

CORE COURSE I

Basic Concept of Taxonomy & Non Chordates I: Protista to Pseudocoelomates

THEORY**(Credits 4)****Unit 1: Basics of Animal Classification****11**

Definitions: Classification, Systematics and Taxonomy; Hierarchy, Taxonomic types;

Codes of Zoological Nomenclature; Principle of priority; Synonym and Homonym;

Species Concept – Biological and evolutionary; basic idea of cladistics

Unit 2: Protista, Parazoa and Metazoa**19**

General characteristics and Classification up to classes

Study of *Euglena*, *Amoeba* and *Paramecium* (Structure, locomotion, reproduction & nutrition)Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*

Evolution of symmetry, grade of organization and segmentation of Metazoa

Unit 3: Porifera and Cnidaria and Ctenophora**12**

General characteristics and Classification up to classes

Canal system and spicules in sponges

Metagenesis in *Obelia* Polymorphism in Cnidaria Corals and coral reefs**Unit 5: Platyhelminthes****10**

General characteristics and Classification up to classes

Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium***Unit 6: Nematelminthes****8**

General characteristics and Classification up to classes of phylum Nematoda

Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*

Parasitic adaptations in helminthes

NOTE: Classification to be followed from Ruppert and Barnes Invertebrate Zoology VI edition, except for Protozoa (American Association of Protozoologist ref: Levine 1980) and Porifera (Brusca and Brusca 2002; IV edition. Invertebrate Zoology)

PRACTICALS**(Credits 2)**

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*
2. Hay Culture of *Paramecium*
3. Study of diversity in Protista colonized on glass slides submerged at different places/ depth in pond water (7 to 14 days)
4. Study of *Obelia*, *Physalia*, *Porpita*, *Euspongia*, *Scypha*, *Aurelia*, *Tubipora*, Sea Anemone, *Pennatula*, *Fungia*
5. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/ micro-

- photographs)
6. Study of adult *Fasciola hepatica* and its life stages (Slides/micro-photographs)
 7. Preparation of dichotomous key from provided taxonomic data

Note: Classification to be followed from "Ruppert and Barnes (2006) Invertebrate Zoology, 8th edition, Holt Saunders International Edition"

SUGGESTED READINGS

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

CORE COURSE II

Principles of Ecology

(Credits 4)**THEORY****Unit 1: Introduction to Ecology****06**

Levels of organization, Laws of limiting factors, study of physical factors

Unit 2: Population**24**

Population attributes: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and Patterns, r and K strategies

Population regulation - density-dependent and independent factors

Population interactions; Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition

Unit 3: Community**12**

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example; Theories pertaining to climax community

Unit 4: Ecosystem**14**

Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies

Nutrient and biogeochemical cycle with one example of Nitrogen cycle

Unit 5: Wildlife & Conservation**04**

Wildlife Conservation (ideas of in-situ and ex-situ conservation) Management strategies for tiger conservation; protection laws for wildlife conservation, Bio-resource assessment and planning

PRACTICALS**(Credits 2)**

1. Preparation of nested quadrat and estimation of effective quadrat size
2. Determination of population density in a natural/ hypothetical community by quadrat method and calculation of Sorenson's Similarity & Shannon-Weiner diversity indices for the same community
3. Study of an aquatic ecosystem: Major Phytoplankton (Up to Family) and zooplankton (Up to Genus), temperature, turbidity/ penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method) and free CO₂
4. Estimation of Primary productivity by light & Dark bottle method
5. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary/Sea Shore

SUGGESTED READINGS

1. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum, E.P., Barrett GW (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Smith RL, Smith TM (2002) Ecology and Field Biology, Benjamin Cumming (Pearson education)
5. Ricklefs, R.E., Miller G.L. (2000). Ecology. IV Edition. W.H. Freeman and Co.
6. Stiling P. (2002). Ecology – Science and Applications 2nd edition. Prentice Hall of India

CORE COURSE III

Non-chordates II: coelomates

(Credits 4)**THEORY****Unit 1: Introduction to Coelomates****02**

Evolution of coelom and metamerism

Unit 2: Annelida**07**General characteristics and Classification up to classes
Excretion in Annelida**Unit 3: Arthropoda****16**General characteristics and Classification up to classes
Vision and Respiration in Arthropoda
Metamorphosis in Insects
Social life in honey bees**Unit 4: Onychophora****04**

Affinities, systematic position and evolutionary significance

Unit 5: Mollusca**16**General characteristics and Classification up to classes
Respiration in Mollusca
Torsion and detorsion in Gastropoda
Biology of pearl formation in bivalves
Evolutionary significance of trochophore larva**Unit 6: Echinodermata****15**General characteristics and Classification up to classes
Water-vascular system in Asteroidea
Larval forms in Echinodermata
Affinities with Chordates**Note:** Classification to be followed from "Ruppert and Barnes (2006) *Invertebrate Zoology*, VI edition, Brooks Cole**PRACTICAL****(Credits 2)**

- Study of following specimens:
Annelids - *Aphrodite*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*
Arthropods - *Carcinoscorpius*, *Macrobrachium*, *Balanus*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Apis dorsata*
Onychophora - *Peripatus*
Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Lamellidens*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus*
Echinodermites - *Astropecten*, *Ophiura*, *Strongylocentropus*, *Cucumaria* and *Antedon*
- Study of digestive system, nephridia of earthworm
- Study of T.S. through pharynx, gizzard, and intestine of earthworm (Permanent slide)
- Mount of mouth parts of *Periplaneta*, Mosquito and House fly; dissection of

digestive and reproductive system of *Periplaneta*

SUGGESTED READINGS

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VII Edition. Thompson Brooks Cole(International Edition)
2. Barnes, R.S.K., Callow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition,

CORE COURSE IV

Animal physiology

THEORY**(Credits 4)****Unit 1: Tissues****06**

Classification and functions of epithelial tissue, Connective tissues including bones and cartilages, Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Motor unit

Unit 2: Digestive System**07**

Structural organization and functions of gastrointestinal tract and associated glands; digestion; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Gastrointestinal enzymes and hormonal control of their secretion

Unit 3: Respiratory system**06**

Histology of trachea and lung in mammals; Mechanism and control of respiration, Respiratory volumes and capacities; Dissociation curves and the factors influencing it

Unit 4: Blood Vascular system**09**

Components of mammalian blood and their functions; Structure and functions of haemoglobin; Transport of oxygen and carbon dioxide in blood;
Blood groups: Rh factor, MN, ABO and Bombay phenomenon
Structure of mammalian heart, Origin and conduction of cardiac impulses; Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart

Unit 5: Urino-genital System**07**

Structure of kidney and nephron; Urine formation
Histology of testis and ovary; menstrual & estrous cycle

Unit 6: Endocrine System**15**

Functions of endocrine glands - pineal, pituitary, thyroid, pancreas, adrenal; hormones secreted by them; regulation of endocrine secretion; Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus and neuroendocrine control of anterior pituitary; Placental hormones

Unit 7: Nervous System**10**

Structure of neuron; Types of synapse and neuromuscular junction; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Synaptic transmission; Autonomic Nervous system with reference to V, VII, IX and X cranial nerves

PRACTICALS**(Credits 2)**

1. Demonstration of the unconditioned reflex action (knee jerk reflex)
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells (from fish)
3. Study of permanent slides of Mammalian cartilage, stomach, small intestine, liver, lung, kidney, Pancreas, Testis, Ovary, Adrenal, Thyroid.
4. Microtomy: Preparation of permanent slide of five tissues (liver, stomach, kidney, testis, ovary of goat)
5. Determination of ABO Blood group

6. Enumeration of red blood cells and white blood cells using haemocytometer
7. Estimation of haemoglobin using Sahli's haemoglobinometer

SUGGESTED READINGS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculart Asia PTE Ltd. /W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P. Eroschenko. (2008). di Fiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
5. C. L. Prosser (XXXX) Comparative Animal Physiology
6. Schmidt Nielsen, K. (1994) Animal Physiology: Adaptation & Environment, Low priced Cambridge Edition

CORE COURSE V

Diversity of chordates

(Credits 4)**Theory****Unit 1: Protochordata****10**

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata, Origin of Chordata

Unit 2: Agnatha**02**

General characteristics and biology of cyclostomes

Unit 3: Pisces**08**

General characteristics of Chondrichthyes and Osteichthyes, classification up to order, Migration, Osmoregulation and parental care in fishes

Unit 4: Amphibia**07**

Origin of Tetrapoda (Evolution of terrestrial ectotherms), General characteristics and classification up to order; Parental care in Amphibians

Unit 5: Reptilia**08**

General characteristics and classification up to order; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes

Unit 6: Aves**10**

General characteristics and classification up to order; Archaeopteryx - a connecting link; Principles and aerodynamics of flight and migration in birds

Unit 7: Mammalia**09**

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

Unit 8: Zoogeography**06**

Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

PRACTICAL**(Credits 2)****1. Protochordata**

Study of *Balanoglossus*, *Branchiostoma*, Colonial Urochordata, T. S. of *Balanoglossus* through proboscis and branchiogenital regions (Permanent Slide)

2. Agnatha

Study of *Petromyzon*, *Myxine*

3. Fishes

Study of *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus vitattatus*, *Heteropneustes*, *Catla*, *Gudusia chapra*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Anabas*, Flat fish; Dissection of afferent and efferent Branchial system of fish, Mount of Weberian ossicles

of any carp, Mount of cycloid and ctenoid scales and study of placoid scale (Permanent Slide)

4. Amphibia

Ichthyophis, Necturus, Bufo, Rachophorous, Salamandra

5. Reptilia

Chelone, Hemidactylus, Varanus, Calotes, Chamaeleon, Draco, Bungarus, Vipera, Naja, Hydrophis

6. Aves

Study (Identification & habitat) of six common birds (Crow, Parakeet, Bulbul, Bee-eater, Pigeon and Cuckoo). Types of beaks and claws; Dissection of fowl head to do Vth and VIIth cranial nerves, pecten from fowl

7. Mammalia

Sorex, Pteropus, Funambulus, Bandicoota, Cavia

Classification from Young, J. Z. (1981) to be followed except for classification fishes

SUGGESTED READINGS

1. Young, J. Z. (1981). *The Life of Vertebrates*. III Edition. Oxford university press.
2. Pough H. *Vertebrate life*, VIII Edition, Pearson International.
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub Co.
4. Hall B.K. and Hallgrimsson B. (2008).
5. *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
6. Nelson, J. S. (2006). *Fishes of the World*, Wiley
7. Lomolino, M. V. et al (2010) *Biogeography*, 4th Edition, Sinauer Associates

CORE COURSE VI

Comparative anatomy of vertebrates

(Credits 4)**Theory****Unit 1: Integumentary System****10**

Structure & functions of integument, integumentary derivatives: horn & antler, glands

Unit 2: Skeletal System**08**

Types of vertebrae and modification, Jaw suspension, Visceral arches

Unit 3: Digestive System**07**

Ruminant stomach: Structure & Function; dentition

Unit 4: Respiratory System**07**

Skin, gills, lungs and air sacs; Accessory respiratory organs in fishes

Unit 5: Circulatory System**08**

Evolution of aortic arches and heart

Unit 6: Urinogenital System**07**

Evolution of urinogenital ducts, Types of kidney: Pronephros, mesonephros, opisthonephros and metanephros; Types of mammalian uteri

Unit 7: Nervous System**08**Comparative account of brain with special reference to shark, carp, frog, *Varanus*, *Columba*, *Cavia*

Cranial nerves in Amphibia & Mammalia

Unit 8: Sense Organs**05**

Comparative account of eye in fish, bird and mammal

PRACTICAL**(CREDITS 2)**

1. Vertebrae of fish, toad, Snake, Fowl and Rabbit
2. Pectoral & pelvic girdles of fish, toad, *Varanus*, Fowl and Rabbit
3. Skulls: Toad, Snake, *Galus* and *Cavia*
4. Comparative study of digestive system in *Tilapia* and *Channa*
5. Study of structure of urinogenital system of fish, toad, *Galus*, *Cavia* from video recording/ Photograph
6. Project on modifications of Integumentary derivatives in vertebrates

SUGGESTED READINGS

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
4. Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House

CORE COURSE VII

Fundamentals of Biochemistry

Theory**(Credits 4)****Unit 1: Biological macromolecules**

30

Structure, types and Biological importance: carbohydrate, Protein, lipid and nucleic acids

Unit 2: Enzymes

Enzymes: Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action

Unit 3: Carbohydrate Metabolism

30

Carbohydrate Metabolism; Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 4: Protein Metabolism

30

Protein Metabolism; Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Lipid Metabolism

30

Lipid Metabolism; β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

PRACTICAL**(Credits 2)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids
2. Paper chromatography of amino acids
3. Action of salivary amylase under optimum conditions
4. Effect of pH, temperature and inhibitors on the action of salivary amylase
5. Demonstration of proteins separation by Lowry et al (1951).

SUGGESTED READING

1. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J. L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

CORE COURSE VIII

Cell Biology

Theory (Credits 4)**Unit 1: Plasma Membrane** **10**

Fluid Mosaic model of plasma membrane

Transport across membranes: Active and Passive transport, Facilitated transport

Cell junctions: Tight junctions, Gap junctions, Desmosome

Unit 1: Endomembrane System **10**

Endoplasmic Reticulum; Golgi apparatus; Lysosome

Unit 2: Mitochondria and Peroxisomes **08**

Mitochondria: Structure, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis

Peroxisomes

Unit 3: Cytoskeleton **08**

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments

Unit 4: Nucleus **12**

Structure of Nucleus: Nuclear envelope, nuclear pore complex, nucleolus

Unit 4: Cell division **08**

Mitosis; Meiosis; Cell cycle and its regulation; MTOC

Unit 4: Cell Signaling **04**

GPCR and Role of second messenger (cAMP)

PRACTICAL**(Credits 2)**

1. Study of polytene chromosome from chironomid larvae
2. study of mitosis from bone marrow of goat/ Onion root tip
3. Study of various stages of meiosis grasshopper/ testis of mouse
4. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells
5. Demonstration of Preparation of permanent slide to demonstrate of:
 1. DNA by Feulgen reaction
 2. DNA and RNA by MGP
 3. Proteins by Mercurobromophenol blue/Fast Green

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia

3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco
5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London

CORE COURSE IX

Parasitology and immunology

Theory**(Credits 4)****Unit 1: Parasitology****30**

Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector); Host parasite relationship

Study of Morphology, Life Cycle, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Leishmania donovani*, *Plasmodium vivax*, *Taenia solium*, *Ascaris lumbricoides*, *Wuchereria bancrofti*

Unit 2: Immunology**30**

Cells and organs of the Immune system, Properties and functions of cytokines, Therapeutics Cytokines,

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation, hypersensitivity

Innate and Adaptive Immunity, Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Structure and functions of different classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

PRACTICAL**(Credits 2)**

1. Study of life stages of *Entamoeba histolytica*, *Leishmania donovani* and *Plasmodium vivax*, *Taenia solium*, *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* through permanent slides/micro photographs
2. Study of *Pediculus humanus* (Head louse and Body louse), *Ctenocephalides* spp. and *Cimex lectularius* through permanent slides/ photographs
3. Study of nematode/cestode parasites from the intestines of Poultry bird
4. Histological study of spleen, thymus and lymph nodes through slides/ photographs
5. Preparation of stained blood film to study various types of white blood cells
6. Ouchterlony's double immuno-diffusion method
7. Demonstration of ELISA

SUGGESTED READINGS

1. Arora, D. R and Arora, B. (2001) *Medical Parasitology*. II Edition. CBS Publications and Distributors
2. E.R. Noble and G.A. Noble (1982) *Parasitology: The biology of animal parasites*. V Edition, Lea & Febiger
3. Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) *Biology of Disease* Taylor and Francis Group
4. Parija, S. C. Textbook of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributors, Medical Books Publishers, Chennai, Delhi

5. Rattan Lal Ichhpujani and Rajesh Bhatia. Medical Parasitology, III Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi
6. Meyer, Olsen & Schmidt's Essentials of Parasitology, Murray, D. Dailey, W.C. Brown Publishers
7. K. D. Chatterjee (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.

CORE COURSE X

Biochemistry of Metabolic Processes

THEORY**(Credits 4)****Unit 1: Overview of Metabolism****10**

Catabolism vs Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism**16**

Glycolysis and its regulation; Citric acid cycle; Phosphate pentose pathway
Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism**14**

β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis

Unit 4: Protein Metabolism**10**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation**10**

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

PRACTICALS**(Credits 2)**

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO₂ in the TCA cycle

SUGGESTED READINGS

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

CORE COURSE XI
Molecular biology

THEORY (Credits 4)

Unit 1: Nucleic Acids 04

Salient features of DNA and RNA; Watson and Crick model of DNA

Unit 2: DNA Replication 12

DNA Replication in prokaryotes and eukaryotes, DNA polymerases, primosome, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres

Unit 3: Transcription 10

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, transcription factors

Unit 4: Translation 12

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; mechanism of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA 06

Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of hnRNA

Unit 6: Gene Regulation 10

Transcription regulation in prokaryotes: lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers

Unit 7: DNA Repair Mechanisms and cancer 03

Pyrimidine dimerization and mismatch repair, protooncogene, oncogene, tumor suppressor gene, activation of oncogene, multy hit and two hit hypothesis

Unit 8: Regulatory RNAs 03

Ribo-switches, RNA interference, miRNA, siRNA

PRACTICAL (Credits 2)

1. Isolation of DNA from blood Fish Blood (Demonstration)
2. Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A₂₆₀ measurement)
3. Quantitative estimation of RNA using Orcinol reaction
4. Study and interpretation of electron micrographs/ photograph showing
 - (a) DNA replication

- (b) Transcription
- (c) Split genes

SUGGESTED READINGS

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). *The World of the Cell*. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
6. Lewin B. (2008). *Gene XI*, Jones and Bartlett
7. McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology IV* Edition. GS, Taylor and Francis Group, New York and London.

CORE COURSE XII

Developmental Biology

THEORY**(Credits 4)****Unit 1: Introduction****04**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2: Early Embryonic Development**28**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

Unit 3: Late Embryonic Development**08**

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit 4: Post Embryonic Development**12**

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories

Unit 5: Implications of Developmental Biology**08**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *In vitro* fertilization, Stem cell (ESC), Amniocentesis

PRACTICALS**(Credits 2)**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicrograph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press

CORE COURSE XIII

Principles of Genetics

THEORY**(Credits 4)****Unit 1: Mendelian Genetics and its Extension****08**

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex influenced and sex-limited characters inheritance

Unit 2: Linkage, Crossing Over and Chromosomal Mapping**12**

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization

Unit 3: Mutations**10**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method

Unit 4: Sex Determination**04**

Chromosomal mechanisms of sex determination in *Drosophila* and Man

Unit 5: Extra-chromosomal Inheritance**06**

Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects

Unit 6: Polygenic Inheritance**03**

Polygenic inheritance with suitable examples; simple numericals based on it

Unit 7: Recombination in Bacteria and Viruses**09**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

Unit 8: Transposable Genetic Elements**08**

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans

PRACTICALS**(Credits 2)**

1. To study the Mendelian laws and gene interactions
2. Chi-square analyses using seeds/ beads/ *Drosophila*
3. Linkage maps based on data from conjugation, transformation and transduction
4. Linkage maps based on data from *Drosophila* crosses
5. Study of human karyotype (normal and abnormal)
6. Pedigree analysis of some human inherited traits

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
6. Fletcher H. and Hickey I. (2015). *Genetics*. IV Edition. GS, Taylor and Francis Group, New York and London

CORE COURSE XIV
Evolutionary Biology

THEORY (Credits 4)

Unit 1: 07

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes

Unit 2: 04

Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Unit 3: 10

Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular (universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c

Unit 4: 08

Sources of variations: Heritable variations and their role in evolution

Unit 5: 13

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

Unit 6: 07

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches

Unit 7: 03

Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

Unit 8: 06

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin

Unit 9: 02

Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees

PRACTICALS (CREDITS 2)

1. Study of fossils from models/ pictures

2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation

SUGGESTED READINGS

1. Ridley, M (2004) Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin Cummings.
4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
5. Snustad. S Principles of Genetics.
6. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell