

SEMESTER- 1
ZOOLOGY- CC-I
DIVERSITY AND EVOLUTION OF NON-CHORDATA (PROTISTA TO
PSEUDOCOELOMATES)

(CREDITS: THEORY-4, PRACTICALS-2)

THEORY

Full mark 100: **Theory – 75** (Mid Sem: 15 + End Sem: 60), Practical – 25

Unit 1: Protista, Parazoa and Metazoa and Porifera

General characteristics and Classification up to classes. Study of *Euglena*, *Amoeba*. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*. Locomotion and Reproduction in Protista. General characteristics and Classification up to classes, Canal system and spicules in sponges.

Unit 2: Cnidaria & Ctenophora

General characteristics and Classification up to classes, Metagenesis in *Obelia*, Polymorphism in Cnidaria, Corals and coral reefs. General characteristics and Evolutionary significance of Ctenophora.

Unit 3: Platyhelminthes

General characteristics and Classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Unit 4: Nematelminthes

General characteristics and Classification up to classes. Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereria bancrofti*. Parasitic adaptations in helminthes

Note: Classification to be followed from “Barnes, R.D. (1982). *Invertebrate Zoology*, V Edition”
PRACTICAL – 25 (End Semester Evaluation)

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium*.
2. Examination of pond water collected from different places for diversity in protista.
3. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*.
4. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatulula*, *Fungia*, *Meandrina*, *Madrepora*.

5. One specimen/slide of any ctenophore.
6. Study of adult *Fasciola hepatica*, *Taeniasolium* and their life cycles (Slides/microphotographs).
7. Study of adult *Ascarislumbricoides* and its life stages (Slides/micro-photographs).
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

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

SUGGESTED READINGS

1. Ruppert EE and Barnes, R.D. *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. *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. Barrington, E.J.W..*Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson.
4. Hyman, LH. Invertebrate Series (Recent edition)
5. Verma P S. *A Manual of Practical Zoology: Invertebrates*. S Chand Publication
6. Parker JJ and WA Haswel Textbook of Zoology.Vol I and II
7. Graphical representation of data (Frequency polygon and Histogram)

ZOOLOGY (HONOURS)

SEMESTER- I

Core Course

CC- II – Perspectives in Ecology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem: 15 + End Sem: 60), Practical – 25

Unit 1: Ecosystem and Applied Ecology

Ecology: Autecology and synecology, 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 Nutrient and biogeochemical cycle with one example of Nitrogen cycle. Ecology in Wildlife Conservation and Management. Laws of limiting factors, Study of physical factors- (Light, temperature).

Unit 2: Population

Attributes of population: 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.

Unit 3: Community

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 : Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity; Conservation strategies (in situ and ex situ); Role of ZSI, WWF, IUCN; Wildlife (Protection) Act, 1972.

ZOO.-C-II LAB PRACTICALS **Marks 25**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content(Winkler's method), Chemical Oxygen Demand and free CO₂.
4. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

SUGGESTED READINGS

1. Colinvaux PA (1993) Ecology. II Edition. John Wiley and Sons, Inc., USA.
2. Dash MC (1993) Fundamentals of Ecology. McGraw Hill Book Company, New Delhi.
3. Joshi N and Joshi PC (2012) Ecology and Environment. 1st Edition. Himalaya Publishing House, New Delhi.
4. Odum EP (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
5. Ricklefs, R.E., (2000). Ecology. 5th Edition. Chiron Press.
6. Robert Leo Smith Ecology and field biology Harper and Row.
7. Singh JS, Gupta SR and Singh SP (2014) Ecology, Environmental Science and Conservation. S. Chand, New Delhi.

GENERIC ELECTIVES

Semester-I & III

GE - 1 : FOOD, NUTRITION AND HEALTH THEORY (CREDITS 4)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Basic concept of food and nutrition

Food Components and food-nutrients, Concept of a balanced diet, nutrient needs and dietary pattern for various groups, adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit 2: Nutritional Biochemistry:

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role
Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance
Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

Unit 3: Health

Introduction to health- Definition and concept of health, Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications, Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention, Common ailments- cold, cough, and fevers, their causes and treatment

Unit 4: Food hygiene:

Potable water- sources and methods of purification at domestic level Food and Water borne infections: **Bacterial infection:** Cholera, typhoid fever, dysentery; **Viral infection:** Hepatitis, Poliomyelitis, **Protozoan infection:** amoebiasis, giardiasis; **Parasitic infection:** taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention Brief account of food spoilage: Causes of food spoilage and their preventive measures

PRACTICAL (Credits 2)

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. Estimation of Lactose in milk
4. Ascorbic acid estimation in food by titrimetry
5. Estimation of Calcium in foods by titrimetry
6. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogodermagranarium*, *Callosobruchuschinensis* and *Triboliumcastaneum*): their identification, habitat and food sources, damage caused and control. Preparation of temporary mounts of the above stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups. OR Identify nutrient rich sources of foods (**fruits and vegetables**), their seasonal availability and price OR Study of nutrition labeling on selected foods

SUGGESTED BOOKS

Mudambi, SR and Rajagopal, MV. Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed; 2007; New Age International Publishers

Srilakshmi B. Nutrition Science; 2002; New Age International (P) Ltd.

Srilakshmi B. Food Science; Fourth Ed; 2007; New Age International (P) Ltd.

Swaminathan M. Handbook of Foods and Nutrition; Fifth Ed; 1986; BAPPCO.

Bamji MS, Rao NP, and Reddy V. Text Book of Human Nutrition; 2009; Oxford & IBH Publishing Co. Pvt Ltd.

Dubey R C and Maheswari D K. *A Textbook of Microbiology*. S Chand Publication

Zoology general DSC-1/2/3 -I is same as CC - I of zoology honours.

ZOOLOGY(HONOURS)

SEMESTER- II

Core Course

CC- III – Non- Chordates II: Coelomates (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Coelomates and Annelids

Evolution of coelom and metamerism. General characteristics and Classification up to classes.

Excretion in Annelida.

Unit 2: Arthropoda&Onychophora

General characteristics and Classification up to classes. Vision and Respiration in Arthropoda. Metamorphosis in Insects. Social life in bees and termites. Onychophora: General characteristics and Evolutionary significance.

Unit 3: Mollusca

General characteristics and Classification up to classes. Respiration in Mollusca. Torsion and detorsion in Gastropoda. Evolutionary significance of trochophore larva.

Unit 4: Echinodermata

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*,8th edition, Holt Saunders International Edition”

PRACTICAL – 25 (End Semester Evaluation)

Study of following specimens:

1. Annelids - *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria*
2. Arthropods – *Tachypleus*, *Carcinoscorpius*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, termites and honey bees
3. Onychophora – *Peripatus*
4. Molluscs - *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus*
5. Echinodermates - *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Cucumaria* and *Antedon*
6. Study of digestive system, nephridia of earthworm (Virtual).
7. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
8. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta*.*
9. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Note: Classification to be followed from “Ruppert and Barnes (2006) *Invertebrate Zoology*, 8th edition, HoltSaunders 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.
4. Jordan and Verma P.S., *Invertebrate Zoology*. S Chand publication.
5. Kotpal RL, *Text book of Zoology, Invertebrate*, Rastogi Publication
6. Verma P S and Srivastava P C. *Advanced Practical Zoology*. S Chand Publication
7. Verma P S. *A Manual of Practical Zoology: Chordates*. S Chand Publication

ZOOLOGY (HONOURS)

SEMESTER- II

Core Course

CC - IV - Physiology: Life Sustaining Systems (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Physiology of Digestion

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.

Unit 2: Physiology of Respiration

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration.

Unit 3: Renal Physiology and blood

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance. Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Haemopoiesis, Blood clotting system, Blood groups: Rh factor, ABO and MN.

Unit 4: Physiology of Heart

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation.

PRACTICAL – 25 (End Semester Evaluation)

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer
6. Examination of sections of mammalian slides: oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

Suggested Readings

- (a) Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
- (b) Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- (c) Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- (d) Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- (e) Moyes CD, Schulte PM, Principles of physiology, 2nd edition, Pearson education.
- (f) Marieb E N and Hoehn K N. *Human Anatomy and Physiology*. Pearson Education Publication

GENERIC ELECTIVES

Semester-II&IV

GE - 2 : HUMAN PHYSIOLOGY THEORY (CREDITS 4)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Digestion and Respiratory Physiology

Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (*in brief*), Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases.

Unit 2: Functioning of Excitable Tissue (Nerve and Muscle)

Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory), Neuromuscular junction

Unit 3: Renal Physiology and Cardiovascular Physiology

Functional anatomy of kidney, Mechanism and regulation of urine formation, Structure of heart, Coordination of heartbeat, Cardiac cycle, ECG

Unit 4: Endocrine and Reproductive Physiology

Structure and function of endocrine glands (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes), Brief account of spermatogenesis and oogenesis, Menstrual cycle.

PRACTICAL

1. Preparation of temporary mounts: Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Estimation of haemoglobin using Sahli's haemoglobinometer.
4. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary.

SUGGESTED READINGS

- Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc. □
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill. □
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company. □
- Marieb, E. (1998). Human Anatomy and Physiology, IV Edition, Addison-Wesley. □
- Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers. □
- Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd. □

Zoology general DSC-1/2/3 -II is same as CC - II of zoology honours.

ZOOLOGY (HONOURS)

SEMESTER- III

Core Course

CC- V - Diversity of Chordates (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Protochordates and Origin of Chordates

Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata. General characteristics and outline classification Chordata. Dipleurula concept and the Echinoderm theory of origin of chordates.

Unit 2: Agnatha, Pisces & Amphibia

General characteristics of Agnatha: General characteristics and classification of cyclostomes up to class

Chondrichthyes and Osteichthyes, classification up to order, Migration, Parental care in fishes, Accessory respiratory organs in pisces, Evolutionary significance of Dipnoi.

Amphibian: Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order. Parental care in Amphibia.

Unit 3: Reptilia & Aves

General characteristics and classification up to order in reptiles; Affinities of *Sphenodon*; Poison

apparatus and Biting mechanism in snakes. General characteristics and classification up to order in Aves *Archaeopteryx* - a connecting link; Flight adaptations and Migration in birds.

Unit 4: Mammals & Zoogeography

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

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

PRACTICAL – 25 (End Semester Evaluation)

1. Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata, Sections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slides of *Herdmania* spicules.
2. Agnatha: *Petromyzon* and *Myxine*.
3. Fishes: *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon/ Diodon*, *Anabas*, Flat fish
4. Amphibia: *Ichthyophis/Ureotyphlus*, *Necturus*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*
5. Reptilia: *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus* Key for Identification of poisonous and non-poisonous snakes
6. Aves: Study of six common birds from different orders. Types of beaks and claws. Study of feathers.
7. Mammalia: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus*, *Loris*, *Herpestes*, *Erinaceous*.
8. Power point presentation on study of any two animals from two different classes by students. Submission of album of local species.

*Classification from Young, J. Z. (2004) to be followed.

SUGGESTED READINGS

1. Young, J. Z. (2004). *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 Hallgrímsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Hickman CP, Roberts LS, Keen S, Larson A, l'AnsonH, IsenhourDJ *Integrated Principle of Zoology*, 14 th edition, 2008, McGrawHill publication
6. Verma P S and Srivastava P C. *Advanced Practical Zoology*. S Chand Publication

ZOOLOGY (HONOURS)

SEMESTER- III

Core Course

CC-VI - Physiology: Controlling and Coordinating Systems (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Tissues & Tissue system

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue. Structure and types of bones and cartilages, Ossification, bone growth and resorption.

Unit 2: Muscle & Nervous System

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction.

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

Unit 3: Reproductive System

Histology of testis and ovary; Physiology of male and female reproduction; Hypothalamus-Pituitary & Gonadal axis. Puberty, Ovarian Cycle, Methods of contraception in male and female, Placental hormones.

Unit 4: Endocrine System

Histology of endocrine glands – Hypothalamus (Neuroendocrine gland) pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones and mechanism of hormone action, (steroidal and non-steroidal hormones).

PRACTICAL – 25 (End Semester Evaluation)

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
2. Squamous epithelium, Striated muscle fibres and nerve cells
3. Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
4. Microtomy: Preparation of permanent slides/photographs/computer models of any five types of mammalian (Goat/rat/etc) tissues

(*Subject to UGC guidelines)

SUGGESTED BOOKS

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hecourt 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). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins
4. Aray L.B. Human Histology, W.B. Saunders publication
5. Marieb EN and Hoehn K, Human anatomy & Physiology, 9th edition, 2013, Pearson Education, USA
6. Martini F H, Nath J L and Bartholomew E F. Fundamentals of Anatomy and Physiology. Pearson Education Publication

ZOOLOGY (HONOURS)

SEMESTER- III

Core Course

CC-VII - Comparative Anatomy of Vertebrates (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Integumentary & Skeletal System

Structure, functions and derivatives of integument (Scale, claw, nail, hair, feather and dentition).

Axial and appendicular skeleton, Jaw suspensorium, Visceral arches.

Unit 2: Digestive & Respiratory System

Alimentary canal and associated glands; Respiration through Skin, gills, lungs and air sacs; Accessory respiratory organs.

Unit 3: Circulatory and Urinogenital system

General plan of circulation, evolution of heart and aortic arches; Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit 4: Nervous System & Sense Organs

Comparative account of brain; Autonomic nervous system, Spinal cord, Cranial nerves in mammals. Classification of receptors: Brief account of visual and auditory receptors in man. Chemo and mechano receptors

PRACTICAL – 25 (End Semester Evaluation)

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit
3. Carapace and plastron of turtle /tortoise (Photographs, charts etc)
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted).

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

Zoology general DSC-1/2/3 -III is same as CC - III of zoology honours.

ZOOLOGY (HONOURS)
SEMESTER- IV
Core Course
CC-VIII: Biochemistry of Metabolic Processes (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Overview of Metabolism

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

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

Unit 3: Lipid and protein Metabolism

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

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

Unit 4: Oxidative Phosphorylation

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

PRACTICAL – 25 (End Semester Evaluation)

1. Estimation of total protein in given solutions
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin/ Lipase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Dry Lab (Virtual): 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. erg, 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. Jain JL and Jain S, Fundamentals of Biochemistry, S.Chand publication

ZOOLOGY (HONOURS)

SEMESTER- IV

Core Course

CC-IX – Cell biology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem: 15 + End Sem: 60), Practical – 25

Unit 1: Overview of cells and plasma membrane

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membranestructure. Transport across membranes: Active and Passive transport, Facilitated transport. Cell junctions: Tight junctions, Desmosomes, Gap junctions.

Unit 2: Cytoskeleton & Endomembrane System

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments; Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes.

Unit 3: Mitochondria and Peroxisomes

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis; Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis. Peroxisomes.

Unit 4: Nucleus, Cell Division and Cell signalling

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome); Mitosis, Meiosis, Cell cycle and its regulation; GPCR and Role of second messenger (cAMP)

PRACTICAL – 25 (End Semester Evaluation)

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.
4. Preparation of permanent slide to demonstrate:
 - i. DNA by Feulgen reaction

- ii. DNA and RNA by MGP
 - iii. Mucopolysaccharides by PAS reaction
 - iv. Proteins by Mercurobromophenol blue/Fast Green
5. Demonstration of osmosis (RBC/egg etc.)

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). *MolecularBiology of the Cell*, V Edition, Garland publishing Inc., New York and London.

ZOOLOGY (HONOURS)

SEMESTER-I V

Core Course

CC-X: Principles of Genetics (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance. Polygenic inheritance with suitable examples; simple numericals based on it.

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 2: Mutations

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 3: Sex Determination & Extra-chromosomal Inheritance

Chromosomal mechanisms of sex determination in *Drosophila* and Man; Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects.

Unit 4: Recombination in Bacteria and Viruses & Transposable Genetic Elements

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage.

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

PRACTICAL – 25 (End Semester Evaluation)

1. Study of Mendelian laws and gene interactions.
2. Linkage maps based on data from conjugation, transformation and transduction.
3. Linkage maps based on data from *Drosophila* crosses.
4. Study of human karyotype (normal and abnormal).
5. 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.
4. Benjamin Cummings. Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition.
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.
7. Benjamin Pierce, *Genetics- A Conceptual Approach*, 5th edition, 2015, WH Freeman publication

Zoology general DSC-1/2/3 -IV is same as CC - V of zoology honours.

ZOOLOGY (HONOURS)
SEMESTER IV
Skill Enhancement Course
SEC-2 - RESEARCH METHODOLOGY(2 Credits)
Full Mark: 50 (End semester 40 + Mid semester 10)

Unit 1: Foundations of Research

Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs applied

Unit 2: Research Design

Need for research design: Features of good design, important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3: Data Collection, Analysis and Report Writing

Observation and Collection of Data-Methods of data collection- Sampling, Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis, writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

Unit 4: Ethical Issues

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

1. Anthony, M, Graziano, A.M. and Raulin, M.L. (2009) Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Walliman, N. (2011) Research Methods- The Basics. Taylor and Francis, London, New York.

3. Wadhwa, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, , Universal Law publishing
4. C.R.Kothari (2009) Research Methodology, New Age International.
5. Coley, S.M. and Scheinberg, C.A. (1990) "Proposal writing". Stage Publications.

ZOOLOGY (HONOURS)

SEMESTER-V

Core Course

CC- XI : Molecular Biology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Nucleic Acids, DNA Replication & Repair

Salient features of DNA and RNA. Watson and Crick model of DNA. DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres. Pyrimidine dimerization and mismatch repair.

Unit 2: Transcription & Translation

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors and regulation of transcription. Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

Unit 3: Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

Unit 4: Gene Regulation & Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, RNA interference, miRNA, siRNA.

7. chromosomes from Chironomous / *Drosophila* larvae

8. Preparation of liquid culture medium (LB) and raise culture of *E. coli*

9. Estimation of the growth kinetics of *E. coli* by turbidity method

10. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking
11. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer ($A_{260\text{nm}}$ measurement)
12. Quantitative estimation of RNA using Orcinol reaction
13. Study and interpretation of electron micrographs/ photograph showing

(g) DNA replication

(h) Transcription

(i) Split genes

SUGGESTED READINGS

10. 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.
11. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
12. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
13. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
14. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
15. Lewin B. (2013). *Gene XI*, Jones and Bartlett
16. McLennan A., Bates A., Turner, P. and White M. (2015). *Molecular Biology* IV Edition. GS, Taylor and Francis Group, New York and London.

ZOOLOGY (HONOURS)

SEMESTER- V

Core Course

CC- XII :Fundamentals of Biochemistry (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Carbohydrates & Lipids

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

Unit 2: Proteins

Amino acids: Structure, Classification and General properties of α -amino acids; Physiological importance of essential and non-essential α -amino acids.

Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Renaturation, Denaturation; Introduction to simple and conjugate proteins

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants.

Unit 3: Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA.

Unit 4: 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 K_m and V_{max} , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

PRACTICAL – 25 (End Semester Evaluation)

5. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
6. Paper chromatography of amino acids.
7. Action of salivary amylase under optimum conditions.
8. Effect of pH, temperature and inhibitors on the action of salivary amylase./Urease/acid or alkaline phosphatase
9. Demonstration of proteins separation by SDS-PAGE.

SUGGESTED READING

7. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
8. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
9. 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.
10. 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 Publication.
6. Jain J L, Jain S and Jain N. *Fundamentals of Biochemistry*. S Chand Publication
7. Bhatt S M. *Enzymology and Enzyme Technology*. S Chand Publication

ZOOLOGY (HONOURS)

SEMESTER- V

Discipline Specific Elective Course

DSE 1 : Immunology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1: Innate and Adaptive Immunity

Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system.

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit 2: Antigens and Immunoglobulins

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Immunoglobulins Structure and functions of different classes of immunoglobulins, Antigen antibody interactions, Immunoassays (ELISA- Direct, Indirect, Competitive, Sandwich and RIA)

Unit 3: Major Histocompatibility Complex, Cytokines and Complement system

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation; Cytokines -Properties and functions of cytokines, Therapeutics Cytokines Complement System -Components and pathways of complement activation.

Unit 4: Hypersensitivity and Vaccines

Gell and Coombs' classification and brief description of various types of hypersensitivities
Vaccines -various types of vaccines.

PRACTICAL – 25. (End Semester Evaluation)

9. Study of lymphoid organs.
10. Histological study of spleen, thymus and lymph nodes through slides/ photographs

11. Preparation of stained blood film to study various types of White blood cells.
12. ABO blood group determination.
- 5.Total WBC counting.
- 6.Demonstration of ELISA.
- 7.Demonstration of Bone marrow smears to study Immune cells.

Suggested Readings

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication. Abbas, K. Abul and Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

DISCIPLINE SPECIFIC ELECTIVE (DSE-2)

ANIMAL BEHAVIOUR AND CRONOBIOLOGY (CREDITS: THEORY-4, PRACTICALS-2)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

THEORY LECTURES: 60

Unit 1: Animal Behaviour

Origin and history of Ethology; Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate behavior; Objective of behaviour, Behaviour as a basis of evolution; Behaviour as a discipline of science; Innate behaviour, Instinct, Stimulus filtering, Sign stimuli and Code breakers.

Unit 2: Patterns of Behaviour

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting

Unit 3: Social and Sexual Behaviour

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects' society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

Unit 4: Chronobiology

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks, Relevance of biological clocks, Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

PRACTICAL Marks 25

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice to dry and humid condition.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Study and actogram construction of locomotor activity of suitable animal models.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

SUGGESTED READINGS

1. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
2. John A (2001) Animal Behaviour. 7th Edition. Sinauer Associate Inc., USA.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
4. Paul WS and John A (2013) Exploring Animal Behaviour. 6th Edition. Sinauer Associate Inc., Massachusetts, USA.
5. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Chronobiology Biological Timekeeping: J, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
6. Vinod Kumar (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-

Verlag, Germany.

Skill Enhancement Course

SEC-3 -APICULTURE (2 Credits)

Full Mark: 50 (Mid Sem 10 + End Sem 40)

Unit 1: Biology of Bees

History, Classification and Biology of Honey Bees, Social Organization of Bee Colony

Unit 2: Rearing of Bees

Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth, Bee Pasturage
Selection of Bee Species for Apiculture, Bee Keeping Equipment, Methods of Extraction
of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies

Bees: Diseases and Enemies, Control and Preventive measures

Unit 4: Bees Economy and Entrepreneurship in Apiculture

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen
Etc. Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial
Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

1. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
2. Bisht D.S., *Apiculture*, ICAR Publication.
3. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, NewDelhi.

Zoo DSE-A/B/C-I Sem.-V (for Gen.) is same as DSE-I (Immunology) Sem.-V (for Hons)

ZOOLOGY (HONOURS)

SEMESTER- VI

Core Course

CC-XIII: Developmental Biology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Introduction to Developmental Biology, Gametogenesis & Fertilization

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. Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy.

Unit 2: Early Embryonic Development

Cleavage: 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

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 & Implications of Developmental Biology

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

PRACTICAL – 25 (End Semester Evaluation)

6. 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).

7. 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).
8. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
9. Study of different sections of placenta (photomicrograph/ slides).
10. Project report on *Drosophila* culture/chick embryo development.
11. Study of developmental stages by raising chick embryo in the laboratory

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. althoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.
6. Verma PS and Agrawal VK, Chordata Embryology (S Chand Publication)
- 7.

ZOOLOGY (HONOURS)

SEMESTER- VI

Core Course

CC-XIV: Evolutionary Biology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), **Practical – 25**

Unit 1: Theories, Evidences of Evolution and Extinction

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Sources of variations: Heritable variations and their role in evolution. Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

Unit 2: Process of Evolutionary changes

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 3: Species concept and Speciation

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

Unit 4: Concept of Origin and Evolution of man

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

PRACTICAL – 25 (End Semester Evaluation)

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

SUGGESTED READINGS

2. Ridley, M (2004) Evolution III Edition Blackwell publishing Hall,
3. B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
4. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
5. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. Snustad. S Principles of Genetics.
6. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell
7. Rastogi BB, Organic Evolution, Ramnath and Kedarnath Publication
7. Freeman Scott and Herron JC, Evolutionary analysis, 4th edition, 2016, Pearson education India

ZOOLOGY (HONOURS)

SEMESTER- VI

Discipline Specific Elective Course DSE- 3 : Animal Biotechnology (6 Credit)

Full mark 100: **Theory – 75** (Mid Sem 15 + End Sem 60), Practical – 25

Unit 1. Introduction to Animal Biotechnology

Concept and scope of biotechnology, Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II, Construction of genomic and cDNA libraries and screening by colony and plaque hybridization
Transformation techniques: Calcium chloride method and electroporation

Unit 2. Molecular Techniques

Southern, Northern and Western blotting, DNA sequencing: Sanger method
Polymerase Chain Reaction, DNA Finger Printing and DNA microarray

Unit 3. Genetically Modified Organisms

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection, Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.

Unit 4. Culture Techniques and Applications

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Thalassemia, Haemophilia and

Sickle cell anemia), Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy.

PRACTICAL – 25 (End Semester Evaluation)

1. Genomic DNA isolation from *E. coli* / Animal tissue
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*
3. Restriction digestion of plasmid DNA / Lambda Phage DNA
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
 - a. Southern Blotting
 - b. Northern Blotting
 - c. Western Blotting
 - d. DNA Sequencing (Sanger's Method)
 - e. PCR
 - f. DNA fingerprinting

Suggested Readings

Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.

Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.

Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.

Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics*. V Edition, John Wiley and Sons Inc.

Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y.,USA.

Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics*. VI Edition, Oxford University Press.

SEMESTER- VI
Discipline Specific Elective Course
DSE- 4 : PROJECT

Dissertation: 60 Marks
Presentation: 25 Marks
Viva-voce: 15 Marks

Projects submitted by the students are to be evaluated by the Internal Examiner and External Examiner appointed by University. Students should opt for Supervision of Dissertation from the internal faculties of his own college/Institution. The Supervisor in consultation with the concerned Head of the Department should decide the topic. The presentation should be open to all faculties as well as graduate students of the concerned Department

Skill Enhancement Course

SEC-4 -SERICULTURE(2 Credits)

Full Mark: 50 (End semester evaluation)

Unit 1: Biology of Silkworm

Life cycle of *Bombyxmori*, Structure of silk gland and secretion of silk, Sericulture: Definition, history and present status; Silk route, Types of silkworms, Distribution and Races, Exotic and indigenous races, Mulberry and non-mulberry Sericulture

Unit 2: Rearing of Silkworms

Selection of mulberry variety and establishment of mulberry garden, Rearing house and rearing appliances, Disinfectants: Formalin, bleaching powder, RKO, Silkworm rearing technology: Early age and Late age rearing, Types of mountages, Spinning, harvesting and storage of cocoons

Unit 3: Pests and Diseases

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates, Pathogenesis of, silkworm diseases: Protozoan, viral, fungal and bacterial, Control and prevention of pests and diseases

Unit 4: Entrepreneurship in Sericulture

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various, sericulture centers

SUGGESTED READINGS

1. Food and Agriculture Organisation (1976) Manual on Sericulture, Rome
2. S.R. Ullal and M.N. Narasimhanna , Handbook of Practical Sericulture: CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn.& Pub. Govt. Press, Bangalore
4. M. S. Jolly, Appropriate Sericultural Techniques; (Ed., Director,) CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1(1972), Fuzi Pub. Co. Ltd., Tokyo, Japan.
6. M. N. Narasimhanna (1988), Manual of Silkworm Egg Production;, CSB, Bangalore.
7. K. Sengupta (1989) A Guide for Bivoltine Sericulture; Director, CSR & TI, Mysore.
8. S. Krishnaswamy (1986) Improved Method of Rearing Young age silkworm;, reprinted CSB,Bangalore.

Zoo DSE-A/B/C-II Sem.-VI (for Gen.) is same as DSE-III (Animal Bio-Technology) Sem.-VI (for Hons)