CURRICULUM AND CREDIT FRAMEWORK FOR UNDERGRADUATE PROGRAMME

Under Graduate Syllabus

Department of Zoology
Nagaland University
Lumami

1. MINIMUM CREDIT REQUIREMENTS TO AWARD DEGREE UNDER EACH CATEGORY

Sl. No.	Broad Category of Course	Minimum Credit Requirement	
		3-year UG	4-year UG
1	Major (Core)	60	80
2	Minor Stream	24	32
3	Multidisciplinary	09	09
4	Ability Enhancement Courses (AEC)	08	08
5	Skill Enhancement Courses (SEC)	09	09
6	Value Added Courses common for all UG	08	08
7	Summer Internship	02	02
8	Research Project/ Dissertation	-	12
	Total Credits	**120**	**160**

2. SEMESTER-WISE AND BROAD COURSE CATEGORY-WISE DISTRIBUTION OF CREDITS

Semester	Major Courses	Minor Courses	Interdisciplinary/multidisciplinary courses	Ability Enhancement Courses	Skill Enhancement Courses/Internship/Dissertation	Common Value-Added Courses	Total Credits
I	C1 **(4)** C2 **(4)**	M1**(4)**	Env. Science **(3)**	Eng -1 **(2)**	SEC **(3)** Common Pool		**20**
II	C3 **(4)** C4 **(4)**	M2 **(4)**	Common Pool/Swayam **(3)**	MIL-1 **(2)**		Soft skill **(3)**	**20**
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline/Subject provided they secure 4 credits in work based vocational courses offered during summer term or internship/Apprenticeship							
III	C5 **(4)** C6 **(4)**	M3**(4)**	Understanding	Eng-2 **(2)**	SEC **(3)** Common Pool		**20**

			heritage/Common pool/ Swayam **(3)**				
IV	C7 **(4)** C8 **(4)**	M4 **(4)**		MIL-2 **(2)**	SEC **(3)** Common Pool	NCC/NSS /CP **(3)**	**20**
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline/Subject provided they secure additional 4 credit in skill based vocational courses offered during first year or second year summer term							
V	C9 **(4)** C10 **(4)** C11 **(4)**	M5 **(4)**			Internship **(2)**	Work ethics **(2)**	**20**
VI	C12 **(4)** C13 **(4)** C14 **(4)** C15 **(4)**	M6 **(4)**					**20**
Total	**60**	**24**	**9**	**8**	**11**	**8**	**120**
Students who want to undertake 3-year UG programme will be awarded UG Degree in the relevant Discipline/Subject upon securing 120 credits							
VII	C16 **(4)** C17 **(4)** C18 **(4)** C19 **(4)**	M7 **(4)**			Research Dissertation starts		**20**
VIII	C20 **(4)**	M8 **(4)**			Research project/Dissertation **(12)** **OR** C21 **(4)** C22 **(4)** C23 **(4)**		**20**

3. MAJOR COURSES (CORE PAPERS)

SEMESTER I

C1 : Non-chordates I: Protista to Pseudocoelomates + Practical
C2 : Principles of Ecology + Practical

SEMESTER II

C3 : Non-chordates II: Coelomates + Practical
C4 : Cell Biology + Practical

SEMESTER III

C5 : Diversity of chordates + Practical
C6 : Physiology: Controlling and Coordinating systems + Practical

SEMESTER IV

C7 : Fundamentals of Biochemistry + Practical
C8 : Comparative anatomy of vertebrates + Practical

SEMESTER V

C9 : Physiology: Life Sustaining Systems + Practical
C10 : Biochemistry of Metabolic Processes + Practical
C11 : Molecular Biology + Practical

SEMESTER VI

C12 : Principles of Genetics + Practical
C13 : Developmental Biology + Practical
C14 : Evolutionary Biology + Practical
C15 : Animal Behaviour and Chronobiology + Practical

SEMESTER VII

C16 : Genetics & Cytogenetics + Practical
C17 : Immunology + Practical
C18 : Parasitology + Practical
C19 : Research Methodology

SEMESTER VIII

C20 : Basics in Entomology + Practical
C21 : Medical Microbiology + Practical
C22 : Biostatistics & Bioinformatics + Practical
C23 : Tools And Techniques + Practical

5. SKILL ENHANCEMENT COURSE (SEC)

SEC : Aquarium Fish Keeping
SEC : Wild Life Conservation and Management
SEC : Food, nutrition and health
SEC : Medical Diagnostics
SEC : Apiculture
SEC : Sericulture

DETAILED SYLLABUS

C1 (T)
NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES
THEORY
Credit: 03

Unit 1:

Protista – general characteristics and classification up to classes.
Life cycle of *Euglena, Amoeba* and *Paramecium*.
Locomotion and reproduction in Protista.

Unit 2:

Symmetry and segmentation in Metazoa.
General characteristics of Porifera and classification up to classes.
Canal system and spicules in sponges.

Unit 3:

General characteristics of Cnidaria and classification up to classes.
Metagenesis in Obelia.
Polymorphism in Cnidaria.
Corals and Coral Reefs.

Unit 4:

Evolutionary significance of Ctenophora.
General characteristics of Platyhelminthes and classification up to classes.
Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Unit 5:

General characteristics of Nemathelminthes 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*"

C1 (P)
NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES
PRACTICAL
Credit: 01

1. Study of whole mount of *Euglena, Amoeba* and *Paramecium*, Binary fission and Conjugationin 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, Pennatula, Fungia, Meandrina, Madrepora*.
5. One specimen/slide of any Ctenophore.
6. Study of adult *Fasciola hepatica, Taenia solium* and their life cycles (Slides/microphotographs).
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs).
8. Identification and taxonomic classification of representative invertebrates.

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

SUGGESTED READINGS

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- 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
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.

C2 (T)
PRINCIPLES OF ECOLOGY
THEORY
Credit: 03

Unit 1:

Ecology – autecology and synecology.
Levels of organization, Laws of limiting factors.
Ecology in wildlife conservation and management.

Unit 2:

Unitary and Modular populations
Unique and group 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.

Unit 3:

Population regulation - density-dependent and independent factors.
Population interactions, Gause's Principle with laboratory and field examples.
Lotka-Volterra equation for competition and predation, functional and numerical responses.

Unit 4:

Community characteristics – species richness, dominance, diversity, abundance, vertical stratification, ecotone and edge effect; ecological succession with one example.
Theories pertaining to climax community.

Unit 5:

Types of ecosystems with one example in detail; Food chain – Detritus and Grazing food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Nitrogen cycle and Carbon cycle.

C2 (P)
PRINCIPLES OF ECOLOGY
PRACTICAL
Credit: 01

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 quadrate method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: phytoplankton and zooplankton; measurement of area, temperature, turbidity/penetration of light, determination of pH, and dissolved oxygen content (Winkler's method), chemical oxygen demand and free CO_2.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

SUGGESTED READINGS

- Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
- Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole.
- Robert Leo Smith Ecology and field biology Harper and Row publisher.
- Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres.

C3 (T)
NON-CHORDATES II: COELOMATES
THEORY
Credit: 03

Unit 1:

Evolution and significance of coelom and metamerism.
General characteristics and evolutionary significance of Onychophora.

Unit 2:

General characteristics of Annelida and Classification up to classes.
Excretion, locomotion and economic importance of Annelida.

Unit 3:

General characteristics of Arthropoda and Classification up to classes.
Vision and Respiration in Arthropoda.
Metamorphosis and parthenogenesis in insects.

Unit 4:

General characteristics of Mollusca and Classification up to classes.
Torsion and detorsion in Gastropoda.
Pearl formation in bivalves.

Unit 5:

General characteristics of Echinodermata and Classification up to classes.
Water-vascular system in Asteroidea.
Larval forms in Echinodermata.

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

C3 (P)
NON-CHORDATES II: COELOMATES
PRACTICAL
Credit: 01

1. Study of following specimens:
   Annelids - *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*
   Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees
   Onychophora - *Peripatus*
   Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus*
   Echinodermates - *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon*
2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm.
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
4. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta**.
5. 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, Holt Saunders International Edition*"

SUGGESTED READINGS

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

C4 (T)
CELL BIOLOGY
THEORY
Credit: 03

Unit 1:

Prokaryotic and Eukaryotic cells; Virus, Mycoplasma and Phages.
Various models of plasma membrane structure.
Transport across membranes – active and passive transport and facilitated transport.
Cell junctions – tight junctions, desmosomes and gap junctions.

Unit 2:

Structure and Functions – endoplasmic reticulum Golgi apparatus and lysosomes.
Transport systems involving endoplasmic reticulum, Golgi apparatus and lysosomes.

Unit 3:

Mitochondria – Structure, semi-autonomous nature, endosymbiotic hypothesis.
Mitochondrial respiratory chain; chemiosmotic hypothesis; Peroxisomes.

Unit 4:

Structure of nucleus – nuclear envelope, nuclear pore complex, nucleolus.
Chromatin – euchromatin and hetrochromatin and packaging (nucleosome).

Unit 5:

Mitosis, meiosis, cell cycle and its regulation.
Structure and functions of microtubules, microfilaments and intermediate filaments.

C4 (P)
CELL BIOLOGY
PRACTICAL
Credit: 01

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:
   a) DNA by Feulgen reaction
   b) DNA and RNA by MGP
   c) Mucopolysaccharides by PAS reaction
   d) Proteins by Mercurobromophenol blue/Fast Green

SUGGESTED READINGS

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

C5 (T)
DIVERSITY OF CHORDATA
THEORY
Credit: 03

Unit 1:

General characteristics and outline classification of chordates.
General characteristics of Hemichordata, Urochordata and Cephalochordata.
Retrogressive metamorphosis in Urochordata.

Unit 2:

Dipleurula concept and the Echinoderm theory of origin of chordates.
Advanced features of vertebrates over Protochordata.
General characteristics of Agnatha and classification of Cyclostomes up to class.

Unit 3:

General characteristics and classification up to order of Chondrichthyes and Osteichthyes.
Migration, Osmoregulation and Parental care in fishes.
General characteristics of Amphibia and classification up to order.
Parental care in Amphibians.

Unit 4:

General characteristics of Reptilia and classification up to order.
Affinities of *Sphenodon*.
Poison apparatus and Biting mechanism in snakes.
Archaeopteryx - a connecting link.
Flight adaptations and Migration in birds.

Unit 5:

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

C5 (P)
DIVERSITY OF CHORDATA
PRACTICAL
Credit: 01

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 slide of *Herdmania* spicules.
2. **Agnatha**: *Petromyzon, 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.
7. **Mammalia:** *Sorex,* Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*. Mount of weberian ossicles of *Mystus*, pecten from Fowl head. Dissection of Fowl head (Dissections and mounts subject to permission).
   Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

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

SUGGESTED READINGS

- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

C6 (T)

ANIMAL PHYSIOLOGY I: CONTROLLING AND COORDINATING SYSTEMS

THEORY

Credit: 03

Unit 1:

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:

Structure of neuron; resting membrane potential; origin of action potential and its propagation across the myelinated and unmyelinated nerve fibres; types of synapse, synaptic transmission and, neuromuscular junction; reflex action and its types, reflex arc.

Unit 3:

Histology of different types of muscle; Ultra structure of skeletal muscle; molecular and chemical basis of muscle contraction; characteristics of muscle twitch; motor unit, summation and tetanus.

Unit 4:

Structure of testis and ovary; physiology of male and female reproduction system.

Hormonal control if testicular function function; endocrine function of testis, young oocyte; mature graffian follicle.

Unit 5:

Endocrine glands in vertebrates; structures of cells and types.

Classification of hormones; mode of hormone action; signal transduction pathways for steroidal and non-steroidal hormones; hypothalamus and pituitary gland – their structures and functions.

C6 (P)

ANIMAL PHYSIOLOGY I: CONTROLLING AND COORDINATING SYSTEMS PRACTICAL

Credit: 01

1. *Recording of simple muscle twitch with electrical stimulation (or Virtual).
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
3. Preparation of temporary mounts: squamous epithelium, striated muscle fibres and nerve cells.
4. Study of permanent slides of mammalian skin, cartilage, bone, spinal cord, nerve cell, pituitary, pancreas, testis, ovary, adrenal, thyroid and parathyroid.
5. Microtomy: preparation of permanent slide of any five mammalian (goat/white rat) tissues.

   (*Subject to UGC guidelines)

SUGGESTED READINGS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

C7 (T)
FUNDAMENTALS OF BIOCHEMISTRY
THEORY
Credit: 03

Unit 1:

Carbohydrate structure and classification; monosaccharides, disaccharides, polysaccharides; glycolysis and gluconeogenesis.

Unit 2:

Lipid classification; Structure, properties and biological significance of tri-acylglycerols, phospholipids, glycolipids and steroids.

Unit 3:

Proteins and Amino acids: structure, classification and general properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids; bonds stabilizing protein structure; levels of organization in proteins; primary, secondary, tertiary and quaternary structures.

Unit 4:

Nucleic Acids: structure of 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 and hyperchromaticity of DNA.

Unit 5:

Enzyme 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.

C7 (P)
FUNDAMENTALS OF BIOCHEMISTRY
PRACTICAL
Credit: 01

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 SDS-PAGE.

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 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.

C8 (T)
COMPARATIVE ANATOMY OF VERTEBRATES
THEORY
Credit: 03

Unit 1:

Integumentary System: structure, functions and derivatives of integument.
Skeletal System – axial and appendicular skeleton of amphibian and reptile.

Unit 2:

Respiratory System: skin, gills, lungs and air sacs; Accessory respiratory organs.

Unit 3:

Digestive System: alimentary canal and associated glands, dentition.

Unit 4:

Circulatory System: general plan of circulation, evolution of heart and aortic arches.
Urinogenital System: succession of kidney; evolution of urinogenital ducts.

Unit 5:

Nervous System: comparative account of brain and spinal cord of mammals and Aves.
Sense Organs: classification of receptors; brief account of visual and auditory receptors in man.

C8 (P)
COMPARATIVE ANATOMY OF VERTEBRATES
PRACTICAL
Credit: 01

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.
4. Mammalian skulls: one herbivorous and one carnivorous animal.
5. Dissection of rat to study arterial and urinogenital system (subject to permission).
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted).
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted).

SUGGESTED READINGS

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

C9 (T)
ANIMAL PHYSIOLOGY II: LIFE SUSTAINING SYSTEMS
THEORY
Credit: 03

Unit 1:

Digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Enzymes in Gastrointestinal tract.

Unit 2:

Mechanism of breathing, transport of oxygen and carbon dioxide in blood; respiratory pigments, dissociation curves and oxyhaemoglobin.

Unit 3:

Structure of kidney and nephron; mechanism of urine formation and osmoregulation; Regulation of water balance

Unit 4:

Composition of blood and its functions; Haemostasis, blood clotting system, Blood groups: Rh factor, ABO and antigenic determinants.

Unit 5:

Structure of mammalian heart; coronary circulation; origin and conduction of cardiac impulses; cardiac cycle; electrocardiogram; blood pressure and its regulation.

C9 (P)
ANIMAL PHYSIOLOGY II: LIFE SUSTAINING SYSTEMS
PRACTICAL
Credit: 01

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 frog's heart beat under *in situ* and perfused conditions.
6. Recording of blood pressure using a sphygmomanometer.
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney.

   (*Subject to UGC guidelines)

SUGGESTED READINGS

- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
- Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.

C10 (T)
BIOCHEMISTRY OF METABOLIC PROCESSES
THEORY
Credit: 03

Unit 1:

Catabolism vs anabolism, stages of catabolism; compartmentalization of metabolic pathways, shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; use of reducing equivalents and cofactors.

Unit 2:

Sequence of reactions and regulation in citric acid cycle, phosphate pentose pathway, glycogenolysis and glycogenesis. Malate-aspartate shuttle, glycerol phosphate shuttle and Cori cycle.

Unit 3:

β-oxidation of saturated fatty acids with even and odd number of carbon atoms; omega - oxidation biosynthesis of palmitic acid; ketogenesis.

Unit 4:

Catabolism of amino acids: transamination, deamination, urea cycle.
Fate of C-skeleton of glucogenic and ketogenic amino acids.

Unit 5:

Redox systems; review of mitochondrial respiratory chain.
Inhibitors and un-couplers of Electron Transport System.

C10 (P)
BIOCHEMISTRY OF METABOLIC PROCESS
PRACTICAL
Credit: 01

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH 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 CO_2 in the TCA cycle.

SUGGESTED READINGS

- Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- 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.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

C11 (T)
MOLECULAR BIOLOGY
THEORY
Credit: 03

Unit 1:

DNA as genetic material; Watson and Crick model of DNA.
Mechanism of DNA replication; semi-conservative, bidirectional and semi-discontinuous replication; RNA priming; replication of telomeres.

Unit 2:

RNA polymerase and transcription Unit; mechanism of transcription in prokaryotes and eukaryotes; synthesis of rRNA and mRNA; transcription factors.

Unit 3:

Genetic code; degeneracy of the genetic code and Wobble Hypothesis; process of protein synthesis in prokaryotes; inhibitors of protein synthesis; difference between prokaryotic and eukaryotic translation.

Unit 4:

Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing; processing of tRNA; pyrimidine dimerization and mismatch repair.

Unit 5:

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, genetic imprinting.

C11 (P)
MOLECULAR BIOLOGY
PRACTICAL
Credit: 01

1. Study of polytene chromosomes from *Chironomous/Drosophila* larvae.
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
3. Estimation of the growth kinetics of *E. coli* by turbidity method.
4. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
5. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (diphenylamine reagent) or spectrophotometer (A260 measurement).
7. Quantitative estimation of RNA using Orcinol reaction.
8. Study and interpretation of electron micrographs/ photograph showing
   a) DNA replication
   b) Transcription
   c) Split genes

SUGGESTED READINGS

- 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.
- Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.
- Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
- Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
- Lewin B. (2008). Gene XI, Jones and Bartlett.
- McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

C12 (T)
PRINCIPLES OF GENETICS
THEORY
Credit: 03

Unit 1:

Principles of Mendelian inheritance; incomplete dominance and co-dominance; multiple alleles, lethal alleles, epistasis, pleiotropy, sex-linked, sex-influenced and sex-limited characters inheritance.

Unit 2:

Linkage and crossing over; cytological basis of crossing over; molecular mechanisms of crossing over; recombination frequency as a measure of linkage intensity; somatic cell hybridization.

Unit 3:

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.

Unit 4:

Sex chromosomes; mechanisms of sex determination in *Drosophila*, Sex-linked chromosomal abnormalities; polygenic inheritance; criteria for extra-chromosomal inheritance; mitochondrial mutations in *Saccharomyces*.

Unit 5:

Conjugation, transformation, transduction; bacteria and bacteriophage; transposable elements; transposons in bacteria; P elements in *Drosophila*.

C12 (P)
PRINCIPLES OF GENETICS
PRACTICAL
Credit: 01

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

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition. Benjamin Cummings.
- 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.
- Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

C13 (T)
DEVELOPMENTAL BIOLOGY
THEORY
Credit: 03

Unit 1:

Historical perspective and basic concepts: phases of development, cell-cell interaction, Pattern formation, differentiation and growth, cytoplasmic determinants and asymmetric cell division.

Unit 2:

Spermatogenesis, oogenesis; types of eggs, egg membranes; fertilization (External and Internal); planes and patterns of cleavage; fate maps (including Techniques); early development of frog and chick up to gastrulation.

Unit 3:

Fate of germ layers; extra-embryonic membranes in birds; implantation of embryo in humans, placenta (structure, types and functions of placenta).

Unit 4:

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:

Teratogenesis: teratogenic agents and their effects on embryonic development; *In vitro* fertilization, stem cell (ESC), amniocentesis.

C13 (P)
DEVELOPMENTAL BIOLOGY
PRACTICAL
Credit: 01

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 (photomicropgraph/ slides).
5. Project report on *Drosophila* culture/chick embryo development

SUGGESTED READINGS

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

C14 (T)
EVOLUTIONARY BIOLOGY
THEORY
Credit: 03

Unit 1:

Origin of life; Lamarckism, Neo Lamarckism, Darwinism, Neo-Darwinism; Germplasm and mutation theory of organic evolution.

Unit 2:

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.

Unit 3:

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); evolutionary forces upsetting H-W equilibrium; concept of fitness, selection coefficient, genetic load, types of selection, sexual selection. genetic drift - founder's effect, bottleneck phenomenon.

Unit 4:

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 5:

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.

C14 (P)
EVOLUTIONARY BIOLOGY
PRACTICAL
Credit: 01

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.

SUGGESTED READINGS

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

C15 (T)
ANIMAL BEHAVIOUR AND CHRONOBIOLOGY
THEORY
Credit: 03

Unit 1:

Origin and history of ethology; brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour.
Methods and recording of a behaviour.

Unit 2:

Stereotyped behaviours (Orientation, Reflexes); individual behavioural patterns; instinct vs. learnt behaviour; associative learning, classical and operant conditioning, habituation, imprinting.

Unit 3:

Social Behaviour: concept of society; communication and the senses; altruism; 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:

Historical developments in chronobiology; biological oscillation: the concept of Average, amplitude, phase and period; adaptive significance of biological clocks.

Unit 5:

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; seasonal reproduction of vertebrates.
Relevance of biological clocks; chronopharmacology, chronomedicine, chronotherapy.

C15 (P)
ANIMAL BEHAVIOUR AND CHRONOBIOLOGY
PRACTICAL
Credit: 01

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 conditions.
3. To study geotaxis behaviour in earthworm.
4. To study the phototaxis behaviour in insect larvae.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.
6. Study and actogram construction of locomotor activity of suitable animal models.
7. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

SUGGESTED READINGS

- David McFarland, Animal Behaviour, Pitman Publishing Limited, London, UK.
- Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.
- John Alcock, Animal Behaviour, Sinauer Associate Inc., USA.
- Paul W. Sherman and John Alcock, Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
- Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
- Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barens and Noble Inc. New York, USA
- Biological Rhythms: Vinod Kumar (2002) Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

C16 (T)
GENETICS & CYTOGENETICS
THEORY
Credit: 03

Unit 1:
C-value and C- value paradox Unique and repetitive sequences in eukaryotic genome Transformation, transduction and conjugation Transposable elements in prokaryotes and eukaryotes DNA repair mechanisms Over lapping genes and pseudo genes

Unit 2:
Role of Y chromosome in sex determination Sex linked, sex limited and sex influenced inheritance Inborn errors of metabolism Polygenic and multifactorial inheritance Human genome project Functional genomics and Reverse genetics

Unit 3:
Chromatin structure, Histones, DNA, nucleosome morphology and higher-level organization. Functional states of chromatin. Metaphase chromosomes, centromere, and kinetochore. Telomere and its maintenance. Holocentric chromosomes, heterochromatin and euchromatin. Giant chromosomes like polytene and lampbrush chromosomes.

Unit 4:
Extra chromosomal inheritance. Inheritance of mitochondrial and chloroplast genes, mechanism of maternal inheritance, Role of Mitochondrial inheritance in evolution.

Unit 5:
Chromosomal anomalies. Structural and numerical alterations of chromosomes, Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

C16 (P)
GENETICS & CYTOGENETICS
PRACTICAL
Credit: 01

1. Study of permanent histological slides of testis and ovaries of insects/ mice/rat.
2. Study of permanent histological slides of Liver and kidney of insects/ mice/rat
3. Double staining techniques for histological study.
4. Study of sex chromatin in human buccal cavity cells.
5. Techniques in the study of chromosomes and their applications: short term (lymphocyte) and long term (fibroblast) cultures, chromosome preparations, karyotyping, chromosome labeling, in situ hybridization, chromosome painting.
6. Study banding pattern of chromosome.

SUGGESTED READINGS

- Pollard T.D, Earnshaw W.C, (2002); Cell Biology; Saunders, an imprint of Elsevier Science, New York.
- Gupta/Jangir (2002); Cell biology, Fundamentals and Applications, Published by Agrobios (India) Jodhpur.
- Chhazillani V.K (2008); Cell Biology; mangala Publications, Delhi.
- Benjamin Lewin (2008) Genes IX.
- Jones and Bartlett Publishers Griffiths AJF, Wessler SR, Carroll SB and Doebley J (2012) Introduction to Genetic Analysis. WH Freeman and Company
- Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick (2012) Lewin's GENES XI

C17 (T)
IMMUNOLOGY
THEORY
Credit: 03

Unit 1:
Historical perspective of immunology; early theories of immunology; cells, molecules and organs of the immune system, Anatomical barriers, inflammation, 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:
Cells and organs of acquired immunity, Innate and acquired immunity, Humoral and cell mediated immune response, Antigen–Antigenicity and immunogenicity, factors affecting immunogenicity, Epitopes and Haptens.

Unit 3:
Antibody- basic molecular structure, classes and functions, Major Histocompatibility complex (MHC)- in mouse and Human, MHC genes arrangement, MHC class I and II molecules- structure and functional significance, T-cell and B-cell generation, activation, differentiation and proliferation.

Unit 4:
Cytokines and interferons- various types of cytokines and interferons, Cytokine receptors and signaling, Complement system- characteristic features, Classical pathway and alternative pathways of Complement system.

Unit 5:
Hypersensitivity-types and features of immediate and delayed hypersensitivity reactions.
Autoimmune- Mechanisms for induction of Autoimmunity; Treatment of Autoimmune diseases. Immunodeficiency. Vaccine types and vaccine development.

C17 (P)
IMMUNOLOGY
PRACTICAL
Credit: 01

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs.
3. Preparation of stained blood film to study various types of blood cells.
4. Ouchterlony's double immuno-diffusion method.
5. ABO blood group determination.
6. Study of WBC in blood smears from mouse/Human.
7. Study of RBC in blood smears from mouse/Human
8. *Cell counting and viability test from splenocytes of farm bred animals/cell lines.

* The experiments can be performed depending upon usage of animals in UG courses.

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 Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication.

C18 (T)
PARASITOLOGY
THEORY
Credit: 03

Unit 1:
Basic principles and concepts of parasitism; Symbiotic associations, Evolution of parasitism. Types of parasites and hosts. Parasitic transmission, Host-parasite interactions. Molecular, cellular and physiological basis of host-parasite interactions. Alteration of host behaviour by parasites. Zoonosis with reference to filariasis and schistosomiasis.

Unit 2:
Distribution, habit and habitat, structure, life cycle and diseases caused by *Plasmodium* sp., Problems and strategies in development of vaccination for malaria, Morphology and life cycle of insect vectors involved in Leishmaniasis and Trypanosomiasis.

Unit 3:
General morphology, life cycle and diseases caused by parasites (*Entamoeba histolytica*, *Giardia* sp., *Trichomonas* sp. *Toxoplasma gondii*), Soil amoebae involved in newly emerging infections of humans (*Naegleria fowleri*, *Cryptosporidium parvum*, *Pneumocystis* spp.).

Unit 4:
Monogenetic trematodes (*Polystoma integerrimum*); digenetic trematodes (*Fasciola* spp, *Schistosoma* spp, *Paragonimus* spp, *Clonorchis* spp), Cestodes (*Diphyllobothrium latum*, *Taenia* spp, *Hymenolepis nana*, *Echinococcus granulosus*), Nematodes (*Trichuris* spp, *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Dracunculus* spp), Filarial worms.

Unit 5:
Fish and poultry parasites and its impact on human society, Vectors and its importance in transmission of parasites, Antigen antibody reaction and its role in clinical parasitology, Molecular techniques in parasitology: (Isolation of DNA and RNA, Hybridisation, ELISA, Blotting techniques, DNA sequencing, Amplification of DNA by polymerase chain reaction)

C18 (P)
PARASITOLOGY
PRACTICAL
Credit: 01

1. Preparation of thin, and thick blood smears for detection of blood parasites.
2. Study of parasitic infections with special reference to locally available fish/amphibians/mammal hosts.
3. Study of enteric and paenteric protozoans in earthworms/fish/frogs.
4. Study of parasites of medico-veterinary importance from permanent preparations.
5. Submission of prepared Slides.
6. Identification of permanent slides

SUGGESTED READINGS

- Chandler, A.C. & Read, C.P. Introduction to Parasitology (10th ed.), John Wiley & Sons Inc.
- Cheng, T.C. General Parasitology, Academic Press, Inc. (1986).
- Faust, E.C., Beaver, P.C., & Jung, R.C. Animal Agents and Vectors of Human Diseases (4th ed.), Lea & Febiger.
- Manual of Veterinary Parasitological Techniques (1997), Technical Bulletin No. 18, HMSO, London.

C19 (T)
RESEARCH METHODOLOGY
THEORY
Credit: 04

Unit 1:

Research Methodology **(15 Lectures)**

Objectives and motivations in research; Characteristics and limitations of research; Components of research work; Criteria of good research, Research process; Types of Research; Fundamental, Pure or Theoretical Research, Applied Research, Descriptive Research, Evaluation Research, Experimental Research, Survey Research, Qualitative Research, Quantitative Research.

Unit 2:

Research Design Formulation **(15 Lectures)**

Research Design – definition – essentials and types of research design – errors and types of errors in research design. Research problem: Selecting and analyzing the research problem – problem statement formulation – formulation of hypothesis. Variables in Research – Measurement and scaling, Different scales, Construction of instrument, Validity and Reliability of instrument.

Unit 3:

Research Publication Ethics **(15 Lectures)**

Publication Ethics: Definition, Introduction and Importance, Conflicts of Interest, Best practices/standards initiatives, and guidelines: COPE, EAME, etc. Plagiarism, Self-Plagiarism, Software for detection of Plagiarism. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice-versa, types, complaints and appeals.

Unit 4:

Code of Ethics in Research **(15 Lectures)**

Ethical issues in research: Code of Ethics in Research, Violation of publication ethics, authorship and contributorship, Intellectual Property Rights, Ethics related to Participants and Researchers: Copyright; Royality, Patent Law, Citation, Acknowledgment. Predatory publishers and journals

C20 (T)
BASICS IN ENTOMOLOGY
THEORY
Credit: 03

Unit 1: **10 hours**

Origin and evolution of insects; phylogeny; pterygotes and apterygotes; theories on the evolution of wings; insect classification upto orders; insect life history patterns; metamorphosis types; voltinity.

Unit 2: **12 hours**

Insect-plant interactions - phytophagy, entomophagy, entomophilly, symbiosis, dissemination of pathogens; insect pests of crops – cabbage (*Plutella xylostella* cabbage moth), rice (*Scirpophaga incertulas* yellow stem borer/rice yellow stem borer).

Unit 3: **10 hours**

Insects as vectors of diseases – malaria, kala azar, typhus, dengue; IPM – history, principles and tenets, pesticide resistance and secondary pest outbreaks; tools/approaches.

Unit 4: **13 hours**

Social, beneficial and harmful insects with representative examples – ants, honeybees, lac insect, termites; nest architecture; introduction to aquatic insects; apiculture and sericulture techniques.

C20 (P)
BASICS IN ENTOMOLOGY
PRACTICAL
Credit: 01

1. Morphological study of some representative insect orders
2. Study of larva and pupa of some representative insect orders
3. Morphology of various castes of some social insects
4. Study of the nest architecture of some social insects
5. Food preference of *Tribolium* species
6. Study of permanent slides of some ectoparasites
7. To determine the LC_{50} of any contact insecticide
8. Collection, preservation, and display of insect specimens.

SUGGESTED READINGS

- Blum M.S. (1985). Fundamental of Insect Physiology, John Wiley and Sons.
- Gullan P.J. and Cranston P.S. (2010). The Insects: An Outline of Entomology. Wiley-Blackwell.
- Kerkut G.A. and Gilbert L.I. (1985). Comprehensive Insect Physiology, Biochemistry and Pharmacology, Vols. 1-12. Edn. Pergamon Press, Oxford.
- Ramakrisnan, T.V. (1984). Handbook of Economic Entomology of South India, International Books and Periodicals Service, India.

C21 (T)
MEDICAL MICROBIOLOGY
THEORY
Credit: 03

Unit 1: **10 hours**

Principles of classification of microbes. A brief introduction to major group of bacteria. Ultra structure of bacteria. Microbial Cultivation, Growth curve and factors influencing growth.

Unit 2: **10 hours**

Disinfection and sterilization techniques. Staining characteristics and techniques. Serological characteristics. Bacterial respiration.

Unit 3: **12 hours**

Antibiotics and their Mechanism of action. Molecular principles of drug targeting. Bacterial resistance to antibiotics. New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine clinical trials.

Unit 4: **13 hours**

Diseases caused by gram negative bacteria of family Enterobacteriaceae, sexually transmitted diseases, Overview of medical parasitology.

SUGGESTED READINGS

- Mackie & McCartney Practical Medical Microbiology 14th edition: Eds: J.G. Colle, A.G. Fraser, B.P. Marmion, A.Simmons- Reprint 2008 Elsevier, New Delhi.
- Koneman's Color Altas and Textbook of Diagnostic Microbiology 6th edn: Eds: Washington winn and others. 2006 Lippincott Williams and Wilkins, Baltimore, USA
- Ananthanarayan and Paniker's Textbook of Microbiology 8th edn. 2009 Universities Press, Hyderabad.
- Ananthanarayan & Paniker's Textbook of Microbiology, 8th Ed., Orient Longsman, India; 2009.

C21 (P)
MEDICAL MICROBIOLOGY
PRACTICAL
Credit: 01

1. Preparation of culture media: Nutrient Agar
2. Sterilization techniques
3. Serial dilution techniques
4. Streaking techniques
5. Preparation of broth and culture plate for microbial growth
6. Isolation of pure culture of bacteria
7. Identification of microbes.
8. Gram staining techniques
9. Catalase and indole test.
10. Temperature and salt tolerance test

SUGGESTED READINGS

- Apurba S, Bhat S. (2023): Essentials of Medical Microbiology: Jaypee Brothers Medical Publishers (P) Ltd.
- Patricia M. (2021) Bailey & Scott's Diagnostic Microbiology, Elsevier.
- Joanne M. Willey, Joanne Willey, Kathleen M. Sandman, Dorothy H. Wood (2002). Prescott's Microbiology, 12th Ed. Mcgraw and Hill.
- Geo F Brooks, Karen C Carroll, Janet S Butel, Stephen A Morse. (2008). Jawetz, Melnick & Adelberg's Medical Microbiology. 24th Ed. McGraw Hill, New York.

C22 (T)
BIOSTATISTICS & BIOINFORMATICS
THEORY
Credit: 03

Unit 1: **10 hours**

Definition and relevance of Biostatistics in biological research. Descriptive Statistics: Meaning, Objectives, Organization of data, Population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution, tabulation, bar diagram, histograms, pie diagram, Measures of Central Tendency: Arithmetic Mean, median, mode, Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis.

Unit 2: **12 hours**

Inferential Statistics: Hypothesis testing, Errors in Hypothesis Testing- Null Hypothesis, Alternative Hypothesis, Type I and Type II errors, Confidence Limits. Setting up of level of significance. One tailed and Two- tailed tests. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability

Unit 3: **10 hours**

Correlation and Regression: Correlation coefficient (r), properties, interpretation of r, partial and multiple correlations, linear regression: Fitting of lines of regression, regression coefficient, Bivariate and Multiple Regression. Parametric and Non-Parametric Statistics: Definition, Advantages, Disadvantages, Assumptions Parametric Tests: Student's t-test, One Way Analysis of Variance, Two Way Analysis of Variance Non-Parametric Tests: Chi square test

Unit 4: **13 hours**

Definition and scope of Computational Biology and Bioinformatics, National Centre for Biotechnology Information (NCBI), Basic Local Alignment Search Tool (BLAST), Flavors of BLAST (BlastP, BlastN, BlastX, tBlastN), Different file formats, Bioinformatics in India-current status and future implications.

C22 (P)
BIOSTATISTICS & BIOINFORMATICS
PRACTICAL
Credit: 01

1. Central tendencies
2. Chi square test
3. T-test analysis
4. P value analysis
5. Analysis of variance test
6. Basic bioinformatics tools
7. BLAST
8. FASTA

SUGGESTED READINGS

- Jensen, J.R. (2000). Remote sensing of the environment: An earth resource perspective. Prentice Hall, Upper Saddle River, NJ.
- Joseph, G. (2003). Fundamentals of Remote Sensing. University Press (India) Pvt. Ltd, Orient Longman Pte. Ltd., Hyderabad, India.
- Mount, D. (Second Edition). Bioinformatics: Sequence and Genome Analysis.
- Zar, J. H. (2008). Biostatistical analysis. 5th edition. Pearson Education Inc. and Dorling Kindersley Publishing Inc.

C23 (T)
TOOLS AND TECHNIQUES
THEORY
Credit: 03

Unit 1: **11 hours**

Introduction, types, simple and compound microscope, bright field microscope, stereoscopic zoom microscope, fluorescence microscope and confocal microscope. Scanning Electron Microscope (SEM) and Transmission Electron Microscope (TEM). Significance of microscopy in research.

Unit 2: **12 hours**

Basic Lab. Instruments (laminar air flow, incubator, oven, autoclave, centrifuge). Colorimetry, spectrophotometry, atomic absorption spectrophotometry (AAS). Tissue processing and fixation. Cell staining techniques.

Unit 3: **10 hours**

Introduction, definition and application of chromatography, Types of chromatography (paper chromatography, thin layer chromatography (TLC), high performance liquid chromatography (HPLC), Gas chromatography (GC), gas chromatography mass spectroscopy (GCMS).

Unit 4: **12 hours**

Electrophoresis and its types. Blotting techniques. Polymerase Chain Reactions (PCR) and its application. Enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) and its application.

C23 (P)
TOOLS AND TECHNIQUES
PRACTICAL
Credit: 01

1. Application and working principle of analytical instruments:
    i. Colorimeter
    ii. Spectrophotometer
    iii. Ultracentrifuge
    iv. Polymerase Chain Reaction (PCR)
    v. Microtomy
    vi. Compound Microscope
    vii. Electrophoresis
    viii. High Performance Liquid Chromatography
    ix. ELISA techniques
    x. Autoclave
2. DNA isolation techniques
3. DNA quantification techniques
4. Estimation of Gene and Genotypic frequencies in light of Hardy Weinberg's law based on facial traits.

SUGGESTED READINGS

- Wilson & Walker (2018). Principles and Techniques in biochemistry and molecular biology. Edited by Andreas Hofmann and Samuel Clockie.
- Freshney I. A (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.
- Sharma V.K. (1991). Techniques in microscopy and cell Virology, Tata-Mc Craw Hill.
- Basant Kumar & Rinesh Kumar (2008). Principles of animal cell culture, Int. Bork XXII edn.