Central University of Punjab, Bathinda

M.Sc. Zoology

Academic Session: 2020–22

Department of Zoology

School of Basic and Applied Sciences

Program Learning Outcome:

The program focuses on developing an aptitude and employable skills required in the area to meet the challenge in capacity building with innovative ideas and to train with initiate start-ups in the field of interdisciplinary science.

Semester – I

Course Code	Course Title	Type of course	L	T	P	Cr
	Core Courses					
ZOL.508	Biochemistry	**Core**	3	0	0	3
ZOL.511	Cell Biology	**Core**	3	0	0	3
ZOL.516	Animal Evolution and Classification	**Core**	3	0	0	3
ZOL.517	Ecological Principles	**Core**	3	0	0	3
ZOL.520	Lab Course (Practical) – I	**SB**	0	0	8	4
	Discipline Elective Course (Opt any one)/MOOC					
ZOL.514	Animal Cell Culture and Applications	**DE**	2	0	0	2
ZOL.525	Nanobiology	**DE**	2	0	0	
	Inter-Disciplinary (ID) Course					
ZOL.515	Fundamentals of Cell Biology (For students of other departments)	**IDC**	2	0	0	2
XXX	For department students	**IDC**	2	0	0	
	#Compulsory Foundation					
CST.501	Computer Applications for Sciences	**CF**	2	0	0	2
	Total Credits					**22**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; #CF: Compulsory Foundation Course will be offered at the University level; SB: Skill-based Course

Semester – II

Course Code	Course Title	Type of course	L	T	P	Cr
	Core Courses					
ZOL.521	Animal Physiology – I	**Core**	3	0	0	3
ZOL.522	Immunology	**Core**	3	0	0	3
ZOL.523	Molecular Biology	**Core**	3	0	0	3
ZOL.527	Essentials of Genetics	**Core**	3	0	0	3
ZOL.540	Lab Course (Practical) – II	**SB**	0	0	10	5
	Discipline Elective Course (Opt any one)/ MOOC					
ZOL.529	Genetic Engineering	**DE**	2	0	0	2
ZOL.572	Endocrinology	**DE**	2	0	0	
	Inter-Disciplinary (ID) Course					
ZOL.528	Basics in Neuroscience (For students of other departments)	**IDC**	2	0	0	2
XXX.YYY	For our students from other departments					
	Seminar					
ZOL.542	Seminar-I	**SB**	0	0	0	1
	Total Credits					**22**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SB: Skill-based Course

Semester – III

Course Code	Course Title	Type of course	L	T	P	Cr
	Core Courses					
ZOL.551	Developmental Biology	**Core**	3	0	0	3
ZOL.555	Animal Physiology-II	**Core**	3	0	0	3
ZOL.513	Techniques in Life Sciences	**Core**	3	0	0	3
ZOL.570	Lab Course (Practical) – III	**SB**	0	0	8	4
	Discipline Elective Courses (Opt any one)/MOOC					
ZOL.553	Vascular Biology	**DE**	2	0	0	2
ZOL.554	Neurobiology and Degeneration	**DE**	2	0	0	
	Compulsory Foundation#					
ZOL.556	Research Methodology	**CF**	2	0	0	2
ZOL.557	Basic Statistics for Sciences	**CF**	2	0	0	2
	Value Added Course					
XXX.YYY	VAC	**VB**	1	0	0	1
	Research					
ZOL.599	Project	**SB**	0	0	0	4
	Total Credits					**24**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; CF: Compulsory Foundation Course; VB: Value-based Course; SB: Skill-based course; #CF: Compulsory Foundation Course will be offered at the University level

Semester – IV

Course Code	Course Title	Type of course	L	T	P	Cr
	Core Courses					
ZOL.573	Metabolism	**Core**	3	0	0	3
ZOL.574	Animal Behavior	**Core**	3	0	0	3
	Discipline Elective Courses (Opt any one)					
ZOL.552	Cancer Biology	**DE**	2	0	0	2
ZOL.577	Reproductive Physiology	**DE**	2	0	0	
ZOL.578	Insect Biology	**DE**	2	0	0	
	Seminar					
ZOL.544	Seminar – II	**SB**	0	0	0	1
	Discipline Enrichment Course					
ZOL.575	Career Prospects in Life Sciences-1	**DEC**	2	0	0	2
ZOL.576	Career Prospects in Life Sciences-2	**DEC**	2	0	0	2
	Value added course					
XXX.YYY	VAC	**VB**	1	0	0	1
	Research					
ZOL.599	Project	**SB**	0	0	0	8
	Total Credits					**22**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; VB: Value-based Course; DE: Discipline Elective Course; ID: Interdisciplinary Course; SB: Skill-based Course

Criteria for Evaluation for Theory Courses

A: Continuous Assessment: [25 Marks]

i. Surprise Test (minimum three) - Based on Objective Type Tests (10 Marks)

ii. Term paper (10 Marks)

iii. Assignment(s) (5 Marks)

B: Pre-Scheduled Mid Semester Test-1: Based on Subjective Type Test [25 Marks]

C: End Semester Examination (ESE) part-1: Based on Subjective Type Test [25Marks]

D: End Semester Examination part-2: Based on Objective Type Tests [25 Marks]

SEMESTER – I

Course Code: ZOL.508
Course Title: Biochemistry

L	T	P	Cr
2	1	0	3

Learning outcomes: After going through the course the learners will be able to

- Define fundamentals and basics of biochemistry
- Illustrate a thorough knowledge of the intersection between the disciplines of biology and chemistry
- Explain advanced aspects of biochemistry such as nutrition and metabolism associated with human physiology
- Develop a comprehensive knowledge of the theory and practice of modern biochemistry and its application to solve chemical problems

Unit I **9 Hours**

Principles of Biophysical Chemistry: pH, buffers, reaction kinetics, thermodynamics, colligative properties, chemical bonds and stabilizing interactions: van der Waals, electrostatic, hydrogen bonding & hydrophobic interactions.

Unit II **12 Hours**

Bioenergetics: Introduction, Laws of thermodynamics, Concept of free energy, Entropy, Enthalpy, standard free energy, determination of ΔG. Relationship between equilibrium constant and standard free energy change. Biological oxidation-reduction reactions.

Unit III **12 Hours**

Composition, Structure and Function of Biomolecules: CZOOsification, structure, general properties and functions of polysaccharides. **Lipids** – Classification, structure, properties and functions of fatty acids. **Proteins** – Peptide synthesis, Primary, Secondary, Tertiary and Quaternary structures of proteins.

Unit IV **12 Hours**

Enzymology: Historical perspective, general characteristics, nomenclature, IUB enzyme classification, measurement and expression of enzyme activity, enzyme assay, factors influencing enzyme activity, active site, Michaelis-Menten equation and its importance. Definitions of IU, Katal, enzyme turnover and specific activity. Clinically important enzymes.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning,

Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2010). Biochemistry. W.H. Freeman & Company. USA.
2. Mathews, C. K., Van Holde, K. E. and Ahern, K. G. (2000). Biochemistry. Oxford University Press Inc. New York.
3. Nelson, D. and Cox, M. M. (2008). Lehninger Principles of Biochemistry. BI publications Pvt. Ltd. Chennai, India.
4. Shukla, A. N. (2009). Elements of Enzymology. Discovery Publishing. New Delhi, India.
5. Voet, D. and Voet, J. G. (2008). Principles of Biochemistry. CBS Publishers & Distributors. New Delhi, India.

Course Code: ZOL.511
Course Title: Cell Biology

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Define the structure and basic components of a cell
- Distinguish the structure of prokaryotic and eukaryotic cell
- Explain macromolecules, membranes, organelles and their related functions in cell and molecular biology
- Develop a basis for understanding disease processes in which signaling is compromised

Unit I **12 Hours**
Cell: Evolution of the cell, molecules to cell, prokaryotes and eukaryotes.

Membrane Structure and Function: Models of membrane structure, membrane proteins, membrane carbohydrates, membrane transport of small molecules, membrane transport of macromolecules and particles.

Unit II **12 Hours**
Structural Organization and Function of Intracellular Organelles: Lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum and its types, mitochondria and chloroplast, Structure of mitochondria and nucleus, oxidation of glucose and fatty acids, electron transport chain (ETC): oxidative phosphorylation.

Unit III **12 Hours**
The Cytoskeleton and Cell Communication: The nature of cytoskeleton, intermediate filaments, microtubules, actin filaments, cilia and centrioles,

organization of the cytoskeleton. Cell adhesions, cell junctions and the extracellular matrix, cell-cell adhesion and communication, cell matrix adhesion, collagen the fibrous protein of the matrix, non-collagen component of the extra cellular matrix.

Unit IV **12 Hours**

Cell Cycle and signaling pathways: Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle events, Introduction to cell signalling: signalling networks, protein phosphorylation/de-phosphorylation, Intracellular signalling pathways: covering the major pathways in cells (MAPK, PI3K-AKT, JAK-STAT, SMAD and NF-kB), their components and key roles of protein kinases and phosphatases.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J. D. (2010). Molecular Biology of the Cell. Garland publishers, Oxford.
2. Celis, J. E. (2006). Cell Biology: A Laboratory Handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P. K. (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.
4. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

Course Code: ZOL.516

Course Title: Animal Evolution and Classification

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe how life and organisms evolved, forces that drive the evolution and diversity of life forms
- Illustrate the evidence for evolution and its required corollaries
- Explain the processes of evolution by mutation, migration, genetic drift, non-random mating and natural selection
- Develop a basic knowledge on animal classification system

Unit I **12 Hours**

Evolution: Darwin & the origin of species, Natural selection: Concept, Selection against recessive, recessive lethal, dominant & Heterozyote advantage Genetic drift & Mutation: Founder and bottle neck effect. Mutation-Selection Balance, drift balance, Genetic load and Genetic death, Mutational load, gene flow, Hardy Weinberg law: Speciation: biological species concept, allopatric, sympatric and parapatric speciation, concept of hybrid zone. Evolutionary trends (Humans, Whales, Horses, and Dinosaur).

Unit II **10 Hours**

Systematics: Binomial nomenclature; three domain classification; phylogenetic tree construction; applications of phylogeny; cladistics: monophyletic, paraphyletic and polyphyletic groups; shared and derived characters; homoplasy; parsimony analysis; molecular clocks.

Unit III **12 Hours**

Non-chordates: Phylums porifera, cnidarian, Platyhelminthes, Rotifera, Lopophorates, Mollusca, Annelida, nematode, Arthropoda, Echinodermata.

Unit IV **12 Hours**

Chordates: Overview of chordates: cephalochordate, urochordata, Myxini, Petromyzontida, Chondrichthyes, Actinopterygii, Actinistia, Dipnoi, Amphibia, Reptilia and Mammalia.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Damron, W.S. (2012). Introduction to Animal Science. Prentice Hall. 5th Edition.
2. Evolution: Making sense of life by Carl Zimmer
3. Lisa A.U. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
4. Primack, R.B. (2014). Essentials of Conservation Biology. Sinauer Associates Inc., 6th edition
5. Modern textbook of Zoology: Vertebrates by R.L. Kothpal
6. The Tree of Life by Pablo Vargas. Sinauer Associates, Oxford University Press
7. Kapoor,V.C., 1983. Theory and practice of animal taxonomy. (Oxford & IBH Publ. Co.)

8. Mayr, E. & Ashlock, P.D., 1991. Principles of Systematic Zoology. (McGraw Hill International Edition)

Course Code: ZOL.517
Course Title: Ecological Principles

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe the process of interaction among the living organisms with their environment
- Explain energy flow and the movement and recycling of matter in communities and ecosystems
- Develop a broad understanding of the processes that shape the distribution and abundance of organisms

Unit I **10 Hours**

Introduction to Ecology: Habitat and niche, niche width and overlap; fundamentaland realized niche; resource partitioning; character displacement. Adaptation, ecosystem, biotic and abiotic factors, food chain, food webs, trophic levels. Biomes:types (terrestrial and aquatic), distribution and unique features. Biomes: types (terrestrial and aquatic), distribution and unique features, Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.

Unit II **12 Hours**

Community ecology and biogeography: Nature of communities; community structure and attributes; richness and evenness; keystone species, flagship species and umbrella species; dominant species, ecotone, edge effect, ecotypes, plant indicators; ecological succession – types and mechanism; MacArthur and Wilson's island biogeography equilibrium theory-limitations and modifications; colonization vs. extinction; species area relationship.

Unit III **11 Hours**

Ecosystem Dynamics: Concept and components of ecosystem, ecological pyramids, energy flows in different ecosystems, energy models, ecosystem productivity. Types and characteristics of ecosystem- terrestrial (forest, desert, grassland) and aquatic (pond, marine), wetlands, estuaries, natural and manmade ecosystems, forest types in India. Biogeochemical cycles – cycling of water, nutrients.

Unit IV **12 Hours**

Population Ecology: Population characteristics, population interaction; prey-predator relationships; Theories of population growth, population dynamics, regulation. Population growth curves; population regulation; life history strategies (*r* and *K* selection); Concept of metapopulation, demes and

dispersal, niche- concept and types, interdemic extinctions, age structured populations

Mode of Transaction
The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
2. Smith, T. M. and Smith, R. L. (2012). Elements of Ecology. Benjamin Cummings Publishing Company, 8th edition.
3. Begon, M., Howarth, R. W. and Townsend, C. R. (2014). Essentials of Ecology. Wiley
4. Publishers, 4th edition.
5. Odum, E. and Barrett, G. W. (2004). Fundamentals of Ecology. Cengage Learning, 5th edition.
6. Prasanthrajan, M and Mahendran, P. P. (2008). A Text Book on Ecology and Environmental Science

Course Code: ZOL.520:
Course Title: Lab Course (Practical) – I

L	T	P	Cr
0	0	8	4

Learning Outcomes: After going through the course the learners will be able to

- Acquaint students with a fundamental knowledge of the lab instrumentation and reagents preparation
- Illustrate biochemical estimation of biomolecules
- Demonstrate different techniques involved in biomolecule separation
- Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Laboratory instrumentation
2. Preparation of Buffers and Solutions
3. Biochemical estimation and analysis of Proteins, Lipids and Carbohydrates
4. SDS-and native polyacrylamide gel electrophoresis
5. Gel filtration and Ion-exchange chromatography
6. Cell structure: Compound, Fluorescence, and Electron microscopy

7. Histochemistry: Fixation, Sectioning, Embedding, Processing and Staining
8. Immunocytochemistry
9. Identification of cell mitosis and meiosis stages
10. Life cycles of Silkworm
11. Life cycle of the honeybee
12. Measurement Frequency and abundance of plant communities
13. Mark recaptures method

Mode of Transaction

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cshl Press. New York.
2. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.

Discipline Elective Courses:

Course Code: ZOL.514
Course Title: Animal Cell Culture and Applications

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe the foundational knowledge of cell culture techniques and competence in laboratory techniques
- Explain problems common to routine cell culture
- Develop a thorough knowledge on application of molecular techniques to *in vitro* conditions

Unit I **8 Hours**

Introduction to Animal Cell Culture: Historical background. Good Laboratory Practices (GLP), sterilization methods and techniques. Biology of animal cell and cell-cell interactions, growth environment and culture requirement. Culture, subculture, cell line, cell strain, cell clone. Importance of serum and serum-free media.

Unit II **7 Hours**

Cell Culture Types and Characterization: Primary cell culture, tissue culture, organ culture, cell line immortalization, cell line preservation & characterization, karyotype analysis, cellular markers, commercial cell lines, and insect cell culture.

Unit III **8Hours**

Applications of Animal Cell Culture: *In vitro* transfection of animal cells, cell-based assays, and cell differentiation and movement. Cancer Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, and toxicology studies.

Unit IV **7 Hours**

Translational Research Applications: Animal cells as the applicable products (recombinants, hybridomas, stem cells and transplants). Focus on Rodent and murine models in scientific research associated with cancer and neurodegenerative diseases.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Freshney, R. I. (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell, 2010. 6th Edition.
2. Davis, J. M. (2008). Basic Cell Culture. Oxford University Press. New Delhi.
3. Davis, J. M. (2011). Animal Cell Culture. John Willy and Sons Ltd. USA.
4. Freshney R. I. (2005). Culture of Animal Cells. John Willy and Sons Ltd. USA.
5. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York, USA.

Course Code: ZOL.525

Course Title: Nanobiology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Define the interdisciplinary knowledge of basic concepts of nanoscience and biomaterials
- Explain characterization of techniques and biomedical aspects of nanomaterials
- Apply learned knowledge to develop nanomaterials

Unit I **8 Hours**

Nanoscience: Definition and concepts, nanomaterials including nanomaterials classification, properties, applications. Criteria for suitability of nanostructures for biological applications.

Unit II **8 Hours**

Nanomaterials: Synthesis, biofunctionalization and characterization techniques like electron microscopy (scanning and transmission), atomic force microscopy; nanoparticle analyzer, zeta potential measurement, electrochemical analyzer, flow cytometry, spectroscopic techniques including spectrophotometer, spectro-fluorimeter & FTIR

Unit III **7 Hours**

Materials in Medicine: Biomaterials, Nanostructures for drug delivery and therapeutics, biosensor, bioimaging and point-of-care diagnostics tools including flow immunoassay and microfluidic devices.

Unit IV **7 Hours**

Nanotoxicity: Effect of nanomaterials on human health, nanomaterial-cell interaction and characterization, recent progress and challenges in the risk assessment of nanomaterials.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Bagchi, D., Bagchi, M., Mariyama, H. and Shahidi, F. (2013).Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences. Wiley–Blackwell publication.
2. Rai, M., Duran, N. and Southam, G. (2011). Metal Nanoparticles in Microbiology. Springer publication.
3. Udupa, N., Gupta, P. D. (2009). Nanotechnology in Health Care. Shyam Prakashan publication.
4. Xie, Y. (2012). The Nanobiotechnology Handbook. CRC Press.

5. Murty, B. S., Shankar, P., Raj, B., Rath, B. B.and Murday, J. (2013). A Textbook of Nanoscience and Nanotechnology. Tata Mc Graw Hill Publication.

Inter-Disciplinary Course:

Course Code: ZOL.515
Course Title: Fundamentals of Cell Biology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Define the basic unit of life: the cell, its structure, composition and function
- Explain macromolecules, membranes, and organelles and their related functions in cell and molecular biology
- Develop a basis for evaluating disease processes

Unit I **8 Hours**

Basic unit of Life: Life at the cellular and molecular level. Introduction to the topics include cellular energetics, membrane phenomena, genetics, and molecular biology.

Unit II **7 Hours**

Introduction to the Cell: The evolution of the cell, from molecules to first cell, from prokaryotes to eukaryotes, prokaryotic and eukaryotic genomes, from single cell to multicellular organism.

Unit III **8 Hours**

Membrane Structure and Function: Biomembrane at a glance**,** membrane models: structure and composition, and membrane transport.

Unit IV **7 Hours**

Structural Organization of Intracellular Organelles: Introduction of subcellular organelles: lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum, nucleus, mitochondria, and chloroplast.

Mode of Transaction

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Gupta, P. K. (2005). Cell and Molecular Biology. Rastogi publications, Meerut, India.
2. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
3. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
4. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2008). Molecular Cell Biology. W.H. Freeman, USA. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J.D. (2010).
5. Molecular Biology of the Cell. Garland publishers, Oxford.
6. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. New Delhi, India.

Compulsory Foundation Course:

Course Code: CST.501
Course Title: Computer Applications for Sciences

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe different operating system and their tools
- Explain word processing software, presentation software, spreadsheet software and latex;
- Identify networking and internet concepts
- Develop a basic idea on use computers in various field like teaching, industry and research

Unit I **8 Hours**

Computer Fundamentals: Introduction to Computer, Input devices, Output Devices, Memory (Primary and Secondary), Concept of Hardware and Software, C.P.U., System bus, Motherboard, Ports and Interfaces, Expansion Cards, Ribbon Cables, Memory Chips, Processors, Software: Types of Software, Operating System, User Interface of popular Operating System, Introduction to programming language, Types of Computer.

Unit II **7 Hours**

Computer Network: Introduction to Computer Network, Types of Network: LAN, WAN and MAN, Topologies of Network, Internet concept

Word Processing using MS Word: Text creation and Manipulation; Table handling; Spell check, Hyper-linking, Creating Table of Contents and table of figures, Creating and tracking comments, language setting and thesaurus, Header and Footer, Mail Merge, Different views, Creating equations, Page setting, Printing, Shortcut keys.

Unit III **8 Hours**

Presentation Tool: Creating Presentations, Presentation views, working on Slide Transition, Making Notes Pages and Handouts, Drawing and Working with Objects, Using Animations, Running and Controlling a Slide Show, Printing Presentations, Shortcut keys.

Spread Sheet: Entering and editing data in cell, Basic formulas and functions, deleting or inserting cells, deleting or inserting rows and columns, printing of Spread Sheet, Shortcut keys.

Unit IV **7 Hours**

Use of Computers in Education and Research: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Sinha, P.K. Computer Fundamentals. BPB Publications.
2. Goel, A., Ray, S. K. 2012. Computers: Basics and Applications. Pearson Education India.
3. Microsoft Office Professional 2013 Step by Step https://ptgmedia.pearsoncmg.com/images/9780735669413/samplepages/97807356694%2013.pdf

Examination Pattern

A: Practical: Lab course – I [100 Marks each]

i. Day to day performance – 60 Marks
   a. *Attendance –* *10 Marks*
   b. *Continuous assessment -* *30 Marks*
   c. *Lab Record -* *10 Marks*
   d. *Overall performance -* *10 Marks*

ii. End-semester exam – 40 Marks

   a. *Major Question -* *20 Marks*
   b. *Minor Question -* *10 Marks*
   c. *Viva-voce -* *10 Marks*

SEMESTER – II

Course Code: ZOL.521
Course Title: Animal Physiology – I

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Define comprehensive and detailed aspect of the physiological principles in relation to humans and other animals
- Distinguish and recognize principal tissue structures
- Explain the functions of important physiological systems including the digestive, respiratory, circulation and nervous system
- Develop an enhanced knowledge and appreciation of mammalian physiology

Unit I **12 Hours**

Digestive System: Hunger and thirst mechanisms, Feeding strategies, Foregut, midgut, and hindgut fermentation in animals, ruminant and monogastric digestive system, absorption, energy balance, and BMR.

Unit II **10 Hours**

Respiratory System:- Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Unit III **10 Hours**

Circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostic control mechanisms, Biochemistry of blood, plasma proteins, and blood coagulation.

Unit IV **13 Hours**

Nervous System: Gross neuroanatomy of the brain and spinal cord, blood brain barrier, central and peripheral nervous system, Neurons, Neuroglial cells, action potential, neurotransmitters, neural control of muscle tone and posture.

Sense Organs: Vision, hearing and tactile response.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Guyton. (2007). Textbook of Medical Physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). Animal Physiology. Sinauer Associates Inc. USA.
3. Murray, R. K. (2009). Harper's Illustrated Biochemistry. Jaypee Publishers, New Delhi.
4. Tyagi, P. (2009). A Textbook of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.

Course Code: ZOL.522
Course Title: Immunology

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Define the basics of immune system
- Illustrate the components and molecules of immunity
- Explain various immune responses at the cellular level that work together to protect the host

Unit I **12 Hours**

Immune System: Recognition of self and non-self, innate and adaptive immunity, humoral immunity, immunoglobulins: basic structure, classes and subclasses, structural and functional relationship. Molecular mechanisms of antibody diversity and class switching, Cytokines, Interferons and interleukins.

Unit II **12 Hours**

Complement System and Major Histocompatibility System: Complement components, their structure & function and mechanisms of complement activation. Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system. Antigen processing and role of MHC molecules in antigen presentation.

Unit III **11 Hours**

Hypersensitivity: Types, features and mechanisms of immediate and delayed hypersensitivity reactions, immunity to microbes, immunity to tumors, AIDS and immune-deficiencies, hybridoma technology, development of vaccine for diseases like AIDS and cancer.

Unit IV **10 Hours**

Monoclonal Antibodies and Diagnostic Immunology: Production, characterization and applications in diagnosis, therapy, quantitative and qualitative methods for immunoglobulin determination, antigen and antibody reactions, agglutination-precipitation, immunoflourescence and immunoblotting, assessment of human allergic and hormonal diseases.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Kindt, T. J., Osborne, B. A. and Goldsby, R. A. (2007). Kuby Immunology. 7th Edition. W.H. Freeman, USA.
2. Abbas. (2008). Cellular and Molecular Immunology. CBS Publishers & Distributors, India.
3. Charles, A. and Janeway, J. R. (1994). Immunobiology: The Immune System in Health and Disease. Blackwell Publishing, USA.
4. Delves, P. J., Roitt, I. M. and Seamus, J. M. (2006). Roitt's Essential Immunology (Series–Essentials). Blackwell Publishers, USA.
5. Elgert K. D. (2009). Immunology: Understanding the Immune System. Wiley-Blackwell, USA.
6. Paul, W. E. (1993). Fundamental Immunology. Raven Press, SD, USA.

Course Code: ZOL.523
Course Title: Molecular Biology

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe molecular processes essential for individual cell for proper functioning
- Explain in detail DNA replication, transcription, translation, and regulation of gene expression

Unit I **12 Hours**

Genome Organization, Structure and Conformation of Nucleic Acids: Chromosome structure, chromatin and its regulation, nucleosome and its assembly, nucleolus, repetitive DNA, Structure of DNA, denaturation and renaturation, Various conformations of nucleic acids including non-B DNA structures.

Unit II **11 Hours**

DNA Replication: Prokaryotic and eukaryotic DNA replication, mechanism of DNA replication, enzymes and accessory proteins involved in DNA replication, replication errors, DNA repair & recombination, genome editing.

Unit III **12 Hours**

Transcription and mRNA Processing: Types of RNA, prokaryotic & eukaryotic transcription, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, transcriptional and posttranscriptional gene silencing: initiation, elongation & termination of transcription, capping, polyadenylation, splicing, editing, mRNA stability.

Unit IV **10 Hours**

Translation: Genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanisms of chain initiation, elongation and termination, regulation of translation, co- and post-translational modifications, epigenetics, control of gene expression at transcription and translation level.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Fasman, G. D. (1989). Practical Handbook of Biochemistry and Molecular Biology. CRC Press, Taylor and Francis Group, UK.
2. Gupta, P. K. (2005). Cell and Molecular Biology. Rastogi publications, Meerut, India.
3. James, D. W., Baker, T. A., Bell, S. P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
4. Jocelyn, E. K., Elliott, S. G., Stephen, T. K. (2009). Lewin's Genes X. Jones & Bartlett Publishers, USA.
5. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.

Course Code: ZOL.527
Course Title: Essentials of Genetics

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Comprehensive understanding of the molecular basis of heredity
- Distinguish Mendelian and Non-Mendelian genetics
- Explain how genetic concepts affect broad societal issues including

health and disease, food and natural resources, environmental sustainability, etc

Unit I **12 Hours**

Mendelian Principles and Concept of Gene: Dominance, segregation, independent assortment, allele, multiple alleles, pseudoallele, complementation tests.

Extension of Mendelian Principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit II **12 Hours**

Gene Mapping Methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by somatic cell hybrids, development of mapping population.

Human Genetics: Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders. **Quantitative Genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit III **11 Hours**

Gene Concept: Fine structure of gene, Benzer's experiments, complementation analysis and recombination. **Recombination:** Site-specific, homologous, transposition and non-homologous end joining (NHEJ). **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, applications in reverse and forward genetics, mutations and Hardy Weinberg equilibrium, molecular basis of spontaneous and induced mutations.

Unit IV **10 Hours**

Extra-Chromosomal Inheritance: Chloroplast and mitochondrial inheritance, structural and numerical alterations of chromosomes: deletion, duplication, inversion, translocation, Ploidy and their genetic implications.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Anthony, J. F., Miller, J. A., Suzuki, D. T., Richard, R. C., Gilbert, W. M. (1998). An Introduction to Genetic Analysis. W.H. Freeman publication, USA.
2. Atherly, A. G., Girton, J. R., Mcdonald, J. F. (1999). The Science of Genetics. Saundern College publication.
3. Snusted, D. P., Simmons, M. J. (2010 Hours). Principles of Genetics. John Wiley & Sons, New York.
4. Gupta, P. K. (2009). Genetics. Rastogi publications, Meerut, India.
5. Gupta, P. K (2008). Cytology, Genetics and Evolution. Rastogi publications, Meerut, India.

Course Code: ZOL.540
Course Title: Lab Course (Practical) – II

L	T	P	Cr
0	0	10	5

Learning outcomes: After going through the course the learners will be able to

- Describe parameters toward understanding the pathophysiology of various human disease
- Apply techniques involved in identification and quantification of protein expression
- Demonstrate various molecular biology techniques.
- Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Measurement of vital parameters: Blood pressure, Blood glucose, Heartbeat (ECG), Pulse Rate, and Glucose tolerance test.
2. DigiFrog: Online animal dissection module – 1.
3. Spirometry
4. ELISA
5. Western blotting
6. Dot blot technique
7. Double immunodiffusion
8. Determination of BOD/COD
9. RNA isolation
10. DNA isolation
11. Polymerase Chain Reaction
12. cDNA synthesis and RT-PCR analysis
13. Gene cloning: Primer designing, Restriction digestion, ligation, transformation and screening.

Mode of Transaction
The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning,

Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

3. Sambrook, J. (2006). The Condensed Protocols from Molecular Cloning: A Laboratory Manual. Cshl Press. New York.
4. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.

Discipline Elective Courses:

Course Code: ZOL.529
Course Title: Genetic Engineering

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe versatile tools and techniques employed in recombinant DNA technology
- Formulate knowledge required to design, execute, and analyze the results of genetic experimentation in animal model systems
- Develop a thorough knowledge on methodological repertoire that allows students to innovatively apply in basic and applied fields of biological research

Unit I **7 Hours**

Tools of Genetic Engineering: Restriction enzymes, Enzymes in genetic engineering, recombinant cloning vectors & their biology (Plasmid-, Phage-, and yeast-based), transformation and selection, genomic and cDNA library construction & DNA-sequencing techniques.

Unit II **8 Hours**

Recombinant Expression Systems & Mutagenesis: prokaryotic (Fusion proteins, surface display, removal of selectable marker genes, secretion into periplasm & medium) & eukaryotic (*Sachharomy cescerevisiae* & Mammalian cell expression system), oligonucleotide-directed and site-directed mutagenesis.

Unit III **7 Hours**

Molecular Biotechnology of Microbial Systems: Vaccines (subunit-, peptide-, attenuated-, DNA- and vector-based), Enzymes, Antibiotics, Bioremediation, and Gene therapy.

Unit IV **8 Hours**

Molecular Biotechnology of Eukaryotic Systems: Engineering of plants (Ti-based system), Transgenic animals (Transgenic rodents), Regulation of recombinant DNA technology, Concerns about safety of consuming genetically modified foods, concerns about the impact of genetically modified organisms on the environment.

Suggested Readings:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten, 4th edition. 2010 Hours
2. Principles of Gene Manipulation by Sandy B. Primrose, Richard Twyman, Bob Old Seventh edition.2008
3. An introduction to genetic engineering, Third edition by Dr. Desmond S.T. Nicholl. 2011
4. Molecular cloning by R. Green and Joseph Sambrook, 4th Edition, CSHL Press. 2013

Course Code: ZOL.572
Course Title: Endocrinology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Define the role of the endocrine system in maintaining homeostasis and health
- Explain the knowledge of the major endocrine disorders
- Develop an advanced knowledge on future clinical problems of the endocrine system

Unit I **6 Hours**

General Introduction to Hormone: History, endocrine glands, hormones as chemical messengers, stimulus for hormone release: change in homeostasis, Neurosecretion and neuroendocrine system. **Hormones:** Structure, receptor type, regulation of biosynthesis and release (including feedback mechanism like short, long and ultra-feedback system).

Unit II **10 Hours**

Reproductive Hormones: Male and female sex hormones. Hypothalamic hormones: CRH, TRH, GnRH, PRL/PRIH, GHRH/GHRIH. Pituitary hormones - Anterior and posterior pituitary hormones. Molecular mechanism of origin of GnRH cells, migration and site of release, reproductive cycles in females. Role of different guidance molecules involved during early GnRH development and adult GnRH System. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation: Different pathologies and genes involved. Breeding in animals, including marker – assisted selection.

Unit III **10 Hours**

Hormone Biosynthesis and Mode of Action: The hypothalamo-hypophyseal axis. Hypothalamo-vascular system. Hormones from hypothalamus: chemistry and physiology of releasing and release inhibiting hormones; Regulation of hypothalamic hormone secretion. Thyroid hormones, growth hormones, adrenal hormones and catecholamines, glucocorticoid hormonesNeurohypophysis: synthesis and storage of oxytocin and vasopressin

Unit IV **4 Hours**

Other endocrine organs: Regulation of the release of neurohypophyseal hormones; Other organs with endocrine function: heart (ANP), kidney (erythropoietin), liver (angiotensinogen, IGF-1), adipose tissue (leptin, adiponectin).

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Norris, D. O., and Carr, J. A. (2012). Vertebrate Endocrinology, 5th Edition. Academic Press.
2. Nelson, D. L., and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Edition. WH Freeman & Company, New York
3. Widmaier, E. P., Raff, H., and Strang, K. T. (2013).Vander's Human Physiology, 13 Hours Hoursth Edition. McGraw-Hill Higher Education
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M. P. (2012). Molecular Cell Biology, 7th Edition. W.H. Freeman.
5. Goswami, M. P. (2013). Endocrinology and Molecular Cell Biology.

Inter-Disciplinary Course:

Course Code: ZOL.528
Course Title: Basics in Neuroscience

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe the role of human nervous system and its control over the entire body

- Explain the properties of individual cells to their function in organized neural circuits and systems
- Develop testable scientific hypotheses and generate research plans to test these hypotheses

Unit I **7 Hours**

Introduction to Nervous System: Basic anatomy, parts of central nervous system & peripheral nervous system.

Unit II **8 Hours**

Introduction to Neurons: The neuron doctrine, Nissl and Golgi stains, components of neurons, classification and types of neurons, cytology of neurons, dendrites structure and function, axons structure and functional aspects, ultrastructure, myelination and synapses.

Unit III **8 Hours**

Structure and Function of Glial Cells: Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells, types of astrocytes, importance of astrocytes in glutamate metabolism and blood brain barrier, functions of other glial cells: oligodendrocyte and microglial cells, microglial phenotypes, overview of glial and neuronal relationship in the CNS, glial – neuronal interplay in the CNS.

Unit IV **7 Hours**

Action Potential & Neurotransmitters: Action potentials & channels responsible for action potential, all or none law, Nernst equation; neurotransmitters: excitatory neurotransmitters & inhibitory neuro transmitters.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Guyton. (2007). Textbook of Medical Physiology.11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). Animal Physiology. Sinauer Associates Inc. USA.
3. Tyagi, P. (2009). A Text Book of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.

4. Levitan, I. B., Kaczmarek, L. K. (2015). The Neuron: Cell and Molecular Biology. Oxford University Press, USA; 4th edition.
5. Kandel, E. R., Schwartz, J. H., Jessell, T. M. (2012). Principles of Neural Science. McGraw-Hill Companies; 5th edition.

Course Code: ZOL.542
Course Title: Seminar – I

L	T	P	Cr
0	0	0	1

Learning outcomes: After going through the course the learners will be able to

- Inculcate scientific aptitude and presentation skills and engage in reflective listening and scientific communication
- Explain new and enriched understandings of the texts through sustained collaborative inquiry

The student would select a specific topic based on a review/research article of his/her interest and prepare and deliver a presentation of approximately 15 minutes and submit a brief report

Examination Pattern

A: Practical: Lab course – I [100 Marks each]
iii. Day to day performance – 60 Marks

e. *Attendance –* *10 Marks*
f. *Continuous assessment -* *30 Marks*
g. *Lab Record -* *10 Marks*
h. *Overall performance -* *10 Marks*

iv. End-semester exam – 40 Marks

d. *Major Question -* *20 Marks*
e. *Minor Question -* *10 Marks*
f. *Viva-voce -* *10 Marks*

B: Seminar: [100 Marks]

i. Continuous assessment and report submission
a. Attendance- *10 marks*
b. Content development - *25 marks*
c. Review of literature- *25 marks*

v.
d. Report submission - *15 Marks*
e. Presentation of innovation- *15 Marks*
f. Response to questions - *10 Marks*
(Interaction session)

SEMESTER – III

Course Code: ZOL.551
Course Title: Developmental Biology

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe mammalian development
- Illustrate developmental processes of vertebrates
- Differentiate embryonic developments and regeneration

Unit I **10 Hours**

Beginning of a new organism: Principles of development, Oogenesis, Spermatogenesis, Fertilization, Polyspermy and prevention of polyspermy, Morula, Cleavage and its types, Blastulation and Gastrulation, Different movements occur during Gastrulation.

Unit II **12 Hours**

Early embryonic development: Anatomical and morphological changes that occur during development, Early development of amphibians, Drosophila and mammals; axis formation in Drosophila and Amphibians.

Unit III **12 Hours**

Later embryonic development: Central nervous system and the epidermis; Neural crest cells and axonal specificity; Endoderm, Mesoderm and Ectoderm.

Unit IV **8 Hours**

Regeneration: Tertrapod limb development, metamorphosis, regeneration and ageing, teratogenesis.

Mode of Transaction

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Dawkins, R. (1996). The Blind Watchmaker, W.W. Norton & Company Jones and Bartlett Publishers.
2. Futuyma, D. J. (2009). Evolution. Sinauer Associates Inc. USA.

3. Hake, S. and Wilt, F. (2003). Principles of Developmental Biology. W.W. Norton & Company, New York, USA.
4. Hall, B. K. and Hallgrimsson, B. (2007). Strickberger's Evolution. Jones and Bartlett Publishers, India.
5. Lewin, R. (2004). Human Evolution - An Illustrated Introduction. Wiley-Blackwell, USA.
6. Scott, F. and Gilbert, S. F. (2013). Developmental Biology (10th edition). Sinauer Associates, Inc. USA.

Course Code: ZOL.555
Course Title: Animal Physiology - II

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe physiology of human and other animals.
- Differentiate Cardiovascular, excretory, endocrine and musculoskeletal systems
- Relate chemical and biological processes occurring in the animal tissues and organ systems

Unit I **12 Hours**

Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above, lymph and lymph nodes. Overview of cardiovascular diseases.

Unit II **11 Hours**

Excretory System: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Unit III **12 Hours**

Hormone action: Endocrine glands, Master gland and basic mechanism of hormone action, Neuroendocrine integration- Afferent pathways, Integration centers, Efferent pathways, Physiological and biochemical actions and pathophysiology (hyper and hypo secretion). Thermoregulation - comfort zone; body temperature – physical, chemical, neural regulation, acclimatization.

Unit IV **10 Hours**

Musculoskeletal System: Bones of the skeleton, muscles, cartilage, tendons, ligaments, joints and other connective tissues, The basic mechanism of muscle contraction and muscle fatigue.

Mode of Transaction
The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:
PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Guyton. (2007). Textbook of Medical Physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). Animal Physiology. Sinauer Associates Inc. USA.
3. Murray, R. K. (2009). Harper's Illustrated Biochemistry. Jaypee Publishers, New Delhi.
4. Tyagi, P. (2009). A Textbook of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.

Course Code: ZOL.513
Course Title: Techniques in Life Sciences

L	T	P	Cr
2	1	0	3

Learning outcomes: After going through the course the learners will be able to

- Describe analytical tools in Life Sciences.
- Distinguish spectroscopy, microscopy, molecular and immunological techniques.
- Apply analytical instruments in life science research
- Analyze experimental results.

Unit I **12 Hours**

Spectroscopy and Chromatography Techniques: UV-Vis, fluorimeter, circular dichroism, FTIR, mass spectroscopy, surface plasmon resonance method, X-ray diffraction and NMR. Thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC, GLC and HPLC.

Unit II **10 Hours**

Microscopy: Light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscope, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy.

Unit III **12 Hours**

Basic Molecular Biology Techniques: Isolation, purification and analysis of protein and nucleic acids. Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis and 2-Dimensional gel electrophoresis. Polymerase chain

reaction (PCR): Principle, types and applications. Blotting techniques: Southern, Northern, Western analysis, *In situ* hybridization etc.

Unit IV **12 Hours**

Immunological and Cell Culture Techniques: Perfusion, Fixation, different techniques of sectioning, MTT assay, Electrophysiological techniques like Patch clamp immunochemical techniques, immunocytochemistry, immunofluorescence, radioimmunoassay (RIA), Different enzyme linked immunosorbent assay (ELISA), immunoprecipitation, flow cytometry. Cell and tissue culture techniques: Primary and secondary cultures.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Goldsby, R. A., Kindt, T. J. and Osborne, B. A. (2008). Kuby Immunology. 6th Edition, W. H. Freeman & Company, San Francisco.
2. Gupta, P. K. (2005). Elements of Biotechnology. Rastogi Publications, Meerut.
3. Kothari, C. R. (2008) Research Methodology. New Age International (P) Ltd., New Delhi
4. Lewin, B. (2010). Genes X, CBS Publishers & Distributors. New Delhi.
5. Nelson, D. and Cox, M. M. (2009). Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York.
6. Primrose. S. B. and Twyman, R. (2006). Principles of Gene Manipulation and Genomics. Blackwell Publishing Professional, U.K.
7. Sawhney, S. K. and Singh, R. (2005). Introductory Practical Biochemistry. Narosa Publishing House, New Delhi.
8. Wilson, K. and Walker, J. (2006). Principles and Techniques of Biochemistry and Molecular biology. 6th Edition, Cambridge University Press India Pvt. Ltd., New Delhi.

Course Code: ZOL.570
Course Title: Lab Course (Practical) – III

L	T	P	Cr
0	0	8	4

Learning outcomes: After going through the course the learners will be able to

- Demonstrate animal handling, cell, molecular and immunological techniques

- Illustrate cellular, biochemical and molecular biology techniques
- Demonstrate biochemical assays
- Estimate cellular toxicity
- Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Animal handling: mice/rat/rabbit (tutorials only)
2. DigiFrog: Online animal dissection module – 2
3. Animal Perfusion
4. Polyclonal antibody raising
5. Immunohistochemistry
6. Isolation of Lymphocytes from whole blood
7. Cell trypsinization and Cell count (Hemocytometer)
8. MTT Assay
9. Cell cycle monitoring by flow cytometry
10. Microscopic examination of human parasite life cycles (amoeba, cestodes, nematodes, and plasmodium)
11. Animal cell transfection (lipid based and electroporation)

Discipline Elective Courses:

Course Code: ZOL.553
Course Title: Vascular Biology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe vascular system and cardiovascular biology
- Illustrate vascular dysfunction.
- Classify vascular disorders
- Categorize antiplatelet drugs and diagnostics methods

Unit I **8 Hours**

Vascular Biology: Introduction, structure and function of the vascular system. Vascular dysfunction in various pathophysiological states including endothelial dysfunction, inflammation, atherosclerosis and diabetes.

Unit II **7 Hours**

Cardiovascular Biology: Basic cardiovascular physiology, cardiovascular system including blood coagulation system, platelet biology, haemostasis& thrombosis and signalling pathways involved in thrombus biology.

Unit III **8 Hours**

Vascular Disorders: Peripheral vascular disease, stroke, platelet in cardiovascular diseases, diseases of the circulatory system including lymphatic diseases.

Unit IV **7 Hours**

Vascular Medicine: Novel drugs including antiplatelet drugs, diagnostic methods including vascular angiography, imaging modalities, and other therapeutic approaches to better diagnose, prevent, or treat cardiovascular diseases.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Michael, R. J. and Christopher, J. W. (2011).Vascular Disease: Diagnostic and Therapeutic Approaches. Cardiotext Publishing. 1st Edition.
2. Minar, E. and Schillinger, M. (2013). Peripheral Vascular Disease: Basic & Clinical Perspectives. Future Medicine Ltd.
3. Rasmussen, T. E.,Clouse, W. D., and Tonnessen, B. H. (2008). Handbook of Patient Care in Vascular Diseases. Lippincott Williams & Wilkins. 5th Edition.
4. Bhatt, D. L. (2008). Platelets in Cardiovascular Disease. Imperial College Press.
5. Kirali, K. (2015). Coronary Artery Disease - Assessment, Surgery, Prevention. InTech Publication.
6. Bozic-Mijovski, M. (2015). Thrombosis, Atherosclerosis and Atherothrombosis - New Insights and Experimental Protocols. InTech Publication.

Course Code: ZOL.554
Course Title: Neurobiology and Degeneration

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe Neurobiology
- Illustrate major diseases affecting the nervous system
- Distinguish physiological and molecular features of human

Unit I **6 Hours**

Introduction to Human Brain and Nervous System; Metabolic functions of the Brain; Energy Requirements; Oxidative stress; Factors contributing to the neurodegeneration.

Unit II **8 Hours**

Alzheimer's disease (AD): Mechanism(s) of AD pathogenesis and pathophysiology, e.g. amyloid cascade hypothesis, tau, and the therapeutic approaches. Review of recently completed clinical trials and treatment prospects. **Parkinson's Disease (PD):** genetics - alpha synuclein, parkin, DJ1, PINK1, and LRRK2. Gene therapy for PD.

Unit III **8 Hours**

Huntington's Disease, multiple sclerosis, clinical overview of frontotemporal degeneration (FTD) and amyotrophic lateral sclerosis (ALS).

Unit IV **8 Hours**

Therapeutic intervention: Current treatment strategies including Pharmaceutical and Natural products based therapies for various human neurodegenerative diseases.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Guyton. (2007). *Textbook of Medical Physiology*. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
2. Hill, R. W, Wyse, G. A. and Anderson, M. (2008). *Animal Physiology*. Sinauer Associates Inc. USA.
3. Tyagi, P. (2009). *A Textbook of Animal Physiology*. Dominant Publishers and distributors, New Delhi, India.
4. Mason, P. (2011) Medical Neurobiology. OUP USA publishers; 1st edition.
5. Charney, Dennis, S., (2013) Study guide for Neurobiology of Mental Illness. Cram 101 Publishers.
6. Dennis S. Charney, Nestler, E. J., Sklar, P., and Buxbaum, J. D. (2013). Neurobiology of Mental Illness. OUP USA publishers; 4th edition.
7. Zigmond, M. J, Coyle, J. T., and Rowland, L. P. (2014). Neurobiology of Brain Disorders: Biological Basis of Neurological and Psychiatric Disorders. Academic Press; 1st edition.

Compulsory Foundation Course:

Course Code: ZOL.556
Course Title: Research Methodology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe research methods and scientific ethics
- Write review of literature
- Classify various aspects of research methodology
- Apply bio-statistical tools in life science research
- Analyzing experimental data results
- Design research experiment

Unit I **8 Hours**

Scientific Writing: Literature survey and review, sources of literature, methods of literature review and techniques of writing the reviewed literature. Understanding a research problem, selecting the research problem, steps in formulation of a research problem, formulation of research objectives, and construction of a hypothesis.

Unit II **7 Hours**

Basic principles of experimental designs, data collection, processing, and interpretation. Basics of citation and bibliography/reference preparation styles, report presentation.

Unit III **8 Hours**

Biosafety for Human Health and Environment. Good laboratory practices (GLP), biosafety issues for using cloned genes in medicine, agriculture, industry. Genetic pollution, risk and safety assessment from genetically engineered organisms.

Unit IV **7 Hours**

Ethical theories, ethical considerations during research, ethical issues related to animal testing and human project. Intellectual property rights (IPRs), patents and copyrights, fair use, plagiarism and open access publishing.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Gupta, S. (2005). Research Methodology and Statistical Techniques. Deep & Deep Publications (p) Ltd. New Delhi.
2. Kothari, C. R. (2008). Research Methodology (s). New Age International (p) Limited. New Delhi.
3. Fleming, D. O. and Hunt, D. L. (2006). Biological Safety: Principles and Practices. American Society for Microbiology, USA.
4. Rockman, H. B. (2004). Intellectual Property Law for Engineers and Scientists. Wiley-IEEE Press, USA.
5. Shannon, T. A. (2009). An Introduction to Bioethics. Paulist Press, USA.
6. Kothari, C. R. and G. Garg (2014): Research Methodology: Methods and Techniques, 3rd ed., New Age International Pvt. Ltd. Publisher
7. Kumar, R. (2014): Research Methodology – A Step-By-Step Guide for Beginners, 4th ed., Sage Publications.
8. Jerrold, H. Z. (2010): Biostatistical Analysis, Fifth ed., Pearson.
9. Sokal, R. F and Rohlf, F. J. (2011): Biometry, Fourth Ed., W.H. Freeman Publishers.

Course Code: ZOL.557
Course Title: Basic Statistics for Sciences

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe Statistical tools used in Life Sciences
- Interpret statistical variables and distributions
- Distinguish between parametric and non-parametric statistics
- Apply statistical parameters to available data

Unit I **7 Hours**

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.

Unit II **7 Hours**

Measures: Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

Unit III **8 Hours**

Random variables and Distributions: Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and continuous distributions like Normal, F and student-t distribution.

Unit IV **8 Hours**

Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing. Parametric tests: Test for parameters of Normal population (one sample and two sample problems) z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA). Non-Parametric tests: One sample: Sign test, signed rank test, Kolmogrov-Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. P. L. Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Pub, 1975.
2. R. V. Hogg, J. Mckean and A. Craig, Introduction to Mathematical Statistics, Macmillan Pub. Co. Inc., 1978.
3. F. E. Croxton and D. J. Cowden, Applied General Statistics, 1975.
4. P. G. Hoel, Introduction to Mathematical Statistics, 1997.

Value Added Course:

Course Code: XXX.YYY (As per the VAC Courses of the university)

L	T	P	Cr
1	0	0	1

VAC

Course Code: ZOL.599
Course Title: Project (Part – I)

L	T	P	Cr
0	0	0	4

Learning outcomes: After going through the course the learners will be able to

- Write review of literature
- Outline research project
- Design objectives and methodology
- Execute experiments/Compile literature

- Formulate original research/repeated experiments/review in the form of project

Examination Pattern

A: Practical: Lab course – III [100 Marks each]

vi. Day to day performance – 60 Marks

i. *Attendance* – *10 Marks*
j. *Continuous assessment* - *30 Marks*
k. *Lab Record* - *10 Marks*
l. *Overall performance* - *10 Marks*

vii. End-semester exam – 40 Marks

g. *Major Question* - *20 Marks*
h. *Minor Question* - *10 Marks*
i. *Viva-voce* - *10 Marks*

B: Research Project [100 Marks]: The final result of the project will be on 5 – point scale and evaluated as Excellent, Very Good, Good, Average, and Unsatisfactory. Which will be mentioned on the mark sheet/transcript but not be counted towards overall Grade Point Average (GPA).

SEMESTER – IV

Course Code: ZOL.573
Course Title: Metabolism

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Define Metabolism
- Explain biosynthesis and catabolism
- Differentiate catabolic and anabolic process
- Distinguish metabolic pathways involved in Carbohydrate, Fat, Protein and Nucleic acid metabolism
- Analyze metabolic disorders

Unit I **8 Hours**

Metabolism of Carbohydrates: Glycolysis, gluconeogenesis, TCA cycle, hexose monophosphate (HMP) shunt, disorders of carbohydrate metabolism.

Unit II **7 Hours**

Metabolism of Lipids: Biosynthesis and oxidation of saturated and unsaturated fatty acids, glycerides, phospholipids and cholesterol,

lipoproteins and their significance, disorders of lipid metabolism.

Unit III **8 Hours**

Amino Acid Metabolism: Biosynthesis of protein, general catabolism of amino acids, deamination, transamination, urea cycle, disorders of amino acid metabolism.

Unit IV **7 Hours**

Nucleic Acid Metabolism: Biosynthesis of purine and pyrimidine nucleotides, disorders of purine and pyrimidine metabolism - gout, aciduria, xanthinuria.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Harper H. A. (1997). Review of Physiological Chemistry. Lange Medical Publications, Los Angeles.
2. T. A. Ramakrishnan (1994). Textbook of Clinical Biochemistry. Publications, Chennai.
3. Zilwa, J. E., Pannale, P. A., Philip, R. (1988). Clinical Chemistry in Diagnosis and Treatment, New York.
4. Devlin, D. T. (1997). Textbook of Biochemistry with Clinical Correlations. New York, John Wiley and Sons.
5. Plummer, D. T. (1997). An Introduction to Practical Biochemistry. New Delhi, Tata McGraw Hill Publishing Company.
6. Cromwell, L., Weibel, F. J. and Pfeiffer, E. A. (1996). Biomedical Instrumentation and Measurements. New Delhi, Prentice Hall.

Course Code: ZOL.574
Course Title: Animal Behavior

L	T	P	Cr
3	0	0	3

Learning outcomes: After going through the course the learners will be able to

- Define Animal Behaviour
- Explore variety of different behaviors found in a broad range of animal groups, using a scientific and evolutionary approach
- Analyze the behaviour in animals including humans

Unit I **8 Hours**

Approaches and methods in study of behavior: Conceptual, theoretical and empirical; proximate and ultimate causation; altruism and evolution-group selection, kin selection, reciprocal altruism, co-operation.

Unit II **8 Hours**

Cognition: Neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior.

Unit III **7 Hours**

Sociality: Social communication; social dominance; use of space and territoriality; mating systems, courtship behavior, parental investment and reproductive success; parental care; aggressive behavior.

Unit IV **7 Hours**

Foraging: Habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes, ageing and disease, animal personalities.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Alcock J. Animal Behavior: An Evolutionary Approach, 10th Edition
2. Lee Alan D. Principles of Animal Behavior (Third Edition)
3. Breed M and Moore J. Animal Behaviour (2nd edition)
4. Nichollas et al. (2012). From Brain to Behavior. Sinauer Associates; 5th edition.
5. Griffith et al. (2004). Introduction to Genetic Analysis. W H Freeman & Co Ltd; 8th Revised edition.

Discipline Elective Courses:

Course Code: ZOL.552
Course Title: Cancer Biology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe Cancer biology
- Explain cause and progression of Cancer
- Classify Cancer
- Distinguish different forms Cancer therapy

Unit I **8 Hours**

Biology and Classification of Cancer: Classification, phenotype of a cancer cell, causes of cancer, DNA tumor viruses, RNA tumor viruses, Different forms of cancers, screening and early detection, tumor markers and molecular tools for early diagnosis of cancer.

Unit II **7 Hours**

Basis of Cancer: Oncogenes, tumor suppressor genes, aberrations in signaling pathways, oncogenic mutations in growth promoting proteins, mutations causing loss of growth-inhibition DNA repair in cancer.

Unit III **7 Hours**

Oncogenesis and Apoptosis: Intracellular proteolytic cascade, cascade of caspase proteins, adapter proteins, Bcl-2, IAP family proteins, Extracellular control of cell division, tumor necrosis factor and related death signals.

Unit IV **8 Hours**

Metastasis and Cancer therapy: Heterogeneity of metastatic phenotype, metastatic cascade, basement membrane disruption, three step theory of invasion, proteinase and tumor cell division, prediction of aggressiveness of cancer, different forms of cancer therapy (chemotherapy, radiotherapy, surgery, etc.), use of signal targets towards therapy of cancer and gene therapy.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Dimmock, N. J. and Primrose, S. B. (2005). Introduction to Modern Virology. Bookbarn International, UK.
2. Ford, C. H. J., Casson, A. G. and Macdonald, F. (2004). Molecular Biology of Cancer. Bios Scientific Publishers, USA.
3. King, R. J. B. and Robins M. W. (2006). Cancer Biology. Prentice Hall, USA.

4. Margaret, A. K. and Peter, J. S. (2005). Introduction to the Cellular and Molecular Biology of Cancer. Oxford University Press, USA.
5. Neoptolemos, L. J. (1994). Cancer: A Molecular Approach**.** Blackwell Publishing, USA.
6. Phillis, R., Goodwin, S. and Palladino, M. A. (2002). Biology of Cancer. Benjamin-cummings Publishing Company, USA.

Course Code: ZOL.577
Course Title: Reproductive Physiology

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Provide in-depth knowledge of male and female reproductive systems along with the mechanistic aspects
- Illustrate various reproductive disorders which are cause of major concern in modern times.

Unit I **8 Hours**

Introduction: Regulation of Anterior and Posterior Pituitary hormones, Puberty and mechanism of puberty, Neuroendocrine system and neurosecretion; Concept of neurogenesis, pruning and brain plasticity, Neuron glial endothelial tripartite interactions, Blood brain barrier, Homeostasis, Sexual behavior: Pheromones, Copulatory patterns; Hormones in sexual behavior; Control by brain centers.

Unit II **7 Hours**

Endocrine disorders: Reproductive disorders: IHH and Kallmann syndrome, precocious and delayed puberty, Origin and causes of male sterility (azoospermia, oligozoospermia, varicocoele, cryptorchidism). Female sterility: Tubal factors; Premature ovarian failure; Luteal insufficiency; Endometriosis, PCOS.

Unit III **7 Hours**

Male reproductive system: Spermatogenesis and hormonal regulation; Oxidative stress and spermatogenesis; Seroli cells; Leydig cells; Cell-cell interaction Epididymis: Structure, function and regulation Male accessory sex glands: Structure, function and regulation Male sterility: Parameters of male sterility.

Unit IV **8 Hours**

Female reproductive system: Oogenesis and hormonal regulation; Mechanism of ovulation; Reproductive cycles in female: Menstrual cycle; Control of seasonal reproductive cycle Follicular atresia Female accessory sex glands: Structure, function and regulation Assisted Reproductive Techniques (ART): Principle of ART and protocols; Types of ART; Cryopreservation of gametes.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Reading:

1. Norris and Carr: Vertebrate Endocrinology (5thed, Vol 5, 2011, Academic Press)
2. Brooks and Marshall: Essentials of Endocrinology (1995, Blackwell Science)
3. Larson: Williams Textbook of Endocrinology (10thed, 2002, Saunders)
4. Knobil and Neill: Encyclopedia of Reproduction (Vol 1-4, 1998, Academic Press)
5. Leuang and Adashi: The Ovary (2004, Raven Press)
6. Strauss and Barbieri: Yen and Jaffe's Reproductive Endocrinology (6thed, 2009, Saunders)
7. Knobil and Neill: Encyclopedia of Reproduction (Vol 1-2, 2015, Academic Press)

L	T	P	Cr
2	0	0	2

Course Code: ZOL.578

Course Title: Insect Biology

Learning outcomes: After going through the course the learners will be able to

- Get in-depth knowledge of insect physiology, development and molecular biology
- Explore the current research avenues in the field

Unit I **8 Hours**

Insect Evolution, Diversity and Behavior: Major insect radiations during geological time scale, Major insect orders and their characteristics, Insect Chemical Biology, Behavior aspects and studies of Apis mellifera

Unit II **7 Hours**

Insect Development: Drosophila embryogenesis, metamorphosis, Anterior/Posterior Axis formation & Circadian Biology

Unit III **7 Hours**

Insect Immunity and Reproduction: Cellular and Molecular mechanisms of Insect Immunity, Immune related pathways, oogenesis and spermatogenesis, reproduction–immunity trade-offs

Unit IV **8 Hours**

Insect Pests and Vectors: Integrated Pest management, Major global agricultural pests, Resistance to Pesticides, Anopheles sp., Aedes sp. and Culex sp. as insect vectors

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. For Love of Insects. by Thomas Eisner.
2. Life on a Little Known Planet. by Howard Ensign Evans.
3. Introduction to the Study of Insects. by Charles Triplehorn and Norman F Johnson.
4. Encyclopedia of Insects. by Vincent H Resh and Ring T Cardé
5. The Insect Societies. by Edward O Wilson
6. Review and Research articles

Course Code: ZOL.544
Course Title: Seminar – II

L	T	P	Cr
1	0	0	1

Learning outcomes:

- Inculcate scientific aptitude and presentation skills and engage in reflective listening and scientific communication
- Explain new and enriched understandings of the texts through sustained collaborative inquiry

Discipline Enrichment Course

Course Code: ZOL.576
Course Title: Career Prospects in Life Sciences-1

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe basic biological processes
- revisit and revise the courses offered
- Solve exercises, mock tests and practice tests for competitive examinations

Unit I **6 Hours**

Life Sciences: Scope, importance & career opportunities; classical zoology and basic animal biology; timeline of animal research.

Unit II **8 Hours**

A revision of concepts in core courses: Animal Evolution & Classification, Developmental Biology; Animal Physiology, Ecological Principles, Molecular Biology and Animal behavior

Unit III **6 Hours**

A revision of concepts in elective courses: Genetic Engineering andEndocrinologyAnimal Cell culture and Applications

Unit IV **8 Hours**

Exercises, Mock Tests, Practice Tests from the previous year's related to UGC-CSIR – NET and ICMR - NET examinations and other competitive examinations.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Damron, W. S. (2012). Introduction to Animal Science. Prentice Hall. 5th Edition
2. Lisa AU. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
3. Voet, D. and Voet, J. G. (2008). Principles of Biochemistry. CBS Publishers & Distributors. New Delhi, India.
4. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
5. Smith, T. M. and Smith, R. L. (2012). Elements of Ecology. Benjamin Cummings Publishing Company, 8th edition.
6. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K. and Watson, J. D. (2010). Molecular Biology of the Cell. Garland publishers, Oxford.
7. Guyton. (2007). Textbook of Medical Physiology. 11th Edition. Elsevier India Pvt. Ltd. New Delhi.
8. Alcock J. Animal Behavior: An Evolutionary Approach, 10th Edition
9. Lee Alan D. Principles of Animal Behavior (Third Edition)
10. Competitive examination papers

Discipline Enrichment Course

Course Code: ZOL.576
Course Title: Career Prospects in Life Sciences-2

L	T	P	Cr
2	0	0	2

Learning outcomes: After going through the course the learners will be able to

- Describe applied biological concepts
- revisit and revise the courses offered
- Solve exercises, mock tests and practice tests for competitive examinations

Unit I **6 Hours**

Life Sciences: Scope, importance & career opportunities; Applied Biological concepts, Models of animal research.

Unit II **8 Hours**

A revision of concepts in core courses: Cell Biology, Biochemistry, Immunology, Essentials of Genetics, Metabolism, Techniques in Life Sciences

Unit III **6 Hours**

A revision of concepts in elective courses: Neurobiology and Degeneration, Cancer Biology, Vascular Biology, Nanobiology

Unit IV **8 Hours**

Exercises, Mock Tests, Practice Tests from the previous year's related to UGC-CSIR – NET and ICMR - NET examinations and other competitive examinations.

Mode of Transaction

The classroom learning/practicals/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, focused group discussions, Team teaching, Field visits, Brain storming, E-tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Experimentation, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching and practicals:

PPT, WhatsApp, Videos, Blogs, Multimedia packages, TED Talks, e-content, and google drive.

Suggested Readings:

1. Tizard (2008). Immunology: An Introduction. Cengage Learning, Thompson, USA.
2. Fasman, G. D. (1989). Practical Handbook of Biochemistry and Molecular Biology. CRC Press, Taylor and Francis Group, UK.
3. Snusted, D. P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.

4. An introduction to genetic engineering, Third edition by Dr. Desmond S.T. Nicholl.
5. Devlin, D. T. (1997). Textbook of Biochemistry with Clinical Correlations. New York, John Wiley and Sons.
6. Competitive Examination papers

Value Added Course:

XXX.YYY

L	T	P	Cr
1	0	0	1

VAC

Course Code: ZOL.599
Course Title: Project

L	T	P	Cr
0	0	0	8

Learning outcomes: After going through the course the learners will be able to

- Write review of literature
- Outline research project
- Design objectives and methodology
- Execute experiments/Compile literature
  Formulate original research/repeated experiments/review in the form of project

Examination Pattern

A: Research Project [100 Marks]: The final result of the project will be on 5 – point scale and evaluated as Excellent, Very Good, Good, Average, and Unsatisfactory. Which will be mentioned on the mark sheet/transcript but not be counted towards overall Grade Point Average (GPA).