DAVUNIVERSITY JALANDHAR

Course Scheme & Syllabus

For

M.Sc. (HONS)ZOOLOGY

(Program ID-37)

1st TO 4th SEMESTER

Examinations 2015–2016 Session Onwards

Syllabi Applicable For Admissions in 2015

DAV UNIVERSITY, JALANDHAR

SCHEME OF COURSES

M.Sc. (HONS)Zoology

Semester 1

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	ZOO521	Core	Animal Physiology- I (Life sustaining systems)	3	1	0	4
2	ZOO522	Core	Animal Physiology – I (Life sustaining systems) Laboratory	0	0	3	2
3	BYT513	Core	Cell Biology	4	0	0	4
4	BTY514	Core	Cell Biology Laboratory	0	0	3	2
5	MIC631	Core	Immunology	4	0	0	4
6	MIC632	Core	Immunology Laboratory	0	0	3	2
7	BCH524	Core	Principles of Biochemistry	4	0	0	4
8	BCH525	Core	Principles of Biochemistry Laboratory	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

DAV UNIVERSITY, JALANDHAR

Scheme ofCourses M.Sc.

M.Sc. (HONS)Zoology

Semester 2

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	ZOO523	Core	Animal Physiology- II (Controlling and Coordinating Systems)	3	1	0	4
2	ZOO524	Core	Animal Physiology- II (Controlling and Coordinating Systems) Laboratory	0	0	3	2
3	ZOO525	Core	Advanced Techniques in Zoology	4	0	0	4
4	ZOO526	Core	Advanced Techniques in Zoology Laboratory	0	0	3	2
5	ZOO527	Core	Systematics, Biodiversity and Evolution	3	1	0	4
6	ZOO528	Core	Developmental Biology	4	0	0	4
7	ZOO529	Core	Developmental Biology Laboratory	0	0	3	2
8	Open Elective Course I						4

L: Lectures T: Tutorial P: Practical Cr: Credits

Scheme ofCourses M.Sc.

M.Sc. (HONS)Zoology

Semester 3

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	BTY511	Core	Molecular Biology	4	0	0	4
2	BTY512	Core	Molecular Biology Laboratory	0	0	3	2
3	BOT621	Core	Research Methodology	3	1	0	4
4	ZOO623	Core	Project –I*	2	0	0	2
5	Open Elective Course II						4
6	Departmental Elective I						6
Departmental Elective I(Choose any one theory)							
1	ZOO624	Elective	Animal Behaviour and Chronobiology	4	0	0	4
	ZOO625	Elective	Animal Behaviour and Chronobiology Laboratory	0	0	3	2
2	ZOO626	Elective	Ecology and Wild Life Conservation	4	0	0	4
	ZOO627	Elective	Ecology and Wild Life Conservation Laboratory	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

- **Project I refers to the synopsis of the project to be undertaken in the following semester.**

Scheme ofCourses M.Sc.

M.Sc. (HONS)Zoology

Semester 4

S.No	Paper Code	Course Type	Course Title	L	T	P	Cr
1	ZOO628	Core	Animal Biotechnology	4	0	0	4
2	ZOO629	Core	Animal Biotechnology Laboratory	0	0	3	2
3	ZOO630	Core	Economic Zoology	4	0	0	4
3	ZOO631	Core	Project II				8
4	Departmental Elective II						6
Departmental Elective II (Choose any one theory course and the related laboratory course)							
I	ZOO632	Elective	Parasitology	3	1	0	4
	ZOO633	Elective	Parasitology Laboratory	0	0	3	2
II	ZOO634	Elective	Neuroscience and Neuroendocrinology	3	1	0	4
	ZOO635	Elective	Neuroscience and Neuroendocrinology Laboratory	0	0	3	2
III	ZOO636	Elective	Aquaculture and Fisheries	3	1	0	4
	ZOO637	Elective	Aquaculture and Fisheries Laboratory	0	0	3	2
IV	ZOO638	Elective	Entomology	3	1	0	4
	ZOO639	Elective	Entomology Laboratory	0	0	3	2
V	ZOO640	Elective	Population Genetics	3	1	0	4
	ZOO641	Elective	Population Genetics Laboratory	0	0	3	2

L: Lectures T: Tutorial P: Practical Cr: Credits

Syllabus

SEMESTER 1

Course Title: Animal Physiology –I (Life sustaining systems)

L	T	P	Credits	Marks
3	1	0	4	100

Course Code: ZOO521

Course Objective: The students will learn physiological aspects of body processes at system, organ, tissue and cellular level as well as their regulation.

Unit A 12 hours

Nutrition and Digestion:

- Ingestion of soluble food and particulate food in relation to habitat and habits, Symbiotic nutrition, Mechanism of digestion and regulation of secretion in non-chordates and chordates.
- Histology and functions of gastrointestinal tract and its associated glands; Mechanical and chemical digestion of food; Role of gastrointestinal hormones; Control and action of GI Tract secretions; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; the structure of the absorptive surface. Assimilation of food, Disorders.
- Chemistry, Sources, functions and deficiency diseases of vitamins and micro- and macro- nutrients**,** Metabolism during fasting and starvation, Energy balance and heat balance in animals, BMR.

Unit B 15 hours

Transport and Circulatory Mechanisms:

- Intracellular transport in Protozoa. Circulation of external medium of transport within the body of sponges and cnidarians. Open and closed types of circulatory system. Chambered, tubular and ampullary hearts, neurogenic and myogenic heart, Evolution of Heart and Cardiovascular system
- Blood corpuscles, Haemopoiesis and formed elements, plasma function, blood groups and types, haemoglobin, immunity, coagulation of blood and haemostasis.
- Physiological anatomy of mammalian heart, Coronary circulation; myogenic and neurogenic heart, cardiac musculature and specialized tissue, Origin and conduction of cardiac impulse; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart, Autonomic control and chemical regulation of heart rate, Blood pressure and its regulation, ECG – its principle and significance.

Unit C 15 hours

Excretion and Osmoregulation:

- Osmoconformers and osmoregulators, hyperosmotic, hyposmotic and isosmotic mediums, Excretion and metabolic waste products – an

introduction. Excretory structures and waste disposal in non-chordates, coelom, coelomic ducts, nephridia, antennal / green glands, malpighian tubules.

- Osmoregulation in non-chordates, adaptation to different environments / habitats. Development and adult structural organization of chordate kidney: nephron, the functional unit.
- Physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
- **Thermoregulation** –Adaptations to temperature extremes, torpor, Aestivation and hibernation, counter-current heat exchangers, body temperature – physical, chemical, neural regulation.

Unit D 18 hours

Respiratory system:

- Respiratory organs in aquatic animals and aquatic respiration, Respiratory organs and aerial mode of respiration, Distribution and brief chemistry of respiratory pigments and their function in nonchordates and chordates.
- Anatomical considerations, Pulmonary ventilation; Respiratory volumes and capacities, exchange and transport of gases, exchange of gases, oxygen-haemoglobin dissociation curve, waste elimination, neural and chemical regulation of respiration. Circulatory and respiratory response to extreme conditions, Regulation of body pH.

Reference books:

1. Barrington, E.U.W. *Invertebrates Structure and Functions.* Boston: Houghton Mifflin Co., 1967.
2. Cooper, G.M. and Hausman, E. *The Cell: A Molecular Approach.* Sinauer Associates, 2013.
3. Hall, J.E. *Guyton and Hall Text Book of Medical Physiology*, XIIIth edition, Saunders Company, 2015.
4. Hoar, W.S., General and comparative physiology, Adaptation and Environment, 3rd ed., Cambridge University Press, 1983.
5. Tortora, G.J. and Grabowski, S. *Principles of Anatomy & Physiology.* XI Edition John Wiley & sons, 2006.
6. Victor P. Eroschenko. diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins, 2008.

L	T	P	Credits	Marks
0	0	3	2	50

Course Title: Animal Physiology- I (Life sustaining systems) Laboratory

Course Code: ZOO522

1. Demonstration of activity of digestive enzymes (Amylase, Protease, Lipase).
2. Determination of ABO Blood group
3. Enumeration of red blood cells and white blood cells using haemocytometer
4. Estimation of haemoglobin using Sahli's haemoglobinometer
5. Preparation of haemin and haemochromogen crystals
6. Recording of frog's heart beat under *in situ* and perfused conditions
7. Recording of blood pressure using a sphygmomanometer
8. To study the effect of exercise on cardiovascular and respiratory system.
9. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney
10. Study of mouth parts of: honey bee, housefly, cockroach, butterfly, mosquito, and bug; Salivary glands; Blood of animals; - Radula of Pila and jaws of Leech
11. Study of gut anatomy in relation to food and feeding habits of detritivores, carnivores, herbivores, omnivores and sanguivores.
12. Study of different kinds of Heart and blood vascular system in animals.
13. Study of respiratory structures: Gills (Crustaceans, Bivalves, Cephalopods, and Fish) Book Lungs (Scorpion); Trachea and spiracles (Cockroach).
14. Study of Nephridia in annelids (earthworm), green glands in crustaceans, Malpighian tubules in Cockroach; Excretory system of frog, lizard, bird and rat.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Cell Biology

Course Code: BTY513

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The object of the present course is to develop basic knowledge in cell biology to understand the structure and function of the cellular and sub cellular components of cells and tissues with the help of recent techniques. The course will help students to get an understanding of cell function at the molecular level including the fundamentals of biology. They will become aware of the complexity and harmony of the cell.

1. History of cell biology: Development of cell theory Diversity of cell size and shape: General organization and diversity of prokaryotic and eukaryotic cells. Origin of cells: Assembly of macromolecules (proteins and nucleic acid), mechanism of assembly, evolutionary steps in the origin of cells (Chemical evolution). **9 hours**
2. Microscopic techniques for study of cells: Bright field, Fluorescence, Phase contrast, DIC, dark field, Polarization, Confocal. Electron Microscopy: TEM, SEM, AFM, STEM, Preparation of samples for EM. Applications of Light Microscopy and EM in cell biology. **6 hours**
3. Sub cellular fractionation: Fractionation and marker enzymes and functional integrity, FACS, separation techniques for membrane proteins. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility). **6 hours**

4. Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. **5 hours**
5. Cell Trafficking : Targeting proteins to endoplasmic reticulum, signal recognition parcticle, signal recognition particle receptor, protein folding and processing in ER protein export from ER; Protein sorting and export from Golgi Apparatus; SNARE

hypothesis; Protein import into Mitochondria, mitochondrial genome; Import and sorting of chloroplast protein. Cellular energy transactions: Role of mitochondria and chloroplasts. **8 hours**

6. Cell division and Cell cycle & its regulation: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Molecular events and model systems; the role of the cyclins and cyclin-dependent kinases, cell cycle checkpoints, methods for synchronizing the cell cycle in cell populations.**3 hours**
7. Cellular responses to environmental signals in plants and animals: Mechanism of signal transduction. Cell signaling - Modes of cell signaling, steroid hormone receptors, plant hormones, G-protein coupled receptors; regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing, c- AMP pathway of signal transduction ; c GMP, phospholipids and calcium ions, Ras, Raf , MAP kinase pathway , JAK –STAT pathway , Apoptosis –role of caspases.**4 hours**
8. Cell motility: Cilia, flagella of eukaryotes and prokaryotes, their molecular mechanism. 4 **hours**

Books:

1. Cell biology: A laboratory handbook Vol 1, 2, 3 (2006) by Celis. J.E. (Academic Press, UK).
2. Stryer, L. (1995). Biochemistry, 4th edition, W.H. Freeman and Co., New York.
3. Nelson, D.L. and Cox, M.M. (2000). Lehninger Principles of Biochemistry, 3rd ed., Worth Publishers, New York.
4. Damal, J., Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Scientific American Books, New York.

Course Title: Cell Biology-LAB

Course Code: BTY514

L	T	P	Credits	Marks
0	0	3	2	50

- Microscopy: Bright field.
- Instrumental methods for cell biology-centrifugation, chromatography.
- Preparation of permanent slides of cell division.
- Vital staining for visualizing cell organelles.

Course Title: Immunology
Course Code: MIC631

L	T	P	Credit	Marks
4	0	0	4	100

Unit A:
History of immunology.
Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory
Structure, Functions and origin of Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell and Immune Organs like Bone marrow, Thymus, Lymph Node, Spleen.
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes, Adjuvants, Structure, Types and Functions of antibodies.
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA.

Unit B:
Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors.
Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR).
Markers of suppressor / regulatory T cells - CD4+ CD25+

Unit C:
Genetic organization: Organization of the genes for B and T cell receptors.
Genetic organization of MHC-I and MHC-II complex, Peptide loading and expression of MHC-I and MHC-II molecules.
Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors.
Hybridoma technology and monoclonal antibodies.
Complement system. Classical, lectin and alternative pathway for complement activation.

Unit D:
Major cytokines and their role in immune system: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, IL-10, IL-12, IL-17, TGFβ.
Tolerance and autoimmunity and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases.
Hypersensitivity and allergy. Comparative study of Type I-V hypersensitivities with examples.

Course Title: Immunology Laboratory

Course Code: MIC632

L	T	P	Credit	Marks
0	0	3	2	50

1. Identification of human blood groups.
2. To separate serum from the blood sample (demonstration).
3. To perform Total Leukocyte Count of the given blood sample.
4. To perform Differential Leukocyte Count of the given blood sample.
5. To perform immunodiffusion by Ouchterlony method.
6. Agglutination of bacteria
7. Separation of IgG by ammonium sulfate precipitation of blood serum.
8. Reduction of IgG with mercaptoethanol to four chain.
9. SDS-PAGE electrophoresis of immunologic effector proteins.
10. Papain digestion of IgG
11. Pepsin digestion of IgG
12. Immunoelectrophoresis
13. Western Blotting
14. ELISA

Course Title: Principles of Biochemistry
Paper Code: BCH 524

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course is intended for master's course students. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

Unit A (15 hours)

Introduction to Biochemistry

Water as a biological solvent. Weak acids and bases. pH and buffers. Henderson-Hasselbalch equation. Physiological buffers. Fitness of the aqueous environment for living organisms.

Carbohydrates

Structure of monosaccharides. Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides. Glycoproteins.

Proteins

Introduction to proteins. Classification based on solubility, shape, composition and functions. Amino acids: common structural features, stereoisomerism and RS system of designating optical isomers. Classification and structures of standard amino acids as zwitterion in aqueous solutions. Physical and chemical properties of amino acids. Titration of amino acids. Separation of amino acids. Essential amino acids.

Structure of peptide bond. Solid-phase synthesis of peptides. Peptide sequencing. Chemical and enzymatic cleavage of polypeptide chains and separation of peptides. Levels of structure in protein architecture. denaturation and renaturation of proteins. Behaviour of proteins in solutions. Salting in and salting out of proteins. Structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (haemoglobin, myoglobin), lipoproteins, metalloproteins, glycoproteins and nucleoproteins.

Unit B (15 hours)

Nucleic Acids

Nature of genetic material. Evidence that DNA is the genetic material. Composition of DNA and RNA. Generalized structural plan and Nomenclature of nucleic acids. DNA double helix. Structure and roles of different types of RNA. Size of DNA in prokaryotes and eukaryotes. Central dogma of molecular biology. Concepts of gene, genome and chromosome.

Porphyrins

Porphyrin nucleus and classification of porphyrins. Important metalloporphyrins occurring in nature. Detection of porphyrins. Bile pigments – chemical nature and physiological significance.

Lipids

Definition and classification of lipids. Fatty acids: introduction, classification, nomenclature, structure and properties of saturated and unsaturated fatty acids. Essential fatty acids, prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats – hydrolysis, saponification value, rancidity of fats, Reichert-Meissel Number and reaction of glycerol. Biological significance of fats. Glycerophospholipids (lecithins, lysolecithins, cephalins, phosphatidylserine, phosphatidylinositol, plasmalogens), sphingomyelins, glycolipids – cerebrosides, gangliosides. Properties and functions of phospholipids, isoprenoids and sterols.

Unit C (15 hours)

Introduction to Metabolism

General features of metabolism, experimental approaches to study metabolism – intact organisms, bacterial mutants, tissue slices, radioisotopes.

Carbohydrate Metabolism

Reactions and energetics of glycolysis. Alcoholic and lactic acid fermentations. Reactions and energetics of TCA cycle. Gluconeogenesis, glycogenesis and glycogenolysis. Reactions and physiological significance of pentose phosphate pathway. Regulation of glycolysis and TCA cycle. Photosynthesis – a brief review.

Electron Transport Chain and Oxidative Phosphorylation

Structure of mitochondria. Sequence of electron carriers. Sites of ATP production. Inhibitors of electron transport chain. Chemiosmotic hypothesis. Inhibitors and uncouplers of oxidative phosphorylation. Transport of reducing potentials into mitochondria.

Unit D (15 hours)

Lipid Metabolism

Introduction. Hydrolysis of triacylglycerols. Transport of fatty acids into mitochondria. β-oxidation of saturated fatty acids. ATP yield from fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of ketone bodies. Oxidation of unsaturated and odd chain fatty acids. Biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism.

Amino Acid Metabolism

General reactions of amino acid metabolism – transamination, oxidative deamination and decarboxylation. Urea cycle. Degradation and biosynthesis of amino acids. Glycogenic and ketogenic amino acids.

Nucleotide Metabolism

Sources of atoms in the purine and pyrimidine nucleotides. Biosynthesis and degradation of purines and pyrimidines. Regulation of purine and pyrimidine biosynthesis.

Porphyrin Metabolism

Biosynthesis and degradation of porphyrins. Production of bile pigments.

Recommended Books:

1. Nelson DL & Cox M.M., Lehninger Principles of Biochemistry, 5th Edition, WH Freeman & Company, New York, 2008.

2. Conn EE, Stumpf PK, Bruening G and Doi RH. Outlines of Biochemistry. 5th edition, John Wiley & Sons Inc, 1987.

3. Voet D &Voet JG, Biochemistry, 3rd Edition, John Wiley & Sons Inc., Singapore, 2004.

4. Murray, R.K., Granner, D.K. and Rodwell, V.W. Harper's Illustrated Biochemistry, 27th Edition, McGraw Hill Company Inc. Singapore, 2006.

Course Title: Principles of Biochemistry Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH 525

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNS/o-Toluidine/Enzymatic method
2. Estimation of proteins by Biuret method
3. Quantitative estimation of cholesterol in the blood
4. Estimation of alkaline and acid phosphatases
5. Estimation of blood glucose.
6. Estimation of cholesterol
7. Sugar Fermentation in Microorganisms.
8. Estimation of Glucose 6-P.
9. Estimation of Urea.
10. Estimation of Uric acid.
11. Estimation of Creatinine.

SEMESTER 2

Course Title: Animal Physiology II (Controlling and Coordinating Systems)

L	T	P	Credits	Marks
3	1	0	4	100

Course Code: ZOO523

Course Objective: The students will learn physiological aspects of body processes at system, organ, tissue and cellular level as well as their regulation.

Unit A 12 hours

Integratory systems:

- Chemical coordination of body functions through neuro secretions in non-chordates; Physiology of nerve net and giant fibre system; Evolution of functional anatomy of chordate brain**.**
- **Sensing the environment:** Common characteristic of receptors; Various types of receptors and their function ; Free sensory receptors; Encapsulated sensory receptors; Associated sensory receptors; Mechanisms of perceiving stimuli; Special sensory organs (Radiation, Electroreceptors etc);Hotoreception, chemoreception, mechanoreception, echolocation,; Endogenous and exogenous biological rythms, chromatophores and bioluminescence.
- **Neurophysiology:** Gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, Neurons, neuroglia, Resting membrane potential, generation of action potential and its propagation-role of Na+-K+ and Ca++pumps, conduction of nerve impulse, myelination and saltatory conduction, neurotransmitters and mechanism of synaptic transmission, summation of excitatory and inhibitory nerve impulses and their computation, Reflexes and reflex arcs.

Unit B 15 hours

- **Special Senses:** Physiology of Vision- Anatomy of the eyeball, Retina structure, vision defects, Hearing and equilibrium, Olfaction and Gustation, tactile response.
- **Musculature:** Types of muscles, Fine structure of skeletal muscle fibre and its chemical composition, Molecular and chemical basis of muscle contraction (sliding-filament theory), Characteristics of muscle twitch; Motor unit, summation and tetanus, neuromuscular junction, Neural control of muscle tone and posture.
- **Endocrine System:** Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Regulation of their secretion; Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones.

- **Stress and Adaptations** General adaptation response, Basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones.

Unit C 15 hours

Reproduction:

- Pattern of reproduction in non-chordates and larval forms.
- Evolution of the urino-genital system in chordates with special reference to the separation of the two systems.
- Reproductive patterns in animals, Hypothalamo-hypophyseal gonadal regulation. Structure and hormonal functions of gonads, Gametogenesis, hormonal regulation of ovulation, fertilization and implantation, pregnancy, parturition and lactation.

Unit D 18 hours

Integumentary System:

- Embryonic origin
- General features of the Integument
- Specializations of integument
- Evolution of Skin
- **Skeletal System and Muscle Physiology:**
- Cytoskeleton: Basic characteristics and its role in locomotion.
- Muscles and mechanism of muscle contraction
- Skeleton, its role and types: an overview
- Hydrostatic skeleton in Cnidaria and Flatworms etc.
- Exoskeleton in arthropods, molluscs.
- Locomotory mechanisms in terrestrial, aquatic and aerial animals (including flight in birds and insects).
- Evolution of Coelom, Bilateral symmetry and Metamerism, and their significance in locomotion.
- Appendicular skeleton in vertebrates, Basic Components
- Phylogeny of fishes and tetrapods
- Appendicular skeleton in vertebrates, Basic Components
- Types of muscles, Fine structure of skeletal muscle fibre and its chemical composition, Molecular and chemical basis of muscle contraction (sliding-filament theory), Characteristics of muscle twitch; Motor unit, summation and tetanus, neuromuscular junction, Neural control of muscle tone and posture.

Reference books:

1. Barrington, E.U.W. *Invertebrates Structure and Functions.* Boston: Houghton Mifflin Co., 1967.
2. Cooper, G.M. and Hausman, E. *The Cell: A Molecular Approach.* Sinauer Associates, 2013.

3. Hall, J.E. *Guyton and Hall Text Book of Medical Physiology*, XIIIth edition, Saunders Company, 2015.
4. Hoar, W.S., General and comparative physiology, Adaptation and Environment, 3rd ed., Cambridge University Press, 1983.
5. Tortora, G.J. and Grabowski, S. *Principles of Anatomy & Physiology*. XI Edition John Wiley & sons, 2006.
6. Victor P. Eroschenko. diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins, 2008.

Course Title: Animal Physiology II (Controlling and Coordinating Systems) Laboratory
Course Code: ZOO524

L	T	P	Credits	Marks
0	0	3	2	50

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 Spinal cord,
5. Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
6. Microtomy: Preparation of permanent slide of any five mammalian (white rat) tissues
7. Study of permanent slides:
   - Skin of fish, frog, lizard, bird and mammal.
   -Setae of earthworm
   -Spicules of Sponges and Herdmania.
   -Internal ear of fish
   - Tentorium of grasshopper
   - Muscle fibers, cartilage and bone.
   - Endocrine glands of vertebrates.
   -.Appendicular skeleton.
8. Study the following with the help of charts/models/videos/permanent slides.
   - Appendages of Prawn
   - Wing venation, coupling and types of wings of insects.
   - Comparative anatomy of nervous system in Earthworm, Cockroach, Pila, Sepia and Fishes.
   - Eye muscles of fish.
   - Modification of antenna in arthropods
   - Histology of ovary, oviduct, uterus, testis and placenta in different groups of invertebrates & vertebrates.
   - Reproductive organs in Hydra, Flatworm, Earthworm, Cockroach, Pila, Fish, Frog, Lizard, Bird and Rat.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Advanced Techniques in Zoology
Paper Code: ZOO525

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with various instruments used in scientific laboratories and to make them understand the basic principles involved in the important techniques used in scientific research.

UNIT-A 18 hours

- Microscopic techniques: visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, principles of light, phase contrast, fluorescence, confocal, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, Microphotography and image processing methods in microscopy.
- Cell fractionation method: Different mechanical and chemical procedures. Principle of centrifugation and ultracentrifugation, different methods of ultracentrifugations (in brief) and their applications, structural parts of an analytical ultracentrifuge.
- Cell culture techniques: design and functioning of tissue culture laboratory, aseptic and sterilization techniques, factors affecting cell growth *in vitro*, cell proliferation measurements, cell viability testing, culture media preparation and cell harvesting methods

UNIT-B 7 hours

- Molecular biology methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.

8 hours

UNIT-C

- Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, immunocytochemistry, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

UNIT-D 12 hours

- Chromatography: Principles of chromatography, paper chromatography, thin layer chromatography, gas chromatography, gel permeation chromatography, ion exchange chromatography, high pressure liquid chromatography, affinity chromatography.
- Electrophoresis : Principle of electrophoresis, paper electrophoresis,

polyacrylamide gel electrophoresis, Disc gel electrophoresis, and SDS-PAGE, agarose gel electrophoresis, isoelectric focusing, applications of electrophoresis - distinguishing of Phage DNA, detection of plasmids, separation of DNA molecules, Southern transfer, Northern transfer and Western transfer.

- Radioisotopes: Radioactive isotopes, half-life of isotopes, detection and measurement of radioactivity (Gas ionization, scintillation and autoradiography), applications of radioisotopes in biological sciences, autoradiography, metabolic labelling, Magnetic Resonance Imaging.

Reference books

1. Boyer, R. *Modern Experimental Biochemistry*. 3rd ed. Pearson Education, 2004
2. Freshney, R.I. *Culture of Animal Cells: A manual of basic technique.* 5th Ed. New York: Wiley Liss Inc., 2006.
3. Gurumani, N. *Research methodology for Biological Sciences*. MJP Publishers, Chennai, 2007.
4. Kuby, J. *Immunology*. 6th ed., W.H. Freeman and Company, 2007.
5. Wilson, Keith and Walker, John. *Practical Biochemistry: Principles and techniques*, 5th Edition, Cambridge University Press, 2000.

Course Title: Advanced Techniques in Zoology Laboratory
Course Code: ZOO 526

L	T	P	Credits	Marks
0	0	3	2	50

- To study the parts of the compound microscope fluorescent microscope and phase contrast microscope and their maintenance.
- To study the living material under the phase contrast microscope.
- To find out the diameter, area and circumference with the help of stage micrometer and oculometer.
- To sketch the diagram of any tissue with the help of camera lucida and to draw its magnification line.
- Demonstration of section cutting and mounting of sections on the grid for SEM and TEM. Demonstration of SEM & TEM in the CIL lab.
- To separate a sample of amino acids with the help of paper chromatography and TLC
- To do a short term *in vitro* culture of a parasite.
- Demonstration of SDS-PAGE, 2-D gel electrophoresis, and western blotting to students.
- To demonstrate ELISA to students.
- Primer designing (classical and real time PCR), epitope mapping and their applications

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Systematics, Biodiversity and Evolution
Paper Code: ZOO527

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To enable the students to identify, classify and name the organisms according to international code of zoological nomenclature. To acquaint the student with different procedures of taxonomy and different methods of analysis of variations and theories of classification. To educate students about the importance and conservation of biodiversity.

UNIT-A 10 hours

- Definition and basic concepts of biosystematics and taxonomy-History, Importance and applications in biology, attributes of biosystematics
- Trends in Biosystematics-concepts of different conventional and newer aspects-chemotaxonomy, cytotaxonomy, molecular taxonomy

UNIT-B 10 hours

- Taxonomic procedures-taxonomic collections, preservation, curetting, process of identification
- Taxonomic keys-different kinds, their merits and demerits
- International code of zoological Nomenclature (ICZN)- its operative principles, interpretation and application of important rules, zoological nomenclature; formation of scientific names of various taxa.

UNIT-C 15 hours

- An overview of evolutionary biology, concept of organic evolution during pre- and post-Darwin era
- Evolution and molecular biology- a new synthesis; from molecules to life, life originated from RNA, introns as ancient component of genes
- Origin and diversification of eukaryotes- origin of cells and first organisms; early fossilized cells; evolution of eukaryotic cell from prokaryotes- a case of symbiosis; evolution of eukaryotic genomes; gene duplication and divergence.
- Dimensions of speciation and taxonomic characters: Type of lineage changes, production of additional lineage, mechanism of speciation in panmictic and apomictic species.
- Species concepts-species category, different species concepts, sub species and other intra-specific categories
- Theories of biological classification, hierarchy of categories
- Taxonomic characters- different kinds, origin of reproductive isolation-biological mechanism of genetic incompatability

UNIT-D 5 hours

- Molecular perspective on the conservation of biodiversity
- Evaluation of biodiversity indices-Shannon-Weinner index, dominance index, similarity and dissimilarity index, association index

Reference books

1. Kato, M. *The biology of Biodiversity*. Tokyo: Springer, 2000
2. Mayr, E. and Ashlock D. Principles of Systematic Zoology. Mc Graw Hill, 1991.
3. Simpson, G.G. *Principles of animal taxonomy*. Oxford IBH Publishing Company, 1961.
4. Tikadar , B.K. *Threatened Animals of India*. Calcutta: ZSI Publication, 1983.
5. Wilson, E.O. *The Diversity of life*. Penguin Books, 2001.

Course Title: Developmental Biology
Paper Code: ZOO528

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To enable the students understand the process of development in various animals and the phenomena associated with it. It also includes the genetic involvement and the role of maternal environment on fetal development. It will enable the students understand the environmental influences on development and factors responsible for ageing.

UNIT-A 6 hours

- Introduction to the basic concepts of embryology and developmental biology.
- Gametogenesis: Spermatogenesis, its cellular and hormonal regulation. Oogenesis-Folliculogenesis and oocyte maturatiom
- Fertilization-The cellular and molecular events-cell surface molecules in sperm-egg recognition in animals and union of gametes.

UNIT-B 10 hours

- Cleavage patterns in animals.
- Early embryonic development and role of maternal contributions
- Blastula formation and embryonic fields
- Gastrulation and formation of germ layers
- Morphogenesis, morphogenetic cells and molecules.

UNIT-C 13 hours

- Genetic regulation in early development of *Drosophila*-Homeotic genes
- Neurulation and Organogenesis
- Eye lens induction in *Caenorhabditis elegans*
- Limb development and regeneration in vertebrates
- Post embryonic development-larva formation
- Metamorphosis-environmental regulation in normal development
- Sex determination

UNIT-D 16 hours

- Potency, commitment, specification of embryonic cells
- Induction, Competence
- Differentaition and Determination
- Morphogenetic gradients in egg cytoplasm
- Cell fate, cell lineages
- Stem cells, genomic equivalence
- Cytoplasmic determinants
- Imprinting and mutants
- Transgenics and their role in analysis of development
- Programmed Cell Death, ageing and senescence

Reference books

1. Balinsky, B.I. and Fabian, B. C. *An Introduction to Embryology*. 5th ed. Philadelphia: Saunders, 2012.
2. Browder, L.W. *Developmental Biology*. 3rd ed. Saunders College Publishing, 1991.
3. Gilbert, S. F. *Developmental Biology*. 9th ed., Sinauer Associaters Inc Publishers, 2010.
4. Muller, W. A. *Developmental Biology* Springer, 1997.
5. Rastogi, V. B. and Jayaraj M. S. *Developmental Biology*. Meerut: Kedar Nath Ram Nath, 2009.
6. Wolpert, L. et al. *Principles of Development*. 2nd ed., Oxford, 2001.
7. Wright, S. J. *A Photographic Atlas of Developmental Biology*. Morton Publishing Company, 2005.

Course Title: Developmental Biology Laboratory
Course Code: ZOO529

L	T	P	Credits	Marks
0	0	3	2	50

The following practicals will be conducted using e-resources.

- To study gametogenesis, spermatogenesis and oogenesis- their cellular interactions and quantitative aspects.
- To study the different larvae in the invertebrates.
- To study the different stages of development in frog and chick.
- To study the RNA activity in the polytene chromosomes in dipterans.
- To study larvae of invertebrates.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

SEMESTER 3

Course Title: Molecular Biology

Course Code: BTY511

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

1. Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination. **12 hours**
2. Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA. **12 hours**
3. Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post- translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. **10 hours**
4. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). **10 hours**
5. Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and

recovery of clones, application of sequence information for identification of defective genes. **8 hours**

6. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. **8 hours**

Books:

1. Molecular cell biology (2008) by Harvey F. Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Anthony Bretscher (W.H.Freeman).
2. Genes IX (2008) by Benjamin Lewin (Jones and Bartlett Publishers).
3. Molecular cloning: A laboratory manual (2000) by J. Sambrook, E.F.Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press,New York).

Course Title: Molecular Biology-LAB

Course Code: BTY512

L	T	P	Credits	Marks
0	0	3	2	50

- Isolation of genomic DNA from bacteria.
- Isolation of genomic DNA from plant.
- Isolation of total RNA from tissue.
- Demonstration of DNA protein interaction.
- Quantitation of nucleic acids and proteins.
- Gel electrophoresis:
    - Nucleic acid
    - Protein

Paper: Research Methodology

Code: BOT621

L	T	P	Credits	Marks	Minimum marks
3	1	0	4	100	40

Objective:

To make the students learn how to design an experiment and what are the various research strategies.

Teaching Methodology:

Class room Lectures, practicals, models, charts, power point presentations.

Learning outcomes

This course will impart the comprehensive knowledge of designing a research experiment, how to write a research paper, the relevant ethics, copy right, impact factor etc.

UNIT-I

Biostatistics: Definition and relevance in biological research; Measures of Central Tendency: Arithmetic Mean, median, mode, quartiles and percentiles; Measures of Dispersion: Range, variance, standard deviation, coefficient of variation; Skewness and Kurtosis. **(5 Lectures)**

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. **(2 Lectures)**

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. **(5 Lectures)**

UNIT-II

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: Analysis of Variance, Chi square and Kendall Rank Correlation **(6 Lectures)**

Experimental Set-up: Basic principles and significance of research design; Randomized Block Designs (RBD), completely randomized designs (CRD); Latin square design and Factorial design **(5 Lectures)**

UNIT-III

Data collection, organization and interpretation.

Research articles, research papers, popular research articles and reviews; difference between periodicals; journals; monographs, magazines; proceedings.

How to write a research paper, reference styles, process of submission of a paper; process of proof reading of a research manuscript; process of reviewing.

Important journals in plant sciences. **(15 Lectures)**

UNIT-IV

An introduction to Science citation index; H-index, i10 index, Impact factor calculaton for author, Impact factor of a journal; Eigen factor, Major journal search engines.

Copyright act; Academic frauds; Plagiarism; Softwares to check plagiarism. **(5 Lectures)**

Reference Books

1. Kothari, C.R. *Research Methodology – Methods and Techniques*. 2nd revised edition. New Age International (P) Ltd. Publishers: New Delhi, 2007.
2. McKillup, S. *Statistics Explained. An Introductory Guide for Life Scientists*. Cambridge University Press: Cambridge, UK, 2006.
3. Selvin, S. *Biostatistics – How it Works.* First Impression. Pearson Education Inc.: New Delhi, 2007.
4. Agarwal, B.L. *Basic Statistics*. New Age International: New Delhi, 2006

Course Title: Animal Behaviour and Chronobiology
Paper Code: ZOO624

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with different patterns of animal behaviour and Chronobiology

UNIT-A 15 hours

- **Introduction to Animal Behaviour:** 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 behavior
- **Patterns of Behaviour:** Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

UNIT-B 12 hours

- **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-C 9 hours

- **Introduction to Chronobiology:** Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks
- **Biological Clocks:** Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

UNIT-D 9 hours

- **Biological Rhythm:** 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.

Reference books

1. Alcock, J. *Animal Behaviour.* USA: Sinauer Associate Inc., 2013.
2. Dunlap J.C. et al. *Chronobiology: Biological Timekeeping.* Sunderland, MA, USA: Sinauer Associates, Inc. Publishers, 2004.
3. Kumar, V. *Biological Rhythms.* Delhi: Narosa Publishing House, 2002.

4. Manning, A. and Dawkins, M. S. *An Introduction to Animal Behaviour*. UK: Cambridge University Press, 2012.
5. McFarland, D. *Animal Behaviour: Psychology, Ethology and Evolution.* London, UK: Pitman Publishing Limited, 1999
6. Saunders, D.S. *Insect Clocks*. New York, USA: Barens and Noble Inc. 2002.
7. Sherman, P.W. and Alcock, J. *Exploring Animal Behaviour*. Massachusetts, USA: Sinauer Associate Inc., 2010.

Course Title: Animal Behaviour and Chronobiology Laboratory

Paper Code: ZOO625

	T	P	Credits	Marks
0	0	3	2	50

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).

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Ecology and Wild Life Conservation
Paper Code: ZOO626

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with the animal ecology and conservation strategies to protect wild life.

UNIT-A 15 hours

- Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors, 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, 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-B 12 hours

- Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies, Nutrient and biogeochemical cycle with one example of Nitrogen cycle, Human modified ecosystem

UNIT-C 9 hours

- Importance of Wildlife conservation; Causes of depletion; World conservation strategies, Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS. Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.

UNIT-D 9 hours

- Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Bio- telemetry; Protected areas: National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve.

Reference books

1. Caughley, G. and Sinclair, A.R.E. *Wildlife Ecology and Management*. Blackwell Science, 1994.
2. Colinvaux, P. A. *Ecology.* II Edition. Wiley, John and Sons, Inc., 1993.
3. Hunter M.L., Gibbs, J.B. and Sterling, E.J. *Problem-Solving in conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing, 2008.
4. Krebs, C. J. *Ecology.* VI Edition. Benjamin Cummings, 2001.
5. Odum, E.P. *Fundamentals of Ecology.* Indian Edition. Brooks/Cole, 2008.
6. Ricklefs, R.E. *Ecology.* V Edition. Chiron Press, 2000.
7. Sutherland, W.J. *The Conservation Handbook: Research, Management and Policy.* Blackwell Sciences, 2000.

Course Title: Ecology and Wild Life Conservation Laboratory
Paper Code: ZOO627

L	T	P	Credits	Marks
0	0	3	2	50

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. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna
5. Demonstration of basic equipment needed in wildlife studies use, care and maintenance.
6. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
7. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences)
8. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

SEMESTER 4

Course Title: Animal Biotechnology
Paper Code: ZOO628

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with animal tissue culture and cloning methods.

UNIT-A 9 hours

- Advantages & Disadvantages of animal tissue culture, Design and layout of ATC Lab, Growth and viability of cells in culture, Cryopreservation and retrieval of cells from frozen storage, Transportation of cells, Characteristics of normal and transformed cells. Contamination monitoring and eradication, Cross Contamination. Safety considerations in ATC laboratory, Clean Environment – P1, P2, P3 facility and their applications**.**

UNIT-B 15 hours

- Culture Media and Reagents-Types of cell culture media, physiochemical properties, Balanced salt solution, Constituents of serum, Serum free media (SFM), Design of SFM, Advantages and disadvantages of serum supplemented and serum free media, Conditioned media. Primary culture methods, Culture of attached cells and cells in suspension, phases of cell growth and determination of cell growth data (calculation of in vitro age, multiplication rate, population doubling time, cell counting, phases of cell cycle) Commonly used animal cell lines, their origin and characteristics, Organ Culture, Cell synchronization methods and their applications.

UNIT-C 12 hours

- Transfection methods (calcium phosphate precipitation, DEAE-Dextran- mediated transfection, Lipofection, electroporation,Retroviral infection, Microinjection), Detection of transgenics, need to express proteins in animal cells, Genetic engineering in production of regulatory proteins, blood products, vaccines and hormones; Transgenic mice: Methodology and applications; Transgenic cattle, Livestock transgenesis- production of drugs using animals.

UNIT-D 9 hours

- Animal cloning- IVF & embryo transfer, Cellular therapy; Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adult stem cells; Concept of tissue engineering; Histotypic and Organotypic culture for tissue engineering; Genetically engineered stem cells in cancer treatment.

Reference books:

1. Atala, A. and Lanza, R. *Methods of Tissue Engineering*. 1st Edition. Academic Press. 2001. Print.
2. Freshney, R. I. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications.* 6th Edition. Wiley-Blackwell, 2010. Print.
3. Harrison, M.A. and Rae, I.F. *General Techniques of Cell Culture*. 1st Edition. Cambridge University Press. 1997. Print.
4. Masters, J.R.W. *Animal Cell Culture: A Practical Approach*. 3rd Edition. Oxford University Press. 2000. Print.
5. Spier, R.E. and Griffiths, J.B. *Animal Cell Biotechnology*. Vol. 1-6. Academic Press. 1994. Print.
6. Twine, R. *Animals as Biotechnology: Ethics, Sustainability and Critical Animal Studies.* 1st Edition. Routledge Publishers. 2010. Print.
7. Verma, A. and Singh, A. *Animal Biotechnology: Models in Discovery and Translation*. 1st Edition. Academic Press. 2013. Print.

Course Title: Animal Biotechnology Laboratory

Course Code: ZOO629

L	T	P	Credits	Marks
0	0	3	2	50

- Preparation of culture media and concept of sterilization in animal cell culture.
- Subculturing and maintenance of continuous cell lines such as myeloma, Hep-2 and HeLa cells.
- To determine doubling time of a given cell line.
- Cytotoxic assay of a given antibiotic for a cell line.
- Effect of nutrient (serum) on growth of given cell line.
- Cryopreservation of animal cells.

Course Title: Economic Zoology
Paper Code: ZOO630

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with the applied aspects of Zoology.

UNIT-A 15 hours

- **Bee-keeping and Bee Economy (Apiculture):** Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Diseases of honey bee, American and European Foulbrood, and their management; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee; Visit to an Apiculture Institute and honey processing Units

UNIT-B 12 hours

- **Silk and Silk Production (Sericulture**): Different types of silk and silkworms in India; Rearing of *Bombyx mori* – Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles, and their management; Silk reeling techniques; Quality assessment of silk fibre

UNIT-C 9 hours

- **Aquaculture:** Brood stock management; Induced breeding of fish and prawn; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish; Fishery by-products

UNIT-D 9 hours

- **Dairy/Poultry Farming:** Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy/poultry farm management and business plan; Visit to any Dairy farm/Poultry farm

Reference books

1. Hafez, E. S. E. *Reproduction in Farm Animals*, Lea and Fabiger Publishers, 1962.
2. Prost, P. J. *Apiculture.* Oxford and IBH, New Delhi, 1962.
3. *Sericulture*. FAO Manual of Sericulture.

4. Singh, S. *Beekeeping in India*. Indian council of Agricultural Research, New Delhi.
5. Srivastava, C. B. L. *Fishery Science and Indian* Fisheries. Kitab Mahal Publications, India, 1999.

Course Title: Parasitology
Paper Code: ZOO632

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To enable the students to classify and study the variation in morphology, life cycle and pathogenesis of important parasites causing diseases in animals and human beings.

UNIT-A 15 hours

- Introduction to parasitic protozoa.
- General account of medically important parasites in Kinetoplastida, Coccidia, Piroplasmia and Microspora (for example *Leishmania, Trypanosoma, Encephalitozoon, Babesia, Theileria,, Sarcocystis, Isospora, Cryptosporidium* etc.).
- *In vitro* culture of protozoan parasites e.g. *Plasmodium, Entamoeba, Giardia, Leishmania, Trypanosoma* etc.

UNIT-B 10 hours

- Outline classification of trematodes with general account of important parasites in fasciolidae, paramphistomidae, dicrocoelidae, troglotrematidae, opisthorchidae and schistosomatidae.
- Ultrastructure of the body wall of digenetic trematodes.
- Variation in the life cycle in Digenea.

UNIT-C 10 hours

- Outline classification of cestodes with general account of important parasites of diphyllobothridae, taeniidae and anoplocephalidae.
- Ultrastructure of the body wall of cestodes.
- Variation in the life cycles of cestodes.
- Host Parasite Transmission
- Host parasite Interaction

UNIT-D 10 hours

- General organization and outline classification of nematodes with general account of important
- parasites in strongylidea, ascaridoidea, oxyuroidea, dracunculoidea, filarioidea and trichinelloidea.
- Ultrastructure of nematode sense organs like amphids, phasmids and Papillae.
- Variation in life cycle of nematodes.

Reference books

1. Chatterjee, K. D. *Parasitology: Protozoology and Helminthlogy*. 13th ed. CBS publishers and distributors Pvt Ltd, 2009.
2. Cheng, T.C. *General Parasitology*. 2nd ed., London: Academic Press, 1986.
3. Garcia, L.S. *Diagnostic Medical Parasitology*. 4th Ed. Washington DC: ASM Press, 2001.
4. Ichchpujani R.L.and Bhatia, R. *Medical Parasitology*. 3rd Ed. New Delhi: Jaypee Brothers Medical Publishers, 2002.
5. Larry S. Roberts & John Janovy Jr., Foundations of Parasitology Mc. Graw Hill Book Co., (2000).
6. Noble, E.R. & Noble, G.A. *Parasitology: The biology of animal parasites.* 5th edition. Philadelphia: Lea & Febiger, 1982.
7. Parija, S. C. *Textbook of Medical Parasitology*. All India Publishers and Distributors, 2001.
8. Smyth, J.D. *Introduction to Animal Parasitology*. London: Hodder & Stoughton, 2005.

Course Title: Parasitology Laboratory

Course Code: ZOO633

L	T	P	Credits	Marks
0	0	3	2	50

The following practicals will be conducted using models/charts/e-resources.

1. Study of the cestodes
2. Study of the trematodes
3. Study of the digenetic trematode larvae from the snails.
4. Study of the nematodes infecting sheep, goat, fowl and cockroaches.
5. Detailed morphological and histological studies of *Ascaris.*
6. Study of the protozoan parasites infecting cockroaches and mice.
7. Study of *in vitro* culture of *Leishmania*

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Neuroscience and Neuroendocrinology
Paper Code: ZOO634

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To acquaint students with neuroscience and neuroendocrinology.

UNIT 1:
Origins of Neuroscience; Neuroanatomy, Systems Neurobiology, Molecular and cellular approaches used to study the CNS at the level of single molecules, General organization of neuroendocrine organs and nervous system. Neuroanatomy: form, varieties and distribution of neurons; Structural characteristics of neurons; Stereotaxic atlas of rat brain and the hypothalamus. Neurophysiology: electrical properties of neurons and propagation of nerve impulses; Synapse: types, structure and function. Neurotransmitter and its release; Neuromodulation: neurotransmitter vs neuropeptides, Synaptic transmission: role of G-protein coupled, glutamate and on-channel linked receptors; GABA/glutamate neurons in adult preoptic area. The principles of signal transduction and information processing in the vertebrate central nervous system, and the relationship of functional properties of neural systems with perception and behavior; sensory systems, molecular basis of behavior including learning and memory. Molecular pathogenesis of pain and neurodegenerative diseases such as Parkinson's, Alzheimer's, psychological disorders, addiction, etc.

UNIT 2:
The hypothalamo- hypophyseal axis. Hypothalamo- vascular system. Hormones from hypothalamus: chemistry and physiology of releasing and release inhibiting hormones; Regulation of hypothalamic hormone secretion. Hypothalamo- hypophyseal interactions with the gonads, adrenal and other endocrine organs. Diversity of ovarian steroid signaling in the hypothalamus. Development and cytology of pituitary gland. Regulation of pituitary hormone secretion. Neurohypophysis: synthesis and storage of oxytocin and vasopressin; Regulation of the release of neurohypophyseal hormones. Concepts of feed-back inhibition and feed-forward activation.

UNIT 3:
Regulation of the expression of POMC-related peptides and their differential expression in brain and pituitary. Environment and reproduction. Endocrine disruptors; Embryonic diapauses and other adaptive mechanisms. Biological clock and the pineal: synthesis and regulation of melatonin, phylogeny of pinealocytes, role of pineal in circadian rhythms, regulation of pineal by SCN and vice versa, physiological actions of melatonin, biological clock and clock gene expression, fluoride and pineal.

UNIT 4:

Neuroendocrine regulation of immune system; Stress hormones and immune responses; Regulation of systemic homeostasis by nervous and immune system interactions. Melatonin, immune responses and cancer therapy. Neuroendocrine disorders: genetic versus environmental cause. Principles and application of techniques: electrophysiology, immunocytochemistry, in situ hybridization, in vitro perfusion

References:

1. Brown, R. *An Introduction to Neuroendocrinology*. UK: Cambridge University Press, Cambridge, 1994.

2. Ader R. and Felten, D.L. *Psychoneuroimmunology*. UK: Academic Press, 2007.

3. DeGroot L. J. and Jameson J.L. *Endocrinology*. USA: Saunders Elsevier Press, 2006.

Course Title: Neuroscience and Neuroendocrinology Laboratory

Course Code: ZOO635

L	T	P	Credits	Marks
0	0	3	2	50

1. Demonstration of different parts of the rat brain.
2. Demonstration of hypothalamus region of brain showing variability of GnRH immunostaining in different stereotaxic regions of median-eminence region of hypothalamus.
3. Identification of hypothalamic nuclei following histological/immunohistochemical methods.
4. Immunocytochemical study of marker protein in neuronal/glial cell line.
3. Stereotaxic atlas of hypothalamus.
4. Demonstration of stereotaxic device.
3. Study of novelty, anxiety and spatial learning in mice.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Aquaculture and Fisheries
Paper Code: ZOO636

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To enable the students understand the different fresh water habitats, the classification of water bodies based on various physicochemical and biological parameters and the importance of fisheries as a science.

UNIT-A 15 hours

- Water as a substance: molecular structure and properties, specific heat, density, surface tension
- Types of Freshwater habitats – Lotic and Lentic Waters, Zonation in Lentic habitat
- Hydrobiological characteristics – Temperature, penetration of light, turbidity, dissolved gases, pH, biogenic salts etc.
- Water problems in aquatic and amphibious situations.
- Ecological classifications of freshwater organisms other than fishes :
  On the basis of trophic status
  On the basis of mode of life – Benthos, Periphyton, Plankton, Nekton and Neuston
  On the basis of zonation in lentic and lotic habitats.
- Classification of lakes:
  Trophic classification of lakes – Oligotrophic, eutrophic and dystrophic lakes.
  Thermal classification of lakes – Forel's and Yoshimura's classifications of lakes.
  Hutchinson's classification of lakes – Amictic, cold monomictic, dimictic, warm monomictic, oligomictic and polymictic lakes.
- Productivity: Concepts of productivity – Biomass, biotic potential, standing crop, carrying capacity, yield, productivity, primary and secondary productivity.

UNIT-B 12 hours

- Eutrophication: Definitions and types, Causes and impact of eutrophication. Control of eutrophication
- Thermal stratification
- Bioassay – Terminology, methodology, calculation of LC 50 and EC 50 values and threshhold concentrations.
- Methods in Field Biology: Methods of estimating population density of animals.

UNIT-C 10 hours

- Fishery Science: Its importance and application.
- Form and locomotion
- Morphological variations in the body form- in deep – sea and hillstream fishes.
- Feeding relationships among fishes
- Predation of fishes

UNIT-D 8 hours

- Exotic fishes: Different fishes introduced in India, history, causes, impacts, usefulness to fish culture.
- Pearl culture in India: species involved, implantation procedure, water quality, economics.
- Fish: biodiversity, loss of fish biodiversity, enhancement, role of genetics in aquaculture and fisheries.
- Fish as bioindicators of aquatic ecosystem health.

Reference books

1. *Aquaculture Production*. FAO. Fisheries Circular No.815, No.4, Rev.FAO Rome, 1998.
2. Jhingran, V.G. *Fish and Fisheries of India*. New Delhi: Hindustan Publishing House (India), 1991.
3. Joseph, M. *Aquaculture in Asia*. Manglore: Asian Fisheries Society, 1990.
4. Odum, E.P. *Fundamentals of ecology*. Philadelphia: Saunders Co., 1971.
5. Talwar, P.K. and Jhingran, A.G. *Inland Fishes of India*. Vols.I & II, New Delhi: Oxford & IBH, 1991.
6. Welch, P.S. *Limnology*. New York: Mcgraw Hill Book Co., 1952.
7. Wetzel, R.G. *Limnology*. Philadelphia: Saunders Co., 1983.

Course Title: Aquaculture and Fisheries Laboratory
Course Code: ZOO637

L	T	P	Credits	Marks
0	0	3	2	50

1. Qualitative study of biotic components of aquatic ecosystem.
2. Quantitative study of biotic components of aquatic ecosystem.
3. Study of different types of Phytoplankton (Bacillariophyceae, Chlorophyceae, Euglenophycea & Cyanophyceae).
4. Study of different types of Zooplankton (Protozoa, Rotifera, Cladocera, Copepoda).
5. Study of Benthic fauna.
6. Study of Neuston.
7. Study of Nekton.
8. Study of Macrophytes.
9. Estimation of Nitrates in water.
10. Estimation of Phosphates in water.
11. Estimation of dissolved oxygen by modified winklen method in water.
12. Determination of Primary productivity in an aquatic habitat.
13. Study of impact of Heavy metals on productivity.
14. Identification of the following fishes up to species level of Punjab, Haryana and Himachal Pradesh using already prepared field keys. Noting down their important Characters, making sketches, and economic importance of each fish species along With ecological notes: *Notopterus notopterus, N.chitala, Schiozothorax richardsonii. plagiostomus,Hypophthalmichthys molitrix, Cyprinus carpio, Ctenopharyngodon idella, Puntius Labeo rohita, Catla catla, Cirrhinus mrigala,Tor putitora, Garra gotyla gotyla, Noemecheilus botia, Botia berdi., Mystus seenghala, Aorichthys spp., Wallago attu, Heteropneustes fossilis, Channa, Mastacembelus armatus.*
15. Study of important deep-sea and hills stream fishes with special reference to Various adaptations.
16. Study of hard parts e.g., scales, vertebrae, otoliths and opercular bones for age determination, Calculations of back-calculated lengths using Fraser-Lee. equation.
17. On the basis of available growth data calculation of various growth parameters e.g., annual increment, specific rate of linear growth, growth characteristic, growth constant, calculation of harvestable size and maximum size to be attained by the fish.
18. Study of various exotic fishes introduced in India and their characteristic features.
19. Study of different bivalves involved in Pearl Culture.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Entomology
Paper Code: ZOO638

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To enable the students to understand the dominance of Arthropods and their association with human welfare in a number of ways.

UNIT-A 15 hours

- Preliminary knowledge of thoracic and abdominal segments of insects.
- General structure and functional modifications in the antennae, wings and legs in different insect groups.
- External male genitalia and external female genitalia in different insect group.

UNIT-B 13 hours

- Comparative account of the structure and functions of digestive system in insects with special reference to the functional modifications like filter chamber and peritrophic membrane and digestive glands.
- Comparative account of the nervous in insects.

UNIT-C 10 hours

- General structure and functions of excretory, respiratory (terrestrial and aquatic) and circulatory systems in insects.
- Comparative account of the male and female reproductive systems in insects

UNIT-D 7 hours

- Types of metamorphosis in insects.
- Structural modifications in larvae and pupae and relationship of nymphs and naiads.
- Onset, termination and significance of diapauses

Reference books

1. Chapman, R.F. *The Insects; structure and Function*. The English Language Book Society, and Hodder and Stoughton, Kent, 1980.
2. Mani, M.S. *General Entomolgy*. Oxford and IBH, 1990.
3. Richard, O. W. and Davies, R.G. *Imm's Text book of Entomology*. 10th ed., Vol I & II, New Delhi: B1 publications Pvt. Ltd., 1997.
4. Snodgrass, R.E. *Principles of Insect Morphology*. Delhi: CBS Publishers and distributors, 1994.

Course Title: Entomology Laboratory

Course Code: ZOO639

L	T	P	Credits	Marks
0	0	3	2	30

The following practicals will be conducted using charts/e-resources.

1. Study of representatives from different insect orders in order to understand the salient features and diversity in insect groups.
2. Anatomy of various insects to study the alimentary canal and glands associated with the digestion of different types of food.
3. Study of an insect to study tracheation and spiracles.
4. Study of various insects to demonstrate number, arrangement and associations of malpighian tubules.
5. Neuroendocrine organs of an insect (cockroach/grasshopper).
6. To study the effect of temperature and photoperiod on the development of insects.
7. Project work

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.

Course Title: Population Genetics
Paper Code: ZOO640

L	T	P	Credits	Marks
3	1	0	4	100

Course Objective: To introduce students to the concept of population genetics.

UNIT-A 15 hours

- Introduction to Population Genetics,
- Phenotypic & Genetic Variation in Natural Populations,
- Single Locus (Mendelian) versus Multilocus(quantitative) Inheritance,
- Sources of Data on Genetic Variation,
- Recent Advances in Molecular Methods..

UNIT-B 13 hours

- The Idealized Random-mating Population and the Hardy Weinberg Principle;
- Linkage and Linkage Disequilibrium;Genetic Drift, Effective Population Size,
- Mutation; Mutation and Drift, The Neutral Theory of Molecular Evolution;
- Infinite Alleles Model, Infinite Sites Model and DNA-sequence Based Tests of Neutrality
- Mutation, Recombination and Muller's Ratchet

UNIT-C 10 hours

- Darwinian Selection: the Haploid Model, Selection in Diploid Organisms;
- Equilibria with Overdominance, Mutation Special Cases: Sexual Selection, Kin Selection, Meiotic Drive, Epistasis;
- Multiple Loci and Wright's Shifting Balance Theory, Selection in a Finite Population: The Nearly Neutral Theory;
- Population Structure and F Statistics;
- Migration & Gene Flow

UNIT-D 7 hours

- Population Genomics, Functional Genomics, Haldane's Rule;
- Transposable Elements;
- Human Population Genetics;
- Linkage Disequilibrium in the Human Genome;
- Human Population Structure and Demographic History;
- Population Genetics and Human Disease;
- Evidence of Adaptation in the Human Genome

Reference books

1. Gillespie, J. H. *Population Genetics, a concise guide*. 2nd Edition. The John Hopkins University Press, 2004

2. Hartl, D. L. and A. G. Clark. *Principles of population genetics.* 3rd Ed. Sinauer, 1997.
3. Hedrick, P. W. *Genetics of populations.* 2nd Ed. Jones and Bartlett, 2000.
4. Maynard Smith, J. *Evolutionary genetics.* Oxford University Press, 1989.
5. Nei, M. and S. Kumar. *Molecular evolution and phylogenetics.* Oxford University Press, 2000.

Course Title: Population Genetics Laboratory
Course Code: ZOO641

L	T	P	Credits	Marks
0	0	3	2	30

The following practicals will be conducted using charts/e-resources.

1. Investigate a genetically inherited trait and apply the Hardy-Weinberg Principle to a population.
2. Calculate allele frequencies and genotypes for a population using the Hardy-Weinberg formula.
3. Compare allele frequencies within the classroom to national averages.
4. Demonstrate the stability of allele frequencies over five generations in an ideal Hardy-Weinberg population.
5. Examine the effects of natural selection, heterozygous advantage, and genetic drift on allele frequencies in a simulated mating exercise.

Note: The above mentioned practicals are in accordance with the guidelines of UGC. Practicals involving animal material will be conducted using models/charts/e-resources. Minor modifications in the curriculum is allowed subject to the availability of resources.