DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabi

For

M.Sc. (Hons.) ZOOLOGY

(Program ID-37)

1st to 4th SEMESTER

Syllabi Applicable for Admissions in 2020

DAV UNIVERSITY, JALANDHAR

SCHEME OF COURSES

M.Sc. (Hons.) Zoology

Semester 1

S. No.	Course Code	Course Type	Course Title	L	T	P	Cr
1	ZOO530	Core	Animal Physiology- I	4	1	0	4
2	ZOO531	Core	Cell Biology	4	0	0	4
3	ZOO532	Core	Molecular Biology	4	0	0	4
4	ZOO541	Core	Ecology and Conservation Biology	4	0	0	4
5	ZOO542	Core	Ecology and Conservation Biology 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
Total							24

L: Lectures T: Tutorials P: Practicals Cr: Credits

DAV UNIVERSITY, JALANDHAR

SCHEME OF COURSES

M.Sc. (Hons.) Zoology

Semester 2

S. No.	Course Code	Course Type	Course Title	L	T	P	Cr
1	ZOO536	Core	Animal Physiology- II	4	1	0	4
2	ZOO537	Core	Animal Physiology- Laboratory	0	0	3	2
3	ZOO538	Core	Advanced Techniques in Zoology	4	0	0	4
4	ZOO660	Core	Genetics	4	0	0	4
5	ZOO534	Core	Immunology	4	0	0	4
6	ZOO672	Core	Biological Techniques Laboratory	0	0	3	2
7	Open Elective Course I						4
Total							26

L: Lectures T: Tutorials P: Practicals Cr: Credits

DAV UNIVERSITY, JALANDHAR

SCHEME OF COURSES

M.Sc. (Hons.) Zoology

Semester 3

S. No.	Course Code	Course Type	Course Title	L	T	P	Cr
1	ZOO540	Core	Biosystematics	4	1	0	4
2	ZOO662	Core	Developmental Biology	4	0	0	4
3	ZOO663	Core	Developmental Biology Laboratory	0	0	3	2
4	ZOO632	Elective	Parasitology	4	1	0	4
5	ZOO633	Elective	Parasitology Laboratory	0	0	3	2
6	BOT621	Core	Scientific Writing and Research Methodology	3	1	0	4
7	Open Elective Course II						4
Total							24

L: Lectures T: Tutorials P: Practicals Cr: Credits

*** The students shall submit synopsis of any of these: Project (Laboratory/Field/ Review) Survey, Seminar.**

SCHEME OF COURSES

M.Sc. (Hons.) Zoology

Semester 4

<table>
<tr><th>S. No.</th><th>Course Code</th><th>Course Type</th><th>Course Title</th><th>L</th><th>T</th><th>P</th><th>Cr</th></tr>
<tr><td>1</td><td>ZOO672</td><td>Elective</td><td colspan="4">Research Project/Skill Enhancement Training for Post graduate students
(for one complete semester)</td><td>22</td></tr>
<tr><td rowspan="4">2</td><td colspan="5">Departmental Elective I</td><td>6</td></tr>
<tr><td colspan="5">Departmental Elective II</td><td>6</td></tr>
<tr><td>ZOO673</td><td rowspan="3">Elective</td><td colspan="4">Research Project/Skill Enhancement Training for Post graduate students
(For atleast 15 days)</td><td>10</td></tr>
<tr><td>ZOO674</td><td colspan="4">OR</td><td>4</td></tr>
<tr><td></td><td colspan="4">Seminar/Group Discussion
&
Departmental Elective III*</td><td>6</td></tr>
<tr><td colspan="7">Total</td><td>22</td></tr>
</table>

L: Lectures T: Tutorials P: Practicals Cr: Credits

Note: In Semester 4, the students are required to choose any one combination from S. No. 1 or 2.

List of Departmental Elective Courses							
1	ZOO664	Elective	Animal Biotechnology	4	0	0	4
	ZOO665	Elective	Animal Biotechnology Laboratory	0	0	3	2
2	ZOO666	Elective	Reproductive Neuroendocrinology	4	0	0	4
	ZOO667	Elective	Reproductive Neuroendocrinology Laboratory	0	0	3	2
3	ZOO668	Elective	Animal Behaviour	4	0	0	4
	ZOO669	Elective	Animal Behaviour Laboratory	0	0	3	2
4	ZOO630	Elective	Economic Zoology	4	1	0	4
	ZOO646	Elective	Economic Zoology Laboratory	0	0	3	2
5	ZOO636	Elective	Aquaculture and Fisheries	4	0	0	4
	ZOO637	Elective	Aquaculture and Fisheries Laboratory	0	0	3	2
6	ZOO638	Elective	Entomology	4	0	0	4
	ZOO639	Elective	Entomology Laboratory	0	0	3	2
7	ZOO670	Elective	Population Genetics and Evolution	4	0	0	4
	ZOO671	Elective	Population Genetics and Evolution Laboratory	0	0	3	2

Programme Name: M.Sc (Hons.) Zoology

Programme Mission:

The modern era requires a classical zoologist with a modern approach to master many subjects of Zoology. There is a need for the students to compete with the globe, therefore, the main focus of this curriculum is to enable the student to be professionally competent and successful in a career. Having Zoology as backbone of the curriculum, this course, with the department centric electives will enhance the skills required to perform research in laboratory and experimental research. The students can choose to focus on a "whole animal" or a "bits of animals" approach. The curriculum provides the skills required to pursue laboratory and experimental work such as disease research, DNA technologies, wildlife forensics etc. For specializations, the curriculum focuses on special skills to maximize the students' employment probability.

Learning outcomes: The program is expected to make students as proficient:

1. **Skilled project manager:** Capable of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.
2. **Digitally literate:** Capable of using computers for Bioinformatics and computation and appropriate software for analysis of genomics and proteomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.
3. **Ethical awareness/reasoning:** Capable of conducting their work with honesty and precision thus avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues
4. **Young Enterpneurs:** The curriculum is designed in a way to train students in technical skills and encourage them to for entrepreneurship in their careers.
5. **Researchers:** The curriculum provides a platform for the students to do research projects and acquaint students with appropriate research methodology. This gives them the necessary foundation for continuing research in future.

Syllabi

SEMESTER 1

Course Title: Animal Physiology –I
Course Code: ZOO530

L	T	P	Credits	Marks
4	1	0	4	100

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

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning outcomes: After successfully completing this course, the students will be able to:

1. Understand the physiology at cellular and system levels.
2. Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
3. Understand how mammalian body gets nutrition from different biomolecules.
4. Understand the process of digestion and excretion.
5. Learn the determination of hemoglobin content, blood groups and blood pressure.

Unit-A 15 hours

Nutrition and Digestion:

- Modes of Nutrition. Different types of nutrients, their sources and diseases associated with them.
- 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.

Unit-B 15 hours

Transport and Circulatory Mechanisms:

- Blood corpuscles, haemopoiesis, haemoglobin; coagulation of blood and haemostasis.
- Physiological anatomy of mammalian heart, coronary circulation, cardiac musculature and specialized tissue, origin and conduction of cardiac impulse, cardiac cycle, cardiac output and its regulation-Frank-Starling law of the heart, regulation of heart rate, blood pressure and its regulation; ECG – its principle and significance.

Unit-C 15 hours

Excretion and Osmoregulation:

- Physiology of excretion, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Neuronal and hormonal regulation

Unit-D 15 hours

Respiratory system:

- Anatomy of Respiratory System, pulmonary ventilation, respiratory volumes and capacities; exchange and transport of gases, oxygen-haemoglobin dissociation curve, waste elimination, neural and chemical regulation of respiration; circulatory and respiratory response to extreme conditions.

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*, XIII 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.* XIEdition John Wiley & sons, 2006.
6. Victor P. Eroschenko.diFiore's Atlas of Histology with Functionalcorrelations. XII Edition. Lippincott W. & Wilkins, 2008.

Course Title: Cell Biology
Course Code: ZOO531

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To develop a comprehensive knowledge of cell biology and role played by subcellular organelles in biological functions of the cell.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
2. Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis thus enabling them to understand the anomalies in cancer.
3. Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.
4. Get new avenues of joining research in areas such as genetic engineering of cells, cloning, vaccines development, human fertility programme, organ transplant, etc.
5. Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

UNIT-A 12 hours

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, extracellular matrix.

Structural organization and function of intracellular organelles:
Nucleus, Mitochondria and chloroplast, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, vacuoles, structure & function of cytoskeleton and its role in motility.

UNIT-B 12 hours

Cell cycle & its regulation: Mitosis and meiosis, Cell cycle regulation, Role of the cyclins and cyclin-dependent kinases, Cell cycle checkpoints.

Cancer Biology: Genetic basis for cancer; Oncogenes, proto-oncogenes; Chromosome rearrangements and cancer; Tumor suppressor genes; Cellular roles of tumor suppressor proteins, interaction of cancer cells with normal cells, necrosis, apoptosis, therapeutic interventions of uncontrolled cell growth.

UNIT-C 12 hours

Cell Trafficking: Targeting proteins to endoplasmic reticulum, signal recognition particle, 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, Import and sorting of chloroplast protein.

UNIT-D 12 hours

Cell signaling- Modes of cell signaling, Steroid hormone receptors, G-protein coupled receptors; Regulation of signaling pathways, c- AMP pathway of signal transduction; c-GMP, phospholipids and calcium ions, Ras, Raf, MAP kinase pathway, JAK–STAT pathway, bacterial chemotaxis and quorum sensing, cell adhesion and roles of different adhesion molecules in signalling.

Reference books:

1. Alberts, B. Bracy, P. Lewis , J. Raff, M. Roberts K and Watson, J. (eds) (2008). Molecular Biology of the Cell (5th Ed.), Garland Publishing , New York.
2. Avers, C. J. (1976). Cell Biology, Van Nostrand Reinhold, New York.
3. Cooper, G. M. (2015). The cell, A Molecular Approach (7th Ed)ASM press, Washington, D. C.
4. Darnell, J. Lodish, H. and Baltimore, D. (2007). Molecular Cell Biology, 6th edition, Freeman, New York.
5. Derobertis, E. D. P. and Derobertis, E.M.F. (2011). Essentials of Cell and Molecular Biology(8th Ed) Hold Saunders – Philadelphia.
6. Karp G. (2013). Cell and Molecular Biology. Concepts and Experiments, 7th Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
7. Loewy, A. G. , Siekevitz, P, Menningee, J. R. , and Allant, J. A. N. (1999). Cell structure and Functions. An integrated Approach 3rd edition. Saunders College Publishing, Philadelphia, London.
8. Pollard. T.D. and Earnshaw, W.C. (2002) Cell Biology. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
9. Powar, C. B. (1990). Cell Biology. Himalaya Publishing House, Bombay.
10. Sadava, D. E. (1993). Cell Biology – Organelle, Structure and Fucntions. H. Jones and Bartlett- Boston.

Course Title:Molecular Biology
Course Code: ZOO532

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.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning Outcomes: After successfully completing this course, the students will be able to:

1. Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
2. Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
3. Apply their knowledge in problem solving and future course of their career development in higher education and research.
4. Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

UNIT-A 15 hours

DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA supercoiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extra chromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination.

UNIT-B 15 hours

Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA & tRNA, RNA editing, structure and function of different types of RNA, RNA transport.

UNIT-C 15 hours

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.

UNIT-D 15 hours

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).

Reference books:

1. Alberts, B. Bracy, P. Lewis , J. Raff, M. Roberts K and Watson, J. (eds) (2008). Molecular Biology of the Cell (5th Ed.), Garland Publishing , New York.
2. Cooper, G. M. (2015). The cell, A Molecular Approach (7th Ed)ASM press, Washington, D. C.
3. Darnell, J. Lodish, H. and Baltimore, D. (2007). Molecular Cell Biology, 6th edition, Freeman, New York.
4. Derobertis, E. D. P. and Derobertis, E.M.F. (2011). Essentials of Cell and Molecular Biology(8th Ed) Hold Saunders – Philadelphia.
5. Karp G. (2013). Cell and Molecular Biology. Concepts and Experiments, 7th Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
6. Loewy, A. G. , Siekevitz, P, Menningee, J. R. , and Allant, J. A. N. (1999). Cell structure and Functions. An integrated Approach 3rd edition. Saunders College Publishing, Philadelphia, London.
7. Pollard. T.D. and Earnshaw, W.C. (2002) Cell Biology. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
8. Powar, C. B. (1990). Cell Biology. Himalaya Publishing House, Bombay.
9. Sadava, D. E. (1993). Cell Biology – Organelle, Structure and Fucntions. H. Jones and Bartlett- Boston.
10. Genes IX (2008). Benjamin Lewin (Jones and Bartlett Publishers).
11. Molecular cloning: A laboratory manual (2000). J. Sambrook, E.F. Fritish and T. Maniatis (Cold Spring Harbor Laboratory Press, New York).

Course Title: Ecology and Conservation Biology
Course Code: ZOO541

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with concepts of ecology and the principles which govern animal environment interactions.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand what makes the scientific study of animal ecology a crucial and exciting endeavour.
2. Solve the environmental problems involving interaction of humans and natural systems at local or global level.
3. Develop an understanding of how animals interact with each other and their natural environment
4. Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues

UNIT-A 15 hours

- Introduction to ecology and evolutionary ecology
- Physical environment; biotic environment; biotic and abiotic interactions
- Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement
- Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.
- Competition and coexistence, intra-specific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.

UNIT-B 15 hours

- Nature of ecosystem, production, food webs, energy flow through ecosystem, biogeochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes
- Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones
- Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax
- Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition

- structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine)
- Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

UNIT-C 15 hours

- Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations. Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants.
- Factors influencing bioaccumulation from food and trophic transfer. Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Impact of chemicals on biodiversity of microbes, animals and plants.
- Bioindicator and biomarkers of environmental health.
- Biodegradation and bioremediation of chemicals.

UNIT-D 15 hours

- Biodiversity conservation, principles and strategies; in-situ and ex-situ conservation, Protected Area Network
- Convention on biological diversity, Biodiversity Act
- Wild Protection act - 1972, its amendments and implementation
- NBSAP Mega diversity zones and Hot spots: concepts, distribution and importance; Biodiversity prospecting
- Tiger conservation - Tiger reserves in India, Management challenges in Tiger reserve, Biosphere reserves
- Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics

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.
8. Field Sampling: Principles and Practices in Environmental Analysis, Conklin, A.R. Jr., (2004), CRC Press.
9. Fundamental Processes in Ecology: An Earth system Approach, Wilkinson, D.M., (2007), Oxford University Press, UK

Course Title: Ecology and Conservation Biology Laboratory
Course Code: ZOO542

L	T	P	Credits	Marks
0	0	3	2	50

The following practicals will be conducted using e-resources.

- Physical and chemical characteristics of soil.
- Assessing influence of light, temperature and moisture on plant germination and growth/animal behavior and growth.
- Assessing influence of soil nutrient status on plant germination and growth.
- Assessment of density, frequency and abundance of plants/animal in a community using various techniques i.e. transect, quadrate etc.
- Comparison of stands/communities and ordination.
- Biomass and reproductive allocation under various environments.
- Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro-, and macrofauna in decomposition.
- Understanding ecosystem succession by studying various stages of vegetation/community assemblages development.
- Insect diversity in soil.

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 are allowed subject to the availability of resources.

Course Title: Principles of Biochemistry
Course Code: BCH524

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.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand about the importance and scope of biochemistry.
2. Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
3. Understand the structure and function of immunoglobulins.
4. Understand the concept of enzyme, its mechanism of action and regulation.
5. Understand the process of DNA replication, transcription and translation.
6. Learn the preparation of models of peptides and nucleotides.
7. Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
8. Learn measurement of enzyme activity and its kinetics.

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 pho

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
Course Code: BCH525

L	T	P	Credits	Marks
0	0	3	2	50

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.

DAV UNIVERSITY, JALANDHAR

SEMESTER 2

Course Title: Animal Physiology II
Course Code: ZOO536

L	T	P	Credits	Marks
4	1	0	4	100

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

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand the organization of nervous system and process of nerve conduction.
2. Understand the skeletal system in detail
3. Understand the process of vision and hearing.
4. Understand the process of muscle contraction.
5. Learn the determination of hemoglobin content, blood groups and blood pressure.

Unit -A 15 hours

- **Integumentary system:** Embryonic origin, specializations of integument, evolution of skin
- **Skeletal System:** Bone, Cartilage, ossification, types of bones and joints, skeletal disorders
- **Muscle Physiology:** 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; summation and tetanus, neuromuscular junction and transmission.

Unit-B 15 hours

- **Endocrine system:** Histology and functions of endocrine glands, hormone activity, mechanisms of action for lipid soluble and water soluble hormones.
- **Neurophysiology:** Gross neuroanatomy of the brain and spinal cord, conduction of nerve impulse, myelination and saltatory conduction, neurotransmitters and mechanism of synaptic transmission; reflexes and reflex arcs.

Unit -C 15 hours

- **Reproduction**.
- Structure of gonads, gametogenesis, structure and hormonal functions of gonads, hormonal regulation of ovulation, fertilization and implantation, pregnancy, parturition and lactation. Disorders associated with reproductive system.

Unit-D 15 hours

- **Special senses:** Structure and function of all special senses and their disorders
- **Stress and adaptations** General adaptation response, basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance, stress and hormones.

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.* XIEdition John Wiley & sons, 2006.
6. Victor P. Eroschenko.diFiore's Atlas of Histology with Functionalcorrelations. XII Edition. Lippincott W. & Wilkins, 2008.

Course Title: Animal Physiology Laboratory
Course Code: ZOO537

L	T	P	Credits	Marks
0	0	3	2	50

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. Recording of blood pressure using a sphygmomanometer.
5. To study the effect of exercise on cardiovascular and respiratory system.
6. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney.
7. Study of mammalian heart
8. Anatomy of Digestive, circulatory, urinogenital systems using e-resources.
9. Submission of project report on diseases related to any of the systems.
10. Visit to Anatomy museum.

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 are allowed subject to the availability of resources.

Course Title: Advanced Techniques in Zoology

Course Code: ZOO538

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.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand the purpose of the technique, its proper use and possible modifications/ improvement.
2. Learn the theoretical basis of technique, its principle of working and its correct application.
3. Learn the construction repair and adjustment of any equipment required for a technique.
4. Learn the accuracy of technique.
5. Learn the maintenance laboratory equipments/ tools, safety hazards and precautions.
6. Understand the technique of cell and tissue culture. Learn the preparation of solution of given percentage and molarity.
7. Understand the process of preparation of buffer. Learn the techniques of separation of amino acids, proteins and nucleic acids.

UNIT-A 15 hours

- **Microscopy:** Principles of light, phase contrast, fluorescence, confocal, scanning and transmission microscopes; Different fixation and staining techniques for electron microscope (EM); Freeze-etch and freeze-fracture methods for EM, Microphotography and image processing methods in microscopy.
- **Centrifugation:** Different mechanical and chemical procedures for cell fractionation; Principle of centrifugation and ultra-centrifugation; Different methods of ultra-centrifugations (in brief) and their applications; Structural parts of an analytical ultracentrifuge.

UNIT-B 15 hours

- **Molecular biology techniques:** PCR, qPCR, RFLP, RAPD, AFLP, Microsatellite, SNP; DNA sequencing: Maxam-Gilbert sequencing, Sanger sequencing; Introduction to Next-Generation Sequencing (NGS).
- **Electrophoresis:** Principles of electrophoresis, Agarose gel electrophoresis, Capillary electrophoresis, Two-dimensional gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, Southern blotting, Northern blotting, Isoelectric focussing, Applications of electrophoresis.

UNIT-C 15 hours

- **Immuno-techniques:** Antibody generation, ELISA, RIA, Western blotting, Immunoprecipitation, Flow cytometry and fluorescence, Immunoelectron microscopy, Fluorescent *in situ* hybridization (FISH) and Genome *in situ* hybridization (GISH).
- **Radioisotopes:** Radioactive isotopes, Half-life of isotopes, Detection and measurement of radioactivity (Gas ionization, Scintillation and autoradiography),

Applications of radioisotopes in biological sciences, Metabolic labelling, Magnetic Resonance Imaging.

UNIT-D 15 hours

- **Chromatography:** Principles of chromatography, Paper chromatography, Thin layer chromatography, High pressure thin layer chromatography, Gas chromatography, Gel permeation chromatography, Ion exchange chromatography, High pressure liquid chromatography, Affinity chromatography.
- **Spectroscopy:** Ultraviolet and Visible light spectroscopy, Fluorescence spectroscopy, Atomic spectroscopy, Nuclear magnetic resonance, X-ray diffraction.

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: Genetics
Course Code: ZOO660

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: An integrated understanding of the basic principles and mechanisms of genetics and evolution.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning outcomes: After successfully completing this course, the students will be able to:

1. Understand how DNA encodes genetic information and the function of mRNA and tRNA
2. Apply the principles of Mendelian inheritance.
3. Understand the cause and effect of alterations in chromosome number and structure.
4. Relate the conventional and molecular methods for gene manipulation in other biological systems.
5. Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
6. Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc

UNIT-A 15 hours

Principles of inheritance: Mendelian principles, concept of alleles, types of dominance, lethal alleles, multiple alleles, gene interaction: complementation, epistasis, pleiotropy, penetrance and expressivity, linkage, crossing over, sex linkage, sex-limited and sex-influenced characters, Inheritance of Mitochondrial and chloroplast genes, maternal inheritance, genomic imprinting.

Microbial genetics: Methods of genetic transfers: transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

UNIT-B 15 hours

Cytogenetics: Karyotyping, Staining techniques (Giemsa stain (G) and quinacrine stain (Q), R-banding); Giant chromosomes: Polytene and lampbrush chromosomes.

Quantitative Genetics: Multiple factor hypothesis, Types of quantitative traits, Components of phenotypic variation; Concept of heritability: broad sense heritability, narrow sense heritability, Artificial selection; Quantitative genetics of human behavioral traits: intelligence, personality, QTL mapping.

UNIT-C 15 hours

Human Genetics: Pedigree symbols, Construction of pedigree, Lod score for linkage testing; Sex-linked anomalies (haemophilia, color blindness); Testicular feminization syndrome; Single active X hypothesis; Sex chromatin and drum sticks, Genetic mosaics; Mechanisms of mitotic non-disjunction/meiotic /chromosomal rearrangements (Klinefilter syndrome, Down's syndrome, Turner syndrome); Inborn errors of metabolism (Phenylketonuria (PKU), Alkaptonuria, Albinism, Galactosemia); ABO blood group

system, Rhesus (Rh) blood group, Erythroblastosis fetalis; Multifactorial disorders: Diabetes, Schizophrenia, Huntington disease.

UNIT-D 15 hours

Population Genetics: Gene pool, Gene frequency, Hardy-Weinberg principle, Applications of Hardy-Weinberg principle, Exceptions to the Hardy-Weinberg principle; Natural selection, Models of selection: Directional selection, Balancing selection, Diversifying selection; Effective population size, Genetic drift, Founder effect, Bottleneck effect, Loss of genetic variation: Inbreeding, Inbreeding depression.

Evolutionary Genetics: Molecular evolution and phenotypic evolution, Molecular phylogeny, Rates of molecular evolution, Molecular clock, Neutral theory of molecular evolution; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; Origin of new genes and proteins; Gene duplication and divergence, Concept of species, Modes of speciation: Allopatric, Sympatric, Adaptive radiation; Convergent evolution; Sexual selection; Co-evolution.

Reference books:

1. Futuyama, D.J., *Evolution*, Suinuaer Associates, INC Publishers, Dunderland., 2005
2. Hartl, D.L. and Clark A.G., *Principles of Population Genetics*, Fourth Edition, Sinauer Associates publications, 2007.
3. Hartl, D.L., *A Primer of Population Genetics*, Third Edition, Harvard University press, 2000.
4. Hamilton, M.B., *Population Genetics*, Willey-Blackwell publications,2009.
5. Allendorf, F.W. and Gordon Luikart, G., *Conservation and the Genetics of Populations*, Wiley-Blackwell publications, 2006.
6. Strikberger, M.W., *Evolution*, Jones and Bartett Publishers, Boston London, 2014
7. Snustad, D.P. and Simmons, M.J, *Principles of Genetics*, John Wiley & Sons, 2011.

Course Title: Immunology
Course Code: ZOO534

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint students with the different components of immune system and their functioning.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning outcomes: After successfully completing this course, the students will be able to:

1. Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
2. Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
3. Understand how the immune system distinguishes self from non-self.
4. Gain experience at reading and evaluating the scientific literature in the area.

UNIT-A 20 hours

- **Concepts in immunology:** Specificity, discrimination of self from non-self and memory
- **Cells and organs of immune system:** Lymphocytes, Monocyes, Eosinophils, Basophils, Neutrophils, Dendritic cells; Lymphoid organs
- **Antigens:** Characteristics of antigens, antigenicity vs. immunogenicity, epitopes, B and T cell epitopes, adjuvants
- **Antibodies:** Structure, Types and Functions of antibodies; concept of monoclonal and polyclonal antibodies

UNIT-B 10 hours

Antigen-antibody interactions: Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, IFA, ELISA and Flow cytometry

UNIT-C 15 hours

- **Immunity:** Innate and acquired immunity, Humoral immunity, Cell mediated immunity,
- **Complement system:** Nomenclature of complement components, activation pathways of complement system
- **Cytokines:** Various cytokines and their role

UNIT-D 15 hours

- **Autoimmunity:** Mechanisms of autoimmunity

- **Hypersensitivity:** General concept, types of hypersensitivity
- **Vaccines:** General concept, types of vaccines

Reference books:

1. Abbas AK, Lichtman AH, Pillai S. Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia. 2007. Print
2. Delves P, Martin S, Burton D, Roitt IM. Roitt's Essential Immunology. 11th edition Wiley Blackwell Scientific Publication, Oxford. 2006. Print
3. Goldsby RA, Kindt TJ, Osborne BA. Kuby's Immunology. 6th edition W.H. Freeman and Company, New York. 2007. Print
4. Murphy K, Travers P, Walport M. Janeway's Immunobiology. 7th edition Garland Science Publishers, New York. 2008. Print
5. Peakman M, and Vergani D. Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg. 2009. Print

Course Title: Biological Techniques Laboratory
Course Code: ZOO672

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 separate a sample of amino acids with the help of paper chromatography and TLC
- Demonstration of SDS-PAGE, 2-D gel electrophoresis, and western blotting to students.
- To demonstrate ELISA to students.
- Preparation of permanent slides of cell division
- Preparation of permanent slide of polytene chromosomes
- Isolation of DNA from prokaryotes/eukaryotes
- Designing of primers and ePCR
- Amplification of DNA by PCR
- Analysis of genetic variability in populations of insects.
- To study the phylogenetic relationships using DNA sequences from NCBI.
- Identification of human blood groups.
- To perform immunodiffusion by Ouchterlony method.

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 are allowed subject to the availability of resources.

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SEMESTER 3

Course Title: Biosystematics
Course Code: ZOO540

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: To acquaint the student with different procedures of taxonomy and different methods of analysis of variations and theories of classification.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning Outcomes: At the end of the course the students will be able to:

1. Understand the historical development of systematics from 18th century to the present.
2. Understand the use of taxonomic keys.
3. Understand the uses and limitations of phylogenetic trees.
4. Appreciate the complexities and difficulties of various species concepts.
5. Gain a basic grasp on the rules and philosophy of nomenclature.

UNIT-A 15 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 15 hours

- 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

UNIT-C 15 hours

- Taxonomic characters- different kinds, origin of reproductive isolation-biological mechanism of genetic incompatability
- Taxonomic procedures-taxonomic collections, preservation, curetting, process of identification

UNIT-D 15 hours

- 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

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.

Course Title: Developmental Biology

Course Code: ZOO662

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To enable the students to 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 to understand the environmental influences on development and factors responsible for ageing.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning outcomes: After successfully completing the course, the students will be able to:

1. Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
2. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions of other tissues and organisms.
3. Realize that very similar mechanisms are used in very diverse organisms; and development is controlled through molecular changes resulting in variation in the expression and function of gene networks.
4. Understand how the field of developmental biology has changed since the beginning of the 19th century with different phases of developmental research predominating at different times.
5. Understand the relevance of developmental biology in medicine or its role in development of diseases.

UNIT-A 15 hours

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

UNIT-B 15 hours

- Cleavage patterns in animals.
- Early embryonic development in Pisces, Amphibians, Reptiles, Aves and Mammals.

UNIT-C 15 hours

- Genetic regulation in early development of *Drosophila*-Homeotic genes
- Post embryonic development-larva formation
- Metamorphosis-environmental regulation in normal development
- Sex determination

UNIT-D 15 hours

- Embryonic stem cells and their applications.
- Medical implications of developmental biology: genetic errors of human development- the nature of human syndromes– pleiotropy, genetic heterogeneity, phenotypic variability, mechanism of dominance; gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation.
- Teratogenesis- environmental assaults on human development- teratogenic agents like alcohol, retinoic acid etc.

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: ZOO663

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 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 are allowed subject to the availability of resources.

Course Title: Parasitology
Course Code: ZOO632

L	T	P	Credits	Marks
4	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.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After successfully completing the course, the students will be able to:

1. Describe the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
2. Diagnose the causative agents, describe pathogenesis and treatment for important diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
3. Know how resistance development and resistance transfer occur

UNIT-A 15 hours

- Introduction to parasitic protozoa.
- General account of medically important parasites in Kinetoplastida, Coccidia, Piroplasmia and Microspora (for example *Leishmania, Trypanosoma, Babesia, Isospora* etc.).
- *In vitro* culture of protozoan parasites..

UNIT-B 15 hours

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

UNIT-C 15 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.
- Parasite Transmission
- Host parasite Interactions

UNIT-D 15 hours

- General organization and outline classification of nematodes with general account of importantparasites in strongylidea, ascaridoidea, filarioidea and trichinelloidea.
- Variations in life cycle of nematodes.

Reference books:

1. Chatterjee, K. D. *Parasitology: Protozoology and Helminthlogy*. 13th ed. CBSpublishers 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.

- Study of the protozoan parasites (*Leishmania, Trypanosoma, Plasmodium, Giardia, Balantidium)*
- Study of the trematodes (*Fasciola, Fasciolopsis, Schistosma, Paragonimus, Cloronchis*)
- Study of the digenetic trematode larvae from the snails.
- Study of the cestodes (*Taenia, Echinococcus, Moneizia, Hymenolepis, Diphyllobothrium)*
- Study of the nematodes (*Ascaris, Trichinella, Ancylostoma, Wuchereria, Enterobius)*

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 are allowed subject to the availability of resources.

Course Name: Scientific Writing and Research Methodology

Course 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

DAV UNIVERSITY, JALANDHAR

SEMESTER 4

DEPARTMENTAL ELECTIVE COURSES

Course Title: Animal Biotechnology
Course Code: ZOO664

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with animal tissue culture and cloning methods.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning Outcomes: After successfully completing this course, the students will be able to:

1. Develop an understanding of the fundamental molecular tools and their applications in animal cloning.
2. Develop future course of their career development in higher education and research with a sound base.
3. Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry

UNIT-A 15 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 15 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 15 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: ZOO665

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: Reproductive Neuroendocrinology
Course Code: ZOO666

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with principles and processes underlying central regulation of reproduction

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning outcomes: Upon successful completion of this course, students should be able to:

1. Explain and contrast the processes of spermatogenesis, oogenesis.
2. Demonstrate an understanding of the hormonal control of reproduction in males and how this is regulated;
3. Distinguish between the main stages of embryonic, foetal and neonatal development and causes of foetal disorders.
4. Understand the origin and characteristics of common congenital malformations;
5. Know how sexually transmitted diseases may contribute to altered neonatal or reproductive function.
6. Critically assess relevant scientific literature in Human Reproductive Biology and present their argument in oral and written work.

UNIT-A 10 hours

- 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.

UNIT-B 20 hours

- 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: sexual dimorphism and function.
- 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.

UNIT-C 15 hours

- 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.

- Regulation of the expression of POMC-related peptides and their differential expression in brain and pituitary.

UNIT-D 15 hours

- Environment and reproduction.
- Endocrine disruptors; Embryonic diapauses and other adaptive mechanisms.
- Principles and application of techniques: electrophysiology, immunocytochemistry, *in situ* hybridization, autoradiography, in vitro perifusion

Reference books:

- Brown R., An Introduction to Neuroendocrinology, Cambridge University Press, Cambridge, UK, 1994.
- Endocrinology (3 volumes set), *DeGroot* L. J. and Jameson J.L., Editors,), Saunders Elsevier Press, USA. 5th Ed., 2006

Course Title: Reproductive Neuroendocrinology Laboratory
Course Code: ZOO667

L	T	P	Credits	Marks
0	0	3	2	50

- Identification of hypothalamic nuclei following histological, histochemical and immunocytochemical methods.
- Stereotaxic atlas of Hypothalamus.
- Isolation and characterization of pituitary cells.
- Localisation of GnRH neurons in median eminence arcuate nucleus via immunohistochemistry.
- Stereotaxic devices and administration of stimulants.
- Transcardial perfusion of rat brain.
- Primary culture of neuronal/glial cells.

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 are allowed subject to the availability of resources.

Course Title: Animal Behaviour
Course Code: ZOO668

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The main objective of the course is to acquaint students with different behavioural patterns of animals and to understand animal psychology.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning outcomes: After successfully completing this course, the students will be able to:

1. Learn a wide range of theoretical and practical techniques used to study animal behaviour.
2. Develop skills, concepts and experience to understand all aspects of animal behaviour.
3. Objectively understand and evaluate information about animal behaviour and ecology encountered in our daily lives.
4. Understand and be able to objectively evaluate the role of behaviour in the protection and conservation of animals in the wild.
5. Consider and evaluate behaviour of all animals, including humans, in the complex ecological world, including the urban environment

UNIT-A 12 hours

Introduction - definition, historical out line, patterns of behaviour, objectives of behaviour, mechanism of behaviour, asking questions. Reflexes- reflex action, types of reflexes, reflex arch, characteristics of reflexes and complex behaviour. Orientation primary and secondary orientation; kinesis – orthokinesis, klinokinesis; taxis – different kinds of taxis; sun-compass orientation, dorsal- light reaction.

UNIT-B 12 hours

Eusociality, social organization in honey bee, polyphenism and its neural control, flower recognition, displacement and translocation experiment, various type of communications, production of new queen and hive, swarming, honey bee as super organism**.** Fixed action pattern: mechanism, deprivation experiment, controversies. FAP- characteristics and evolutionary features. Learning and instincts: conditioning, habituation, sensitization, reasoning.

UNIT-C 12 hours

Innate releasing mechanisms: key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM, mimetic releaser, code breakers. Homeostasis and behaviour: motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat, role of hormone, motivational conflict and decision making, displacement activity, models of motivation,

measuring motivation. Hormones and pheromones influencing behaviour of animals.

UNIT-D 12 hours

Altruism – reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call. Parental care, parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care with suitable case studies. Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice), infanticide, sperm competition, mate guarding, sexual selection in human, consequences of mate choice for female fitness, monogamous verses polygamous sexual conflict.

Reference books:

1. Mechanism of Animal Behaviour, Peter Marler and J. Hamilton; John Wiley & Sons, USA
2 Animal Behaviour, David McFarland, Pitman Publishing Limited, London, UK
3 Animal Behaviour, John Alcock, Sinauer Associate Inc., USA
4 Perspective on Animal Behaviour, Goodenough, McGuire and Wallace, John Wiley & Sons, USA
5 Exploring Animal Behaviour, Paul W. Sherman & John Alcock, Sinauer Associate Inc. ,Massachusetts, USA
6 An Introduction to Animal Behaviour, A. Manning and M.S Dawkins, Cambridge University Press, UK

Course Title: Animal Behaviour Laboratory
Course Code: ZOO669

L	T	P	Credits	Marks
0	0	3	2	50

1. To study the responses of woodlice to hygrostimuli.

2. To study the geotaxis behaviour of earthworm.

3. To study the orientational responses of 1st instar noctuid larvae to photo stimuli.

4. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly.

5. To study the orientational responses of larvae to volatile and visual stimuli.

Course Title: Economic Zoology
Course Code: ZOO630

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: To acquaint the students with the applied aspects of Zoology.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand the culture techniques of prawn, pearl and fish.
2. Understand silkworms rearing and their products.
3. Understand the Bee keeping equipments and apiary management.
4. Understand dairy animals management, the breeds and diseases of goats and learn the testing of egg and milk quality.

UNIT-A 15 hours

- **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 bees: American and European Foulbrood; Honey extraction techniques; Physico-chemical analysis ofhoney; Other beneficial products from bee; Visit to an Apiculture Institute and honeyprocessing Units

UNIT-B 15 hours

- **Sericulture**: Different types of 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; Silkworm pests and parasites: Uzi fly,Dermestid beetles; Silk reeling techniques; Quality assessment of silkfibre

UNIT-C 15 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; Fisheryby-products

UNIT-D 15 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 theirmanagement; Dairy/poultry farm management and business plan; Visit to any Dairyfarm/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, NewDelhi.
5. Srivastava, C. B. L. *Fishery Science and Indian* Fisheries. Kitab MahalPublications, India, 1999.

L	T	P	Credits	Marks
0	0	3	2	30

Course Title: Economic Zoology Laboratory

Course Code: ZOO646

- To study the social organization in honey bees
- To study the modern bee hive.
- To study the enemies of honey bees
- To study the life history of *Bombyx mori.*
- Preparation and maintenance of fish aquarium
- Visit to Dairy/Poultry Farm

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 are the curriculum is allowed subject to the availability of resources.

Course Title: Entomology
Course Code: ZOO638

L	T	P	Credits	Marks
4	0	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.
Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.
Learning Outcomes: After successfully completing this course, the students will be able to:

1. Understand the morphology of insects
2. Understand the physiology of insects
3. Understand the development process in insects
4. Identify and learn to manage the insect pests.

UNIT-A **15 hours**

• General introduction of insect order and their examples.

• General Structure, modification and orientation of head; types of mouthparts and antennae in different insects.

• Thorax: structure and modifications of wings, venation; Legs: structure and modifications.

• Abdomen: parts and types of abdomen, modification and external genitalia.

UNIT-B **15 hours**

• General structure and functions of digestive system, respiratory (terrestrial and aquatic) and circulatory systems in insects.

• General structure and functions of excretory, nervous system and reproductive systems in insects.

UNIT-C **15 hours** •
Thermodynamics: Types of metamorphosis and growth in insects with relation to hormones, termination and significance of diapause.

• Structural modifications in larvae and pupae in different orders and relationship of nymphs and naiads.

UNIT-D **15 hours**

• Pest of field crops and stored grains- distribution, biology, nature of damage and management.

• Insects as Bio controlling agents-parasites, predators, insect pathogens and entomophagous insects; Insects as vectors.

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 Entomology. 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	50

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 (Field visit).
2. Study of body parts and appendages of different insects: mouth parts, antenna and legs.
3. Study of insect external male and female genitalia.
4. Preparation of permanent mounts of appendages and genitalia of insects.
5. Study of an insect to study tracheation and spiracles.
6. Anatomy of various insects to study the alimentary canal and glands associated with the digestion of different types of food.
7. Study of various insects to demonstrate number, arrangement and associations of Malpighian tubules.
8. Neuroendocrine organs of an insect (cockroach/grasshopper).
9. Study of life history of important insect pests and non-insect pest.
10. Extraction of DNA from Insect leg using Phenol-Chloroform method.
11. To study the effect of temperature and photoperiod on the development of insects.

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 are allowed subject to the availability of resources.

Course Title: Aquaculture and Fisheries
Course Code: ZOO636

L	T	P	Credits	Marks
4	0	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.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After completing this course the learners will be able to

1. understand the aquatic systems
2. Understand the concept of Pisciculture and Pearl Culture
3. Understand the environmental impacts of aquaculture

UNIT-A 10 hours

- **Fresh water ecosystems:** Introduction, types, distribution, origin and forms.
- **Water and Hydrobiological characteristics** – Molecular structure and properties (specific heat, density, surface tension).
- **Abiotic and Biotic Factors***:* Temperature, penetration of light, turbidity, dissolved gases, pH, Benthos, Periphyton, Plankton, Nekton and Neuston.
- **Lentic Ecosystem:** Zonation and Thermal stratification, concepts of productivity
- **Classification of lakes:** Oligotrophic, Eutrophic and Dystrophic lakes
- **Eutrophication:** Causes, impact and abatement

UNIT-B 10 hours

- **Estuarine Habitat:** Characteristics, classification, estuarine fauna and its adaptations.
- **Special Aquatic Habitats:** Alpine lakes and salt lakes.
- **Bioassay**: Terminology, methodology, calculation of LC 50 and EC 50 values.
- **Aquatic organisms as bioindicators**.
- **Water quality index calculation**.

UNIT-C 25 hours

- **Fishery Science:** Its importance and application.
- **Fish within Aquatic Ecosystem:** Respiration, feeding, digestion and reproductive cycle.
- **Form and Locomotion:** Types and functions of scales, fins, swim bladder and lateral line system

- Age and growth studies and their application in fishery management.
- **Morphological variations in the body form**- in deep – sea and hill stream fishes.

UNIT-D 15 hours

- **Indigenous and Exotic fishes:** Different exotic fishes introduced in India, history, causes, impacts, usefulness to fish culture.
- **Fish farm engineering:** Selection of site, construction of fish farm, Brood stock management; Induced breeding of fish; Management of hatchery nursery, rearing and stocking ponds, by-products of fishery industry.
- **Pearl Culture:** Species involved, procedure, national and international status
- **Fish diseases and their control**

Reference Books:

1. Jhingran, V.G., Fish and Fisheries of India, Hindustan Publishing House (India), New Delhi (1991).
2. Aquaculture Production. FAO. Fisheries Circular No.815, No.4, Rev.FAO Rome (1998).
3. Mohan Joseph, M, Aquaculture in Asia, Asian Fisheries Society, Manglore (1990).
4. Talwar, P.K., & Jhingran, A.G., Inland Fishes of India, Vols.I & II, P.K. Talwar & Jhingran, A.G., Oxford & IBH, New Delhi (1991).
5. Lagler Karl F., Freshwater Fishery Biology, Wm.C.Brown Company Publ., Dubuque, Iowa (1969).
6. Bangenal,T., Methods for Assessment of Fish Production in Freshwaters 3rd Ed , IBH Handbook No.3 Blackwell Scientific Publication, Oxford (1970).
7. Johal, M.S., and Tandon, K.K., Monograph on the Fishes of reorganized Punjab, Parts I & II. Punjab Fisheries Bulletin (1979, 1980).
8. Odum, E.P., Fundamentals of ecology, W.B. Saunders Co. Philadelphia (1971).
9. Welch, P.S., Limnology, Mcgraw Hill Book Co. New York (1952)
10. Wetzel, R.G., Limnology, W.B.Saunders Co. Philadelphia (1983).
11. Hynes, H.B.N., The Biology of Polluted Waters, Liverpool Univ. Press, Liverpool (1978). 12. Ruttner, F., Fundamentals of Limnology, Univ. Press, Toronto (1975).
12. Tandon,K.K. & Johal, M.S., Age and growth in Indian Freshwater Fishes, Narendra Publishing House, Delhi (1995).
13. Johal, M.S., Aggarwal, S.C., Fishery Development, Narendra Publishing House, Delhi (1997).
14. Peter B. Moyle & Jseph J. Cedh, Fishes:An Introduction to Ichthyology, Prentice – Hall, Inc. Jersey, U.S.A. (1986).

Course Title: Aquaculture and Fisheries Laboratory
Course Code: ZOO637

L	T	P	Credits	Marks
0	0	3	2	50

- To measure solids (dissolved and suspended) in water.
- Familiarity with the identification keys for freshwater fish.
- Study of different types of Phytoplankton (diagram/chart/video).
- Study of different types of Zooplankton (diagram/chart/video).
- Estimation of Nitrates/Phosphates in water.
- Estimation of dissolved oxygen by modified Winkler's method in water.
- Calculation of water quality index
- Determination of age with help of fish scale.
- Study of important deep-sea and hills stream fishes with special reference to various adaptations.
- Study of various exotic fishes introduced in India and their characteristic features.
- Identification of the following fishes up to species level using e-resources:
  Clupeiformes - *Notopterus.*
  Cypriniformes – *Schizothorax, Hypophthalmichthys, Cyprinus, Puntius, Labeo, Catla, Cirrhinus, Tor, Garra, Noemacheiulus, Botia.*
  Siluriformes: *Mystus, Aorichthys, Wallago, Heteropneustes*
  Channiformes: *Channa*
  Perciformes: *Colisa, Anabas*
  Mastacembeliformes: *Mastacembelus*
- Visit to a fish farm.

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 are allowed subject to the availability of resources.

Reference books:

1. Futuyama, D.J., *Evolution*, Suinuaer Associates, INC Publishers, Dunderland., 2005
2. Hartl, D.L. and Clark A.G., *Principles of Population Genetics*, Fourth Edition, Sinauer Associates publications, 2007.
3. Hartl, D.L., *A Primer of Population Genetics*, Third Edition, Harvard University press, 2000.
4. Hamilton, M.B., *Population Genetics*, Willey-Blackwell publications,2009.
5. Allendorf, F.W. and Gordon Luikart, G., *Conservation and the Genetics of Populations*, Wiley-Blackwell publications, 2006.
6. Strikberger, M.W., *Evolution*, Jones and Bartett Publishers, Boston London, 2014
7. Snustad, D.P. and Simmons, M.J, *Principles of Genetics*, John Wiley & Sons, 2011.

Course Title: Population Genetics and Evolution
Course Code: ZOO670

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: An integrated understanding of the basic principles and mechanisms of population genetics and evolution.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After completing this course the learners will be able to:

1. Understand the concept of population genetics
2. Understand the Hardy Weinberg Principle
3. Learn to construct phylogenetic trees
4. Understand the concept evolution at molecular level..

UNIT-A 12 hours

- Populations, Gene pool, Gene frequency; Hardy-Weinberg principle; Applications of Hardy-Weinberg principle; Exceptions to the Hardy-Weinberg principle.

UNIT-B 15 hours

- Fundamental principles of genetic variation; Sources of phenotypic variation; Genetic variation in natural population; Polymorphism; Genetic variation at protein level; Genetic variation at DNA level; Variation among populations: Subspecies, cline, ecotype; Adaptive geographic variation: Character displacement; Geographic variation among humans; Variation in cognitive abilities.

UNIT-C 18 hours

- Natural Selection: Concepts and rate of change in gene frequency through natural selection; Natural selection at the level of gene; Models of selection: Directional selection, Balancing selection, Diversifying selection.
- Genetic drift: Genetic drift as sampling error; Radom fluctuations in allele frequencies: Deme, Metapopulation; Effective population size, Founder effect; Bottleneck effect; Loss of genetic variation: Inbreeding, Inbreeding depression; Gene flow: Genetic divergence among populations and gene flow; Gene flow and genetic drift.

UNIT-D 15 hours

- Concept and theories of evolution: Darwin's theory of evolution; Molecular evolution and phenotypic evolution; Molecular phylogeny; Rates of molecular evolution; Molecular clock; Neutral theory of molecular evolution; Speciation: Concept of species; Modes of speciation: Allopatric, Sympatric
- Human Evolution: Humans and the great apes; Human evolution in the fossil record; DNA sequence variation and human origin.

Reference books:

1. Futuyama, D.J., *Evolution*, Suinuaer Associates, INC Publishers, Dunderland., 2005
2. Hartl, D.L. and Clark A.G., *Principles of Population Genetics*, Fourth Edition, Sinauer Associates publications, 2007.
3. Hartl, D.L., *A Primer of Population Genetics*, Third Edition, Harvard University press, 2000.
4. Hamilton, M.B., *Population Genetics*, Willey-Blackwell publications,2009.
5. Allendorf, F.W. and Gordon Luikart, G., *Conservation and the Genetics of Populations*, Wiley-Blackwell publications, 2006.
6. Strikberger, M.W., *Evolution*, Jones and Bartett Publishers, Boston London, 2014
7. Snustad, D.P. and Simmons, M.J, *Principles of Genetics*, John Wiley & Sons, 2011.

Course Title: Population Genetics and Evolution Laboratory
Course Code: ZOO671

L	T	P	Credits	Marks
0	0	3	2	50

- Numericals based on Hardy-Weinberg Law.
- Numericals based on probability
- Similarity search using BLAST
- Phylogenetic relationships among different species using DNA and protein sequences from NCBI
- Study of human evolution using e-resources

DAV UNIVERSITY, JALANDHAR

COURSES FOR OTHER DEPARTMENTS

Course Name: Biology for Chemists
Course Code: ZOO701

L	T	P	Credits	Marks
0	0	3	2	50

Course Objective: To introduce the students of chemistry with the basic concepts of physiology.

Teaching Methodology: Class room Lectures, practicals, models, charts, power point presentations, and activities.

Learning Outcomes: After completing this course the learners will be able to:

1. Understand the structure of Cell
2. Understand the Different types of tissues
3. Understand the physiology of digestion, circulation, respiration and excretion.

Unit I **18hrs**

Introduction: General Introduction to anatomy, physiology and its related sciences. Physico-chemical laws and their applications in Physiology. Elementary Composition of a Human Body Cell Structure and Functions-A Basis of Physiology: Structure and functions of subcellular organelles, Elementary tissues (Epithelial, Muscular, Connective & Nervous) of the Human Body, their structure & functions, molecular mechanism of skeletal muscle contraction, nerve conduction, membrane transport and cell division

Unit-II **12hrs**

Digestive System: Physiological anatomy and histology of the digestive system, Functions of Digestive system, Digestive juices (Saliva, Gastric, Pancreatic Bile and Intestinal), their composition, functions and mechanism of secretions, movements of alimentary canal and gut reflexes, digestion of carbohydrates, proteins, lipids and their absorption Vitamins: History, characteristics, composition and functions of various vitamins (Vitamins A, D, E, K, C B1, B2, B3, B6 and B12) etc.

Unit-III **18hrs**

Cardiovascular System : Systemic & Pulmonary Circulation; Hepatic, Renal & Hypophyseal portal circulation. Anatomy of Heart and properties of cardiac muscles. Origin and conduction of Heart beat. Nervous & chemical regulation of Heart beat. Cardiac cycle, heart sounds, ECG, Cardiac output. Blood pressure and its regulation. Respiratory System: Anatomy of respiratory system, mechanism of pulmonary ventilation, pulmonary volumes and lung capacities, physical principles and mechanisms of gaseous exchange and transport, regulation of respiration.

Unit-IV **12hrs**

Excretory System: Physiological anatomy of the kidneys and urinary tract, urine formation (glomerular filtration, tubular reabsorption and secretion) and its regulation. Endocrine System:Introduction and General Mechanisms of physiological action of Pituitary hormones, Thyroid hormones, Adrenocortical hormones, Pancreatic hormones, Parathormone and Calcitonin, Gonadal hormones