> Edition. Chatterjee Medical Publishers, Calcutta.
4. Thomas C. Cheng. 1999. General Parasitology. 2<sup>nd</sup> Edition. Academic Press, California.
5. Sobti,R.C.1999. Medical Zoology. Shoban Lal Nagin Chand & Co. Jalandhar. India.
6. Roberts L.S. and Janovy J. Foundations of Parasitology, McGraw-Hill Publishers, New York, USA.
7. Modern Parasitology: A Textbook of Parasitology, FEG Cox., Wiley-Blackwell, U. K.

## **B. NEMATODOLOGY**

**32 hrs**

**Unit 8:** History and development of Nematology, General morphology, Biology and general distribution of Nematodes. 2 hr

**Unit 9:** Introduction and economic importance of Nematodes (Nematodes of humans, animals, insects and plants). Characters of group Nematoda, their taxonomic position, life cycle and survival of nematodes. 10 hr

**Unit 10:** Important nematode pests and parasites and distribution in India. Nematode management (Cultural, physical, chemical and integrated approaches). Nematode diseases to man and animals, their systems and control. 8 hr

**Unit 11: Plant nematodes:** Root knot nematode: *Meloidogyne Sp*; **Cyst forming nematode-** *Heyerodera and Globodera Sp.*; **Burrowing nematodes-** *Rhadopholis similis*; **Citrus nematodes-** *Tylenchulus semipenitrans*; **Stem and bulb nematode-** *Ditylenchus dispaci*; Gall nematodes, foliar nematodes, ectoparasitic nematodes, virus transmitting nematodes, pathogenesis, types and management of nematode issues. 12 hr



## **Practicals on B. Nemaotology**

1. Field visit to collect the soil samples and isolation and identification of important nematodes.
2. Identification and symptoms of nematode infestation in plants.
3. Symptoms of Elephantiasis caused by *Wuchereria bancrofti*.
4. Symptoms of Nematode parasites of man and other animals.
5. Methods of managing nematodes.

### References:

1. Qaise H. Baqri and M.Shami Jairajpuri, 195 , Bibliography of Nematology of India. CBS publishers.
2. Ravichandra N.G., 201 Methods and techniques in Plant nematology.

## **Semester IV**

## HC-4.1. Advanced Genetics and Computational Biology 64 hrs

### A-Advanced Genetics 32 hrs

#### **Unit 1: Genome organization:** 7hrs

Prokaryotes – Viruses, Bacteriophages, and Bacteria.  
Eukaryotic organelle genomes  
Eukaryotic nuclear genomes - C-value paradox, Split Genes  
Mobile genetic elements in Prokaryotes (bacteria) and Eukaryotes (*Drosophila*, maize and humans).

#### **Unit 2: Cancer Genetics:** 6 hrs

Cancer incidence and mortality, types of cancer, causes of cancer, properties of cancer cells, transformation of cells in culture.  
Tumor viruses: Hepatitis B Viruses, SV40 and Polyomaviruses, Papilloma viruses, Adenoviruses, Herpes viruses, Retroviruses.  
Genetic basis of Carcinogenesis- Oncogenes: proto-oncogenes, oncogenes, retroviral oncogenes in human cancer.  
Tumor suppressor genes: Functions of tumor suppressor gene products, roles of oncogenes and tumor suppressor genes in tumor development.  
Cancer as a multistep process.  
Animal models of cancer research: Transgenic mouse models.

#### **Unit 3: Neurogenetics:** 4 hrs

Genetics of neural development: Axon guidance and pathfinding, synaptic plasticity.  
Molecular basis of neurological diseases: Neurodegenerative diseases – Alzheimer's, Parkinson's and Huntington's diseases.

#### **Unit 4: Quantitative genetics:** 5 hrs

Introduction, types of quantitative trait, nature of quantitative traits and their inheritance- Polygenic inheritance (Multiple factor hypothesis) – analysis of continuous variation; Variations associated with polygenic traits.  
Resemblance between relatives: Covariance - genetic and environmental.  
Heritability and its measurements, QTL mapping.

#### **Unit 5: Human genetics:** 7 hrs

History of human genetics, pattern of inheritance, pedigree analysis.  
**Human genome:** Organization, distribution of genes, gene families.  
**Genetic basis of syndromes and disorders:** Cystic fibrosis, Neurofibromatosis, Schizophrenia, Anxiety disorder, Congenital heart diseases, Dyslexia.

**Unit 6: Genome Projects:**

3hrs

Structural functional evolutionary and comparative genomics of *C. elegans*, *Drosophila*, Mouse and *Homo sapiens*.

**References:**

1. The Human Genome 2001, Nature Vol. 409.
2. The *Drosophila* Genome. 2000, Science Vol. 267.
3. The *Caenorhabditis elegans* genome 1998. Science Vol. 282.
4. Introduction to Genetic Analysis. Griffiths, Anthony J.F.; Miller, Jeffrey H.; Suzuki, David T.; Lewontin, Richard C.; Gelbart, William M. New York: W.H. Freeman & Co.; 1999
5. Human Molecular Genetics 2. Strachan, Tom and Read, Andrew P. New York and London: Garland Science; 1999
6. Fundamental Neuroscience. Larry R. Squire, Darwin Berg, Floyd Bloom, and Sascha du Lac. Third Edition, Academic Press; 3 edition (2008)
7. Principles of Neural Science. Eric R. Kandel, James H. Schwartz, and Thomas M. Jessell. McGraw-Hill Medical; 4 edition(2000)
8. Motulsky, V. 1977. Human Genetics. Springer & Verlag, Berlin.
9. Neurogenetics: Scientific and Clinical Advances (Neurological Disease and Therapy) David R. Lynch, Informa HealthCare; 1 edition (2005)
10. The Molecular and Genetic Basis of Neurologic and Psychiatric Disease. Roger N Rosenberg, Salvatore DiMauro, Henry L Paulson, and Louis Pt (2007) Lippincott Williams & Wilkins; Fourth edition

**B-Computational Biology****32 hrs****Unit 7: Introduction and Scope of the Computational Biology.**

8 hrs

**Genomics: Definition and types of genomics**

Structural genomics: whole genome shotgun sequencing, gene annotation, gene families and clusters. Orthologs and paralogs.

Functional genomics: Transcriptome, Microarray technology.

Comparative genomics: Comparative study of genomes in different organisms.

**Unit 8: Proteomics:**

8 hrs

Definition, Protein structure determination, protein domains, protein folding, Computer aided protein structure analysis, Protein-protein interactions, Protein microarrays.

**Unit 9: Nucleic acid sequence and Protein analysis:**

8 hrs

Alignment, similarity searches including remote similarity searches, secondary structure element, motifs, Single nucleotide polymorphism(SNP), Two dimensional polyacrylamide gel electrophoresis, Mass Spectrometry.

**Unit 10: Genomics and proteomics databases and tools:**

6 hrs

**Nucleic acid sequence databases and tools:** Genbank, UCSC, ENSEMBL, EMBL, DDBJ, BLAST vs FASTA, file formats-FASTA, GCG, Genscan and ClustalW.  
**Protein sequence databases and tools:** Uni-prot, PDB, PIR, BLAST, PSI- BLAST (steps involved in use and interpretation of results).

**Unit 11: Applications of Genomics and Proteomics:**

2 hrs

Pharmacogenomics, Human health.

**References:**

1. Bioinformatics for Dummies, Claverie J. M., Notredame C., (2nd Ed., 2007), Wiley Publishing, Inc., New York, USA
2. Bioinformatics: Sequence and Genome Analysis, Mount, D. W. (2nd Ed., 2001), Cold Spring Harbor Laboratory Press, New York, USA
3. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
4. A.Malcolm Campbell and Laurie J.Heyer. Discovering Genomics, Proteomics and Bioinformatics. 2004. Low Price edition. Pearson Education, Inc.

**Practicals:**

1. Study of mitotic chromosomes of *Drosophila* species- *Drosophila melanogaster*, *Drosophila nasuta*.
2. Preparation of metaphase chromosomes from bone marrow cells of mouse/frog.
3. Karyotypic studies of normal human chromosomes and syndromes.
4. Creation of pedigrees and study of patterns of inheritance.
5. Studies on phenotypes of different diseases and syndromes.
6. Study of Quantitative characters: Sternoplurals, Acrostichals - mean, standard deviation.
7. Data mining for sequence analysis.
8. Web- based tools for sequence searches and homology screening-BLAST, FASTA
9. Nucleic acid sequence databases: GenBank retrieval, GeneScan.
10. Proteome data bases: Uni-Prot, PROSITE, PDB, PIR, ProtParam.
11. Annotations: ORF finder, Use of ARTEMIS or any other suitable software.

**HC: 4.2 ENVIRONMENTAL POLLUTION & ECOTOXICOLOGY** **64 hrs**

**A - ENVIRONMENTAL POLLUTION** **32 hrs**

**Unit 1: Concept of Biosphere:** Its components, hydrosphere, atmosphere, and lithosphere, Origin of life in the biosphere. **2 hrs**

**Unit 2: Water pollution:** Definition, sources **6 hrs**  
Types and classification of pollutants. Effects of Water Pollution, River Pollution, Oxygen sag curves and Eutrophication  
Drinking water: Collection, purification and distribution.  
Wastewater treatment: Primary, secondary and tertiary treatment.

**Unit 3: Atmospheric pollution:** Primary and secondary air pollutants. Biological effects of Nox, SOx, SPM, Hydrocarbons, Acid rain, Global warming, Radiation & Thermal pollution Sources, types, effects, Atmospheric fallout and abatement, Photochemical smog and Ozone hole. **5 hrs**

**Unit 4: Solid waste and Biomedical waste:** **5hrs**  
Sources, collection, transport, treatment and Disposal methods..  
Noise Pollution: Sources, Biological effects, Control measures and OSHA standards.

**Unit 5: Radiation & Thermal pollution:** Sources, types, effects, Atmospheric fallout and abatement. **5 hrs**

**Unit 6: Environmental Impact Assessment:** Basic elements, Methods Guideline for industrial EIA, Aquaculture related EIA, Transport related EIA and Water related EIA . Case studies: Konkan Railway, Silent valley, Bhopal Tragedy and Love canal tragedy Mangalore Bojpe tragedy **5 hrs**

**Unit 7: Natural hazards:** Volcanoes, Earthquakes, Tsunamis and their effects. **4 hrs**

**References:**

1. APHA, AWWA and WEF. 1992: **Standard Methods for Examination of Water and Wastewater**, XVIII Ed, American Public Health Association. NY, USA
2. Hosetti, B.B. 2001. **A Text Book of Applied Aquatic Biology**, Daya Publishing House, Delhi.
3. Nandini, .N. Sunitha N. and T. Sucharita 2010. **Environmental Studies**, Sapna Book House Bangalore.
4. Prashant, M.S. and B.B. Hosetti, 2010. **Basic elements of Environmental Science**, Pratiksha Publisher, Jaipur,

5. G.T. Miller, 1989. **Resource Conservation and Management**, Wadsworth Publishing Company, Belmont California.
6. Nebel, B.T. and Wrigly R.T. 1998. **Environmental Science**, VI Ed. Prentice Hall New Jersey, USA.

## **B – ECOTOXICOLOGY**

**32 hrs**

- |                                                                                                                                                                                                                             |       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| <b>Unit 8: General Principles of Toxicology:</b> Introduction, Definition of toxicology<br>Importance of Dose and Dose-response, factors influencing toxicity,<br>Bioassay-toxicity evaluation studies using fish as model. | 5 hrs |
| <b>Unit 9: Pesticides:</b> Classification of pesticides, Sources and their effects to man,<br>toxicity of Pesticides-viz. Hematotoxicity, Nephrotoxicity, Neurotoxicity,<br>Immunotoxicity and Biopesticides.               | 5 hrs |
| <b>Unit 10: Toxic compounds:</b> Heavy metals-Lead and mercury, Hydrocarbons-<br>Aromatic and Aliphatic, and cyanides, and toxic gases - Bhopal tragedy.                                                                    | 4 hrs |
| <b>Unit 11: Biotransformation:</b> Bioactivation, Biodetoxification of organo phosphates<br>and organo chorines in the bodies of animals.                                                                                   | 5 hrs |
| <b>Unit 12: Natural toxins, Venoms and poisons:</b> Properties and their effects, Major<br>Sites and mechanism of action, Toxins in lower and higher organisms,<br>Toxin and Venom therapy.                                 | 6 hrs |
| <b>Unit 13: Smoking aids:</b> Active and Passive smoking, Consumption of<br>tobacco, Mariguana(Ganja), their effects and Prevention measures.                                                                               | 3 hrs |
| <b>Unit 14: Cosmetics:</b> Types of cosmetics, Chemical Characteristics , Applications,<br>Exposure and risk assessment, Cosmetic safety regulations.                                                                       | 2 hrs |
| <b>Unit 15: Risk assessment:</b> Exposure assessment, Dose-Dosage, Risk<br>characterization, Risk analysis and communications,<br>Occupational health and illness.                                                          | 2 hrs |

### **Reference:**

1. Gorge W. Warne, 1988. **Reviews of Environmental contamination of Toxicology**, Springer-verlag, New York.
2. Subramanian, M.A. 2004. **Toxicology Principles and methods** MJP Publishers Chennai.
3. Philip, L. Williams, Robert C. Jawes, Stephen M. Roberts, 2000. **Principles of Toxicology**, II Ed. A Wiley Science publication John Wiley & Sons. INC. New York.
4. Pandey, K. and J.P. Shukla, 1990. **Elements of Toxicology**. Radha publ. New Delhi.

5. Pandey, B.N. and G.K. Kulkarni, 1995. **Fisheries and Fish Toxicology**. A.P.H. Publishing Corporation, New Delhi.
6. Bohmont, B.L, 1999. **The standard Pesticide user's guide**. Prentice hall, PRT, New York.
7. Hassall, K.A. 1990. **The Biochemistry and uses Pesticides structure, metabolism and Mode of action and uses in crop protection**, John Wiley & Sons. Inc.
8. Hornshy, A.G., Herner, A.E., and Don Wauchope, R. 1995. **Pesticide properties in Environment**. Springer-verlag, New York.
9. Karmin, M.A., 1997. **Pesticide Profiles: Toxicity, Environmental Impacts and Fate**. CRC press Ohio, USA.

### **Practicals : Environmental Pollution**

1. Estimation of Dissolved oxygen
2. Estimation of Carbon dioxide
3. Estimation of Alkalinity
4. Estimation of Total hardness
5. Estimation of chlorides
6. Estimation of calcium, Magnesium hardness
7. Estimation of phosphates
8. Estimation of total solids
9. Estimation of total dissolved solids
10. Estimation of total suspended solids
11. Estimation of Biochemical oxygen demand
12. Estimation of Sulphates
13. Permanent slides

### **Practicals: Ecotoxicology**

1. Demonstration of LC50 & LD50
2. Estimation of Glycogen
3. Estimation of Protein (Total, Soluble and Structural)
4. Estimation of Inorganic phosphates in tissues
5. Estimation of catalase activity
6. Estimation of Transaminase enzymes
7. Bioaccumulation studies

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