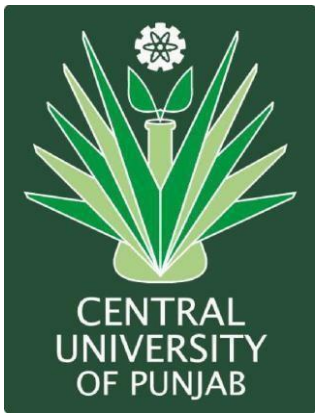
Central University of Punjab



M.Sc. Zoology

Batch: 2024 – 2026

Department of Zoology

Recommended Through 11th BoS

Programme Learning Outcome:

Zoology is a gateway to modern day allied and applied branches of life sciences that deals with animal/cell model systems to understand life processes with potential application in the field of health and agriculture. The program focuses on developing conceptual clarity, research aptitude and employable skills required in the area to meet the challenges in capacity building and to develop compassion for other species and concern for the environment. The program is also aims to inculcate innovation in the field of Zoology, allied life sciences and interdisciplinary sciences.

Graduate Attributes:

Through participation in theory and practical courses offered by the M.Sc. Programme of the department as well as through the research and hands on training i.e. dissertation, graduates will be able to acquire in-depth-understanding of relevant concepts and develop research aptitude and critical thinking. They will also able to design scientific experiments and carry out research independently as well as in a team. Further, students will able to formulate scientific questions, exchange scientific ideas with fellow colleagues, analyze, troubleshoot and summarize the research data. Students will apply domain-specific knowledge to explore feasible solutions for relevant problems of national and global relevance

Course Structure of the Programme
M.Sc. Zoology

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	**SBC**	0	0	10	5
	Discipline Elective (Opt any one)					
ZOL.514	Animal Cell Culture and Applications	**DE**	3	0	0	3
ZOL.579	Medical Genetics	**DE**	3	0	0	
	Remedial Teaching					
ZOL.XXX	Individualized Education Plan (Non-credited course)	**--**	0	2	0	0
	Total Credits					**20**

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

Semester – II

Course Code	Course Title	Type of course	L	T	P	Cr
	Core Courses					
ZOL.521	Animal Physiology	**Core**	3	0	0	3
ZOL.522	Immunology	**Core**	3	0	0	3
ZOL.523	Molecular Biology	**Core**	3	0	0	3
ZOL.574	Animal Behavior	**Core**	3	0	0	3
ZOL.540	Lab Course (Practical) – II	**SBC**	0	0	10	5
	Discipline Elective (Opt any one)					
ZOL.529	Genetic Engineering	**DE**	3	0	0	3
ZOL.513	Techniques in Life Sciences	**DE**	3	0	0	
ZOL.581	Applied Zoology	**DE**	3	0	0	
ZOL.582	Hematology	**DE**	3	0	0	
	Compulsory Foundation Course					
ZOL.557	Basic Statistics for Sciences	**CF**	3	0	0	3
MOOC*	**Biostatistics and Mathematical Biology**	**CF**				
	Interdisciplinary (ID) Courses (for students of other departments)					
ZOL.515	Fundamentals of Cell Biology	**IDC**	2	0	0	2
ZOL.528	Basics in Neuroscience	**IDC**	2	0	0	
	Remedial Teaching					
ZOL.XX	Individualized Education Plan (Non-credited course)	**--**	0	2	0	0
	Total Credits					**25**

*The mentioned MOOC course to be completed during the program whenever it is available.

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SBC: 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.572	Endocrinology	**Core**	3	0	0	3
	Discipline Elective (Opt any one)					
ZOL.552	Cancer Biology	**DE**	3	0	0	3
ZOL.580	Stem Cell Technology and Translation Research	**DE**	3	0	0	
ZOL.577	Reproductive Physiology	**DE**	3	0	0	
ZOL.554	Neurobiology and Degenerative Pathophysiology	**DE**	3	0	0	
ZOL.583	Animal Parasitology	**DE**	3	0	0	
ZOL.584	Pathophysiology of Cardiovascular Diseases	**DE**	3	0	0	
	Compulsory Foundation Courses					
ZOL.556	Research Methodology	**CF**	3	0	0	3
ZOL.558	Entrepreneurship	**CF**	2	0	0	2
	Value Added Course					
ZOL.559	Scientific writing	**VAC**	2	0	0	2
ZOL.600	Dissertation – Part I	**SBC**	-	-	8	4
	Remedial Teaching					
ZOL.XX	Individualized Education Plan (Non-credited course)	**--**	0	2	0	0
	Total Credits					**23**

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

Semester – IV

Course Code	Course Title	Type of course	L	T	P	Cr
ZOL.601	Dissertation- Part II	**SBC**	0		40	20
	Total Credits					**20**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; SBC: Skill-based Course

Students will have an option to carry out dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking.

Total Credits Distribution:

S.N.	Types of Courses	Total Credits
1	Core	30
2.	Skill based including Dissertation/Internship	34
3.	Discipline Elective	09
4.	Interdisciplinary (ID)	02
5.	Compulsory Foundation	08
6.	Value based	02
	Total	**85**

MOOCs may be taken upto 40% of the total credits (excluding dissertation credits). MOOC may be taken in lieu of any course but content of that course should match a minimum 70%.

Evaluation Criteria for Theory Courses: 100 marks

Two or more of the given methods (Surprise Tests, in-depth interview, unstructured interview, Jigsaw method, Think-Pair Share, Students Teams Achievement Division (STAD), Rubrics, portfolios, case based evaluation, video based evaluation, Kahoot, Padlet, Directed paraphrasing, Approximate analogies, one sentence summary, Pro and

con grid, student generated questions, case analysis, simulated problem solving, media assisted evaluation, Application cards, Minute paper, open book techniques, classroom assignments, homework assignments, term paper).

A. Continuous Assessment (Course-wise): [25 Marks]

B. Mid Semester Test: Based on Subjective Type Test [25 Marks]

C. End-Term Exam: Based on Objective Type Tests [50 Marks]: 70% subjective type and 30% objective type.

The objective type will include one word answers, fill-in the blank, sentence completion, true/false, MCQs', and matching, analogies. The subjective type will include a very short answer (1-2 lines), short answer (one paragraph), essay type with restricted response, and essay type with extended response.

Examination pattern

Core, Discipline Elective, and Compulsory Foundation Courses			IDC, VAC, and Entrepreneurship, Innovation and Skill Development Courses	
	Marks	Evaluation	Marks	Evaluation
Internal Assessment	25	Various methods	--	--
Mid-semester test (MST)	25	Descriptive	50	Descriptive (70%) Objective (30%)
End-semester exam (ESE)	50	Descriptive (70%) Objective (30%)	50	Descriptive (70%) Objective (30%)

Dissertation Proposal (Third Semester)			Dissertation (Fourth Semester)		
	Marks	Evaluation		Marks	Evaluation
Supervisor	50	Dissertation proposal and presentation	Supervisor	50	Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce
HoD and senior-most faculty of the department	50	Dissertation proposal and presentation	External expert, HoD and senior-most faculty of the department	50	Dissertation report (30), presentation (10), final viva-voce (10)

Marks for internship shall be given by the supervisor, HoD and senior-most faculty of the department.

Evaluation Criteria for Practical Courses: 100 Marks

Internal Assessment	**50 Marks**
Attendance:	10 Marks
Continuous assessment:	30 Marks
Lab records:	10 Marks

End-semester exam	**50 Marks**
Identification of Spotters	10 Marks
Minor Question	10 Marks
Major Question	20 Marks
Viva-voce:	10 Marks

Multiple Entry and Exit Scheme

As per UGC 2021 guidelines, for the postgraduate programs, to meet the mission of NEP 2020, there shall be one exit point for the students who join the two-year Master's program.

This exit option is to be created at the end of the first year of the Master's program.

Students who exit after the first year shall be awarded the **Post-Graduate Diploma** in the concerned stream.

To award the **Post-Graduate Diploma** after the end of the first year of M.Sc. Zoology program, the student has to complete / earn 4 credits out of the three options listed below:

1. MOOC courses - to opt any two courses from the list recommended (**Annexure - A**) equivalent to 4 credits.

2. A mini project / Internship / Industrial Training should be completed by the student of two-month duration.

3. Skill based and vocational course of 4 credits offered by any of the Life Science departments of CUP with the AAC approval.

SEMESTER – I

Core Courses:

L	T	P	Cr
3	0	0	3

Course Code: ZOL.508
Course Title: Biochemistry
Course type: Core
Teaching hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to

CLO1: Define fundamentals and basics of biochemistry
CLO2: Illustrate a thorough knowledge of the intersection between the disciplines of biology and chemistry
CLO3: Explain advanced aspects of biochemistry such as nutrition and metabolism associated with human physiology and diseases
CLO4: Develop a comprehensive knowledge of the theory and practice of modern biochemistry and its application to solve chemical problems.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	Bioenergetics and Biomolecules: Thermodynamics, Internal Energy, Enthalpy, Entropy, Concept of free energy, standard free energy. Relationship between equilibrium constant and standard free energy change. Biological oxidation-reduction reactions. Classification, structure, general properties and functions of polysaccharides, Lipids, Proteins and Nucleic acids.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	
II / 11 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. Industrially and clinically important enzymes.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	

III / 11 Hours	Carbohydrate and Lipid Metabolism: Glycolysis, gluconeogenesis, TCA cycle, hexose monophosphate (HMP) shunt, disorders of carbohydrate metabolism. Biosynthesis and oxidation of saturated and unsaturated fatty acids, and disorders of lipid metabolism.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	
IV / 11 Hours	Amino Acid and Nucleic Acid Metabolism: Biosynthesis of protein, general catabolism of amino acids, deamination, transamination, urea cycle, disorders of amino acid metabolism. Biosynthesis of purine and pyrimidine nucleotides, disorders of purine and pyrimidine metabolism.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	

Mode of Transaction

The classroom learning would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, 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:

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

Suggested Readings:

1. Shukla, A. N. (2009). Elements of Enzymology. Discovery Publishing. New Delhi, India.
2. Nelson, D. and Cox, M.M. (2021) Lehninger Principles of Biochemistry 8th Edition WH Freeman & Co Publisher, USA
3. Singh and Goyal (2021) Lippincott's Illustrated Reviews 8th Edition - Biochemistry South Asian Edition. Wolters Kluwer (India) Pvt. Ltd.
4. Botham, K.; McGuinness, O. and Weil, P. A. (2022) Harper's Illustrated Biochemistry, Thirty-Second Edition. McGraw-Hill Education, New York City, United States.
5. Voet, D., Voet J.G. and Pratt C.W. (2018) Voet's Principles of Biochemistry 5th Edition. Wiley Publisher, United States.
6. Berg, J. M., Tymoczko, J.L. and Stryer, L. (2023) Biochemistry 10th Edition WH Freeman Publisher, USA.

Web sources:
https://epgp.inflibnet.ac.in/Home
https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: ZOL.511
Course Title: Cell Biology
Course type: Core
Total Hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to
CLO1: Define the structure and basic components of a cell
CLO2: Distinguish the structure of prokaryotic and eukaryotic cell
CLO3: Explain macromolecules, membranes, organelles and their related functions in cell and molecular biology
CLO4: Develop a basis for understanding the basic cell physiology and disease processes in which signaling is compromise

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Cell evolution and Membrane Structure and Function:** Evolution of the cell, molecules to cell, prokaryotes and eukaryotes, Models of membrane structure, membrane proteins, membrane carbohydrates, membrane transport types, passive, active transport, transport of small molecules and membrane transport of macromolecules.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	
II / 11 Hours	**Structural Organization and Function of Intracellular Organelles:** Lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum and its types, Structure and function of mitochondria and nucleus.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions	
III / 11 Hours	**Cytoskeleton and Cell Communication:** The nature of cytoskeleton, intermediate filaments, microtubules, actin filaments, cilia and centrioles, organization of the cytoskeleton. Cell adhesions, cell junctions, cell-cell adhesion and communication and cell-extracellular matrix interaction.	**CLO3**
	Learning activity: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / 11 Hours	**Cell Cycle and signaling pathways: Cell Cycle and Signaling pathways:** Cell division, phases of the cell cycle (G1, S, G2, M), and key events like DNA replication and cytokinesis, molecular regulators (cyclins, CDKs, checkpoints) and the role of cell cycle regulation in development, and diseases. Introduction to cell signalling, signalling networks, protein phosphorylation / dephosphorylation, Intracellular signalling pathways covering the major pathways in cells (MAPK, PI3K-AKT, JAK-STAT, and NF-kB) and recent research developments.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	

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, Brainstorming, 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:

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. (2022). Molecular Biology of the Cell. 7th Edition. Garland publishers, Oxford.
2. Celis, J. E. (2006). Cell Biology: A Laboratory Handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P. K. (2018). Cytology, Genetics and Evolution (BC-7). Rastogi publications, Meerut, India.
4. Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. 9th Edition, John Wiley & Sons. Inc. New Delhi, India.
5. Gupta, P. K. (2017). Cell and Molecular Biology. 5th edition, Rastogi publications, Meerut, India.
6. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
7. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
8. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2016). Molecular Cell Biology. 8th Edition, W.H. Freeman, USA.
9. Alberts, B., Heald. R. and and Johnson A. (2022) Molecular Biology of the Cell Seventh edition. WW Norton & Co. Publisher
10. https://epgp.inflibnet.ac.in/Home
11. https://www.vlab.co.in/
12. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: ZOL.516
Course Title: Animal Evolution and Classification
Course type: Core
Total hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to obtain

CLO1: Detailed understanding on how did the origin of life came into existence, micro evolutionary forces driven diversity of life forms, evolutionary trends and applications of evolution in agriculture, disease and research.

CLO2: Updated knowledge on methods used for animal systematics and updated information on animal biodiversity and conservation strategies

CLO3: Knowledge on updated animal classification and detailed description of non-chordates and latest research

CLO4: Knowledge on updated animal classification and detailed description of chordates and latest research

Units/ Hours	Contents	Mapping with course Learning Outcome
I/12 Hours	**Evolution:** Macroevolutionary concepts and processes, Geological time scale, Microevolutionary: Darwinism and the origin of species, Natural selection, Sexual Selection, Genetic Drift & Mutation, Gene flow, Hardy Weinberg equilibrium, Concept of Speciation, Latest evolutionary trends and research, Applications of the study of evolution.	**CLO1**
	Learning activities: Flipped classroom approach, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes, Task on recent advances in this field.	
II/ 12 Hours	**Systematics:** Binomial nomenclature; three domain classifications; phylogenetic tree construction; applications of phylogeny; cladistics: monophyletic, paraphyletic and polyphyletic groups; shared and derived characters; homoplasy; parsimony analysis; molecular clocks, Biodiversity and Conservation.	**CLO2**
	Learning activities: Problem solving, oral presentations, online resources including e-books, videos and research publications, Task on recent advances in this field.	
III/ 11 Hours	**Non-chordates:** Phylum Protista, Parazoa and Metazoa; Porifera; Cnidaria; Ctenophora; Platyhelminthes; Nemathelminthes; Annelida; Arthropoda; Onychophora; Mollusca; Echinodermata; Economic importance of non-chordates in today's life.	**CLO3**
	Learning Activities: Oral presentations, online resources including e-books, videos and research publications	
IV/ 10 Hours	**Chordates:** Protochordata; Agnatha; Pisces; Amphibia; Reptilia; Aves; Mammals; Economic importance of chordates in today's life.	**CLO4**
	Learning activities: Oral presentations, online resources including e-books, videos and research publications	

Modes of transaction
Lecture cum Demonstration; Problem solving approach, Self-Learning, Inquiry training, Co-operative learning, and Flipped learning

Tools used: PPT, Animations, YouTube, Google Drive, Google Classroom

Suggested Readings:

1. Evolution: Making sense of life by Carl Zimmer and Douglas Emlen, 2020, 3rd Edition
2. Evolution by Carl T. Bergstrom, Lee Alan Dugatkin, 2016. 2nd Edition
3. Modern textbook of Zoology: Vertebrates by R.L. Kothpal, 2019-20, 4th Edition
4. Modern textbook of Zoology: Invertebrates by R.L. Kothpal, 2019-20, 12th Edition
5. Mayr, E. &Ashlock, P.D., Principles of Systematic Zoology. 1991. 2nd edition. McGraw Hill International Edition
6. Relevant research articles and digital resource

Web Resources:
- https://www.britannica.com/animal/animal/Animal-diversity
- https://www.springer.com/series/10153
- https://www.springer.com/series/15188

L	T	P	Cr
3	0	0	3

Course Name: Ecological Principles
Course Code: ZOL.517
Course type: Core
Total Hours: 45

Course Learning Outcomes (CLO): On completion of this course, students will be able to:

CLO1: Describe the process of interaction among the living organisms with their environment

CLO2: Develop a broad understanding of the processes that shape the distribution and abundance of organisms

CLO3: Explain energy flow and the movement and recycling of matter in communities and ecosystems

CLO4: Describe changes in population growth in an ecosystem and types of population factors

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 10 Hours	**Introduction to Ecology:** Habitat and niche, niche width and overlap; fundamental and 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, Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
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.	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
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.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

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	**CLO4**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

Transaction Mode:

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:
Textbooks, GoI e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Urry, L. A. et al. (2016). Campbell Biology. Pearson publishers, 11th edition.
2. Smith, T. M. and Smith, R. L. (2015). Elements of Ecology. Benjamin Cummings Publishing Company, 9th edition.
3. Begon, M., and Townsend, C. R. (2021). Essentials of Ecology. Wiley Publishers, 5th edition.
4. Odum, E. and Barrett, G. W. (2005). Fundamentals of Ecology. Cengage Learning, 5th edition.
5. Relevant research articles and digital resources

Skill Based Course:

L	T	P	Cr
0	0	10	5

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

Total Hours: 150

Course learning outcomes: After going through the course the learners will be able to
CLO1: Acquaint students with a fundamental knowledge of the lab instrumentation andreagents preparation and Illustrate biochemical estimation of biomolecules
CLO2: Demonstrate different techniques involved in biomolecule separation
CLO3: Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Laboratory Safety and Good Laboratory Practices
2. Laboratory instrumentation
3. Preparation of buffers and solutions
4. General characters of each phylum of animal kingdom along with their classification up to order level
5. To study animal diversity using Shannon Wiener diversity index
6. To determine the biomass of a particular area
7. To study the parasitic forms of different animals using permanent slides
8. Biochemical estimation and analysis of Proteins, Lipids, Carbohydrates & Nucleic acids
9. SDS-and native polyacrylamide gel electrophoresis
10. Cell structure: Optical microscopy
11. Histochemistry: Fixation, Sectioning, Embedding, Processing and Staining
12. Immunocytochemistry
13. Identification of cell mitosis and meiosis stages
14. Cell trypsinization and Cell count (Hemocytometer)
15. MTT Assay
16. *In vitro* free radicals-based assays
17. Peripheral blood leukocyte culture for chromosomal studies
18. Isolation of Lymphocytes from whole blood
19. Karyogram/Karyotype
20. Buccal micronucleus
21. Medical Case studies
22. FISH (Video demonstration)

Mode of Transaction

The classroom learning/practical's/project work would be based on:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Focused group discussions, Team teaching, Field visits, Brainstorming, 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 practical:

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:

2. A Laboratory Manual. Cshl Press. New York.
3. Sambrook, J. and Russell, D. W. (2000). Molecular Cloning:
4. A Laboratory Manual (3 Vol-set). 3rd Edition, CSHL Press, New York.
5. https://epgp.inflibnet.ac.in/Home
6. https://www.vlab.co.in/
7. https://lms.cup.edu.in/course/index.php?categoryid=76

Discipline Elective Courses:

L	T	P	Cr
3	0	0	3

Course Code: ZOL.514
Course Title: Animal Cell Culture and Applications
Course type: Discipline Elective
Total hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to
CLO1: Describe the foundational knowledge of cell culture techniques and competence inlaboratory techniques
CLO2: Explain problems common to routine cell culture
CLO3: Develop a thorough knowledge on application of molecular techniques to *in vitro*conditions

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 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.	**CLO 1**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	
II / 12 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.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions	
III / 12 Hours	**Applications of Animal Cell Culture:** *In vitro* transfection of animal cells, cell-based assays, and cell differentiation and movement. Cancer and Neurodegenerative Research, vaccine manufacture, gene and stem cell therapy, production of recombinant proteins, and toxicology studies.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / 10 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.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	

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:

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

Suggested Readings:

1. Freshney, R. I. (2021). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley-Blackwell,8thEdition.
2. Davis, J. M. (2008). Basic Cell Culture. 2nd Edition, Oxford University Press. New Delhi.
3. Davis, J. M. (2011). Animal Cell Culture. John Willy and Sons Ltd. USA.
4. Butler, M. (2004). Animal Cell Culture and Technology. Taylor and Francis. New York.
5. Veer BalaRastogi &NirvikaRastogi.(2023). Animal Cell Culture and Technology. MedTech Science Press.
6. https://epgp.inflibnet.ac.in/Home
7. https://www.vlab.co.in/
8. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: **ZOL. 579**
Course Title: **Medical Genetics**
Course type: **Discipline Elective**
Total hours: **45**

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

CLO1: Provide the knowledge about the classical history about genetics, and Basics of human genetics, Mendelian laws, Chromosome, inheritance patterns and genetic influence to the students for their curriculum development and knowledge enrichment.

CLO2: Provide the knowledge about medical genetics course and information about the various forms of genetic variations resulting into genetic diseases, rare genetic diseases and techniques to understand a patient's medical conditions.

CLO3: Basically, cytogenetic studies are widely used to understand the basic structure of chromosome, how to detect a chromosomal anomaly and what kind of chromosomal mutation has been carried forward can be understood.

CLO4: Describe the various prenatal and postnatal techniques, genetic counselling, recent diagnostic techniques, recent studies and ethical challenges faced in human genetics.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 Hours	**History and Basics of Genetics** Historical events and recent development of Genetics; Father of Genetics, Mendelian Laws - law of dominance, law of segregation, law of independent assortment; Diseases and disorders, Autosomal inheritance pattern, X-linked inheritance pattern, Y-linked inheritance pattern, Mitochondrial inheritance, Multifactorial inheritance, Human genome database; National Center for Biotechnology Information (NCBI) database; Online Mendelian Inheritance in Man (OMIM)	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
II / 12 Hours	**Genetic Variation in Health and Diseases** Basics of Medical Genetics, Criteria to diagnose the disease, Down syndrome, Patau Syndrome, Edward Syndrome, Klinefelter Syndrome, Turner Syndrome, Cri-du-chat, Rare Genetic diseases, Single gene disorder, Inborn errors of metabolism, Genetic principles and their application in medical practice, Pedigree analysis, case studies (Interacting with patients, learning family history, and drawing pedigree chart), Interaction with patients to create the case report; Case report preparation	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III / 12 Hours	**Cytogenetics and ISCN** Classical and molecular Cytogenetics, International System of Chromosomal Nomenclature, Karyotyping, Karyotyping terminology, Nomenclature of aberrant karyotypes, common syndromes due to numerical chromosomal changes, Structural alterations (translocations, duplications, deletions, microdeletions, fragile sites), Chromosomal basis and non-chromosomal basis of sex-determination, Sex Chromatin bodies (Barr bodies), dosage compensation in mammals and Drosophila;consanguinity and its effects	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	

IV / 11 Hours	**Diagnostic Methods (Prenatal and Postnatal Techniques)** Prenatal Diagnosis, Invasive and Non-invasive techniques, Chorionic villi sampling, fetoscopy, Ultrasound, amniocentesis, NIPT and cffDNA. Postnatal diagnosis: Peripheral blood leucocyte culture, sister chromatid exchange, Mosaicism, Molecular Cytogenetics, FISH, Comparative genomic hybridization (CGH), Neonatal diagnostics, Genetic Counselling, Ethical, legal and social issues in Human genetics	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	

Mode of Transaction

The classroom learning/practical's/Video lecture/ project work would be based on: Lecture, Demonstration, Project Method, Seminars, Group discussions, Brainstorming, E- tutoring, Panel discussion and Case studies, Self-Learning, Inquiry training,

The following tools shall be used in teaching:

Textbooks, GOI e-learning platforms, PowerPoint, Educational Videos and Animations, TED Talks, Research and Review articles, YouTube, Google Classroom

Suggested Readings:

1. DP Snustad and MJ Simmons (2012) Principles of Genetics, John Willey & Sons Publication, 6th Edition.
2. Griffiths AJF, Doebley J, Peichel C, Wassarman, DA. (2020).*An introduction to Genetic Analysis*. 12th Edition W.H. Freeman publication, USA.
3. Gelehrter, T.D., Collins, F.S. and Ginsburg, D., 1998. Principles of medical genetics. Lippincott Williams & Wilkins.
4. Principle and Practice of Medical Genetics, Rimoinet et al., 2002
5. ISCN 2020: An International System for Human Cytogenomic Nomenclature 2020. Jean McGowan-Jordan, Ros J. Hastings, Sarah Moore. S.Karger AG.
6. Cytogenetics and Molecular Cytogenetics. 1st Edition, 2023. Thomas Liehr, Taylor & Francis.

Web Sources:

1. https://link.springer.com/protocol/10.1007/978-1-4939-6703-2_25
2. https://www.mayo.edu/research/core-resources/cytogenetics-core/overview
3. https://www.gfmer.ch/SRH-Course-2011/community-genetics/pdf/Cytogenetics-Dahoun-2011.pdf

L	T	P	Cr
0	1	0	0

Course Code: ZOL.xxx
Course Title: Individualized Education Plan
Total Hours: 30

Course learning outcomes (CLO): Students will be able to
CLO1: learn the concept and educational measurement approaches and difficulties in learning process
CLO2: Describe their various assessment techniques and resources and recent technologies.

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 10 Hours	Concept and preparation of diverse needs, Educational approached and measure the diverse needs; Definition and characteristics of students with difficulties; environmental, cultural, and ecological difficulties. Functional assessment for development of compensatory skills, enrichment of academic skills; Types of various resources – exploring and utilizing the services, Role of technology for meeting diverse needs of learners; mobilizing appropriate sources.	**CLO1 & CLO2**

SEMESTER – II

L	T	P	Cr
3	0	0	3

Course Code: ZOL.521
Course Title: Animal Physiology
Course type: Core
Total hours: 45

Course learning outcomes: After going through the course the learners will be able to
CLO1: Describe physiology of human and other animals.
CLO2: Differentiate digestive, respiratory, excretory and musculoskeletal systems
CLO3: Relate chemical and biological processes occurring at the different organizational level in animal and human species.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Introduction to human physiology and organ systems.** **Digestive System:** Digestive System: Hunger and thirst mechanisms, Feeding strategies, Foregut, midgut, and hindgut fermentation in animals, ruminant and monogastric digestive system, absorption, metabolic energy balance, and BMR.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
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.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
III / 12 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.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
IV / 10 Hours	**Musculoskeletal System:** Bones of the skeleton, muscles, cartilage, tendons, ligaments, joints and other connective tissues, The basic physiology of muscle contraction, Sliding filament theory, muscle fatigue and Neuromuscular junction.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	

Mode of Transaction

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Problem solving, Debates and Case studies.

The following tools shall be used in teaching:

Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

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. (2016). Animal Physiology. 4th Edition. Sinauer Associates Inc. USA.
3. Murray, R. K. (2009). Harper's Illustrated Biochemistry. Jaypee Publishers, New Delhi.
4. Tyagi, P. (2016). A Textbook of Animal Physiology. Dominant Publishers and distributors, New Delhi, India.
5. Relevant research articles and digital resources
6. Vaz (2020) Guyton & Hall Textbook of Medical Physiology: Third South Asia Edition. Elsevier Health Science
7. Tortora, G. J. and Derrickson, B.H. (2017) Tortora's Principles of Anatomy and Physiology 15th Edition. Wiley Publisher
8. Netter H. F. (2022) Netter Atlas of Human Anatomy: Classic Regional Approach, International Edition -8th Ed: A Regional Approach (Netter Basic Science). Elsevier - Health Sciences Division Publisher
9. https://epgp.inflibnet.ac.in/Home
10. https://www.vlab.co.in/
11. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: ZOL.522
Course Title: Immunology
Course type: Core
Total hours: 45

Course learning outcomes: After going through the course the learners will be able to
CLO1: Define the basics of immune system
CLO2: Illustrate the components and molecules of immunity
CLO3: Explain various immune responses at the cellular level that work together to protect the host.
CLO4: Develop a thorough knowledge on Immune-Based Diagnosis and Therapy for inflammatory Diseases

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Introduction to Immune System:** Recognition of self and non-self, primary and secondary lymphoid organs, innate and adaptive immunity, Cells involved in immune responses, Professional phagocytes, Non-professional phagocytes, Natural Killer cells, Antigen Presenting cells, T lymphocyte and B lymphocytes, Cytokines, Interferons and interleukins.	**CLO1**
	Learning activity: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
II / 12 Hours	**Complement System, Major Histocompatibility Complex and Immunoglobulins:** Complement system structure, function, activation pathways and its biological consequences, Structure and functions of Major Histocompatibility Complex (MHC) and Human Leukocyte Antigen (HLA) system. Antigen processing and role of MHC molecules in antigen presentation, Immunoglobulins: basic structure, classes and subclasses, structural and functional relationship, Molecular mechanisms of antibody diversity and class switching.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
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, Auto-immune disorders.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
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.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	

Mode of Transaction

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

Lecture, Demonstration, Seminars, Workshop, Group discussions, Team teaching, Brain storming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Quiz, Experimentation, Scientific 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.
7. Punt, J.; Stranford. S. and Jones, P. Kuby Immunology (2018) 8th Edition. WH Freeman & Co Publisher
8. Abbas (2021) Cellular and Molecular Immunology, 10th Ed, South Asia Edition

L	T	P	Cr
3	0	0	3

Course Code: ZOL.523
Course Title: Molecular Biology
Course type: Core
Total hours: 45

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

CLO1: Define the basic knowledge on chromosome, chromatin and chromatid and it is regulation as well as the recent cytogenetic techniques and research work
CLO2: Detailed understanding on the DNA biology, replication and mechanism.
CLO3: Provide the knowledge about the RNA biology and its mechanism towards various diseases.
CLO4: Define the basic information about Prokaryotic and Eukaryotic Transcription and post-translational modifications

Unit/ Hours	Contents	Mapping with Course Learning Outcome
I / 12 Hours	**Introduction of Chromosomes and Chromatin** Historical event of Chromosomes; Definition, Types of Chromosomes, Chromatin and its regulation, Chromatid, peripheral blood lymphocyte cultures; Arrangement of 23 pairs of human chromosomes by banding position, Molecular Cytogenetics, Fluorescence in-situ hybridization (FISH).	**CLO1**
	Learning activities: Brain storming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	
II / 12 Hours	**Basics of DNA** Structure of DNA (Watson and Crick's model), Types of DNA, Prokaryotic and Eukaryotic DNA replication, Mechanism of DNA replication, Mismatch, Epigenetics and its regulation, DNA repair pathways, DNA methylation	**CLO2**
	Learning activities: Brain storming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	
III / 11 Hours	**RNA Biology** Structure of RNA; Types of RNA; Coding – role of mRNA nuclear export and human diseases, Non-Coding Housekeeping - structure and role of tRNA, rRNA, Non-Coding Regulatory – role and functions of lncRNA; X-inactivation (Xist) and ncRNA in imprinting, role and functions of smallncRNA and its types. Recent research work.	**CLO1, CLO3 & CLO4**
	Learning activities: Brain storming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	
IV / 10 Hours	**Transcription and Translation** Prokaryotic and Eukaryotic Transcription: initiation, elongation & termination, Post transcriptional modifications, capping, polyadenylation, splicing, regulation of gene expression, Prokaryotic and Eukaryotic Translation, post-translational modifications (Phosphorylation, Acetylation, Methylation), OMICS	**CLO3 & CLO4**
	Learning activities: Brain storming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	

Mode of Transaction

The classroom learning/practical's/project work would be based on: Lecture, Demonstration, Project Method, Seminars, Group discussions, Brainstorming, E-tutoring, Experimentation, Panel discussion and Self-learning.

The following tools shall be used in teaching:

Textbooks, Power point, Educational Videos and Animations, Research and Review articles

Suggested Readings:

1. Hardin, J. and Lodolce J. (2020) Becker's World of the Cell. 10th Edition. Pearson Publication
2. The Principles of Clinical Cytogenetics, Steven L. Gersen, Martha B. Keagle, Springer; 3rd Edition. 2013
3. CHROMOSOME STRUCTURE AND ABERRATIONS, Bhat, Tariq Ahmad, Wani, Aijaz Ahmad, 2017
4. Cell and Molecular Biology, De Robertis E.D.P, 8th Edition, 2017.
5. Principles of Genetics, D. Peter Snustad, Michael J. Simmons, 7th Edition, 2015
6. Molecular Biology of the Gene by James D. Watson, Seventh Edition, 2013.
7. Ozkan E, Lacerda MP. Genetics, Cytogenetic Testing and Conventional Karyotype. [Updated 2022 Aug 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK563293/
8. Molecular Biology of the Gene by James D. Watson, 2013, Seventh Edition
9. Molecular Biology: Principles and Practice by M.M. Cox, 2016, 2nd Edition Molecular Biology by Robert Weaver, 2012, 5th edition

L	T	P	Cr
3	0	0	3

Course Name: Animal Behavior
Course Code: ZOL.574
Course type: Core
Total Hours: 45

Course learning outcomes (CLO):

On completion of this course, students will be able to:

CLO1: Define Animal Behavior

CLO2: Explore variety of different behaviors found in a broad range of animal groups, using a scientific and evolutionary approach

CLO3: Describe the communication process in animals

CLO4: Analyze behavior in animals including humans

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 11 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.	CLO1
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
II / 11 Hours	**Cognition:** Neural basis of learning, memory, cognition, sleep and arousal; biological clocks; development of behavior	CLO2
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
III / 12 Hours	**Sociality:** Social communication; social dominance; use of space and territoriality; mating systems, courtship behavior, parental investment and reproductive success; parental care; aggressive behavior.	CLO3
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 11 Hours	**Foraging:** Habitat selection and optimality in foraging; migration, orientation and navigation; domestication and behavioral changes, ageing and disease, animal personalities	CLO4
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

Transaction Mode:

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brainstorming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

The following tools shall be used in teaching and practicals:
Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Alcock, J. (2013). Animal Behavior: An Evolutionary Approach. Sinauer Associates, 10th Edition
2. Dugatkin, L.A. (2020). Principles of Animal Behavior. The University of Chicago Press, 4th edition.
3. Breed, M and Moore, J. (2012). Animal Behaviour. Academic Press, 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.
6. Relevant research articles and digital resources

Skill Based Course:

L	T	P	Cr
0	0	10	5

Course Code: ZOL.540
Course Title: Lab Course (Practical) – II
Course type: Skill Based
Total hours: 150

Course learning outcomes: After going through the course the learners will be able to
CLO1: Describe parameters toward understanding the pathophysiology of various human disease
CLO2: Apply techniques involved in identification and quantification of protein expression
CLO3: Demonstrate various molecular biology techniques.
CLO4: Illustrate techniques and procedures routinely used in the core courses offered in the semester

1. Measurement of vital parameters: Blood glucose, Glucose tolerance test, Pulse Rate, Blood pressure, and Heartbeat (ECG)
2. Spirometry
3. ELISA
4. Western blotting
5. Dot blot technique
6. RNA isolation
7. DNA isolation
8. Polymerase Chain Reaction
9. cDNA synthesis and RT-PCR analysis
10. Gene cloning: Primer designing, Restriction digestion, ligation, transformation and screening.

11. DigiFrog: Online animal dissection modules.
12. Animal handling: mice/rat/rabbit (tutorials only)
13. Animal Perfusion (tutorials only)
14. Immunohistochemistry
15. Blood Micronucleus test
16. Mitochondrial DNA isolation
17. mtDNA copy number variations
18. Stem Cell maintenance (Video demonstration)
19. Establishment of hiPSCs (Video demonstration)
20. Cell cycle monitoring by flow cytometry
21. Microscopic examination of human parasite life cycles (amoeba, cestodes, nematodes, and plasmodium)
22. Life cycles of Silkworm
23. Life cycle of the honeybee
24. To study communities by quadrat method and to determine % frequency, diversity and abundance
25. Determination of free CO_2 in given water sample by titration
26. To study external morphology and nomenclature of dairy animals
27. Determination of the specific gravity of milk by using a mercury lactometer.
28. Testing of good quality eggs (Floating test, cracking test) for fertilized and unfertilized eggs (Light test, Cracking test).
29. External morphology of poultry birds (model).
30. Identification and study of common insects, birds and mammals of local area.

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.
3. Hofmann, A. (2018) Wilson and Walkers Principles and Techniques Of Biochemistry and Molecular Biology. 8th Edition. Cambridge University Press
4. https://epgp.inflibnet.ac.in/Home
5. https://www.vlab.co.in/

6. https://lms.cup.edu.in/course/index.php?categoryid=76

Discipline Elective Courses:

L	T	P	Cr
3	0	0	3

Course Code: ZOL.529
Course Title: Genetic Engineering
Course type: Discipline Elective
Total hours: 45

Course learning outcomes: After going through the course the learners will be able to
CLO:1 Describe versatile tools and techniques employed in recombinant DNA technology
CLO:2 Formulate knowledge required to design, execute, and analyze the results of genetic experimentation in animal model systems
CLO:3 Develop a thorough knowledge on methodological repertoire that allows students to innovatively apply in basic and applied fields of biological research

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 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.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
II / 12 Hours	**Recombinant Expression Systems & Mutagenesis:** prokaryotic (Fusion proteins, surface display, removal of selectable marker genes, secretion into periplasm& medium) & eukaryotic (*Sachharomycescerevisiae*& Mammalian cell expression system), oligonucleotide-directed and site directed mutagenesis.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III / 11 Hours	**Molecular Biotechnology of Microbial Systems:** Vaccines (subunit-, peptide-, attenuated-, DNA- and vector-based), Enzymes, Antibiotics, Bioremediation, and Gene therapy.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / 11 Hours	**Molecular Biotechnology of Eukaryotic Systems:** Engineering of plants (Ti-based system), Transgenic animals (Transgenic rodents), Regulation of recombinant DNA technology, Genome editing *tools such as CRISPER/Cas9, ZFN, TALEN, CRE-Lox systems*,Concerns about safety of consuming genetically modified foods, concerns about the impact of genetically modified organisms on the environment.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	

Mode of Transaction

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

Lecture, Demonstration, Project Method, Seminars, Workshop, Group discussions, Team teaching, Brainstorming, E- tutoring, Scientific discussion, Mobile teaching, Collaborative learning, Quiz, Experimentation, Tutorials, Problem solving, Debates, sample analysis and identification.

The following tools shall be used in teaching:

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

Suggested Readings:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard J. Glick, Jack J. Pasternak, Cheryl L. Patten, 4th edition. 2010, USA.
2. Principles of Gene Manipulation by Sandy B. Primrose, Richard Twyman, Bob Old Seventh edition 2006, Blackwell Publishing, USA
3. An introduction to genetic engineering, Third edition by Dr. Desmond S.T. Nicholl. 2011, UK.
4. Molecular cloning by R. Green and Joseph Sambrook, 4th Edition, CSHL Press. 2013, USA.

L	T	P	Cr
3	0	0	3

Course Code: ZOL.513
Course Title: Techniques in Life Sciences
Course type: Discipline Elective
Total hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to
CLO1: Describe analytical tools in Life Sciences.
CLO2: Distinguish spectroscopy, microscopy, molecular and immunological techniques.
CLO3: Apply analytical instruments in life science research
CLO4: Qualitative and quantitative techniques to analyze different physiological/immunological/metabolic experimental results.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Spectroscopy and Chromatography Techniques:** UV-Vis, fluorimeter, circular dichroism, FTIR, mass spectroscopy, and NMR. Thin layer chromatography (TLC), gel filtration and ion exchange, affinity chromatography, GC, GLC and HPLC.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
II / 10 Hours	**Microscopy:** Light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscope, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and live cell microscopy.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
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. Polymerase chain reaction (PCR): Principle, types and applications. Blotting techniques: Southern, Northern, Western analysis, *In situ* hybridization etc.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
IV / 11 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, Cell and tissue culture techniques: Primary and secondary cultures.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	

Mode of Transaction

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

Lecture, Demonstration, Project Method, Seminars, Workshop, Group discussions, Team teaching, Brainstorming, E- tutoring, Scientific discussion, Mobile teaching, Collaborative learning, Quiz, Experimentation, Tutorials, Problem solving, Debates, sample analysis and identification.

The following tools shall be used in teaching:

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. (2018). Kuby Immunology. 6th Edition, W. H. Freeman & Company, San Francisco.
2. Gupta, P. K. (2015). Elements of Biotechnology. Rastogi Publications, Meerut.
3. Kothari, C. R. (2008) Research Methodology. New Age International (P) Ltd., New Delhi
4. Lewin, B. (2014). Genes X, CBS Publishers & Distributors. New Delhi.
5. Nelson, D. and Cox, M. M. (2016). 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.

L	T	P	Cr
3	0	0	3

Course Code: ZOL.581
Course Title: Applied Zoology
Course type: Discipline Elective
Total Hours: 45

Course learning outcomes (CLO): Students will be able to

CLO1: understand the various concepts of prawn culture, pearl culture and fish culture related to industries as well as commercial values

CLO2: establish a sustainable approach for lac and sericulture in India

CLO3: focus the dairy and poultry animal management and their breeds, diseases, learn the testing of milk quality

CLO4: judge a broad array of career options and activities related to leather industry and vermiculture as a viable future option

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 13 Hours	**Aquaculture:** culture of fresh and marine water prawn, preparation of farm, preservation, processing & export of prawn, fish culture, harvesting & preservation of fish, composite fish farming, by products of fishing industry & fish diseases, pearl culture **Apiculture:** species of honey bees in India, life history of Apis and methods of beekeeping, bee products & their uses, extraction of honey & medicinal value of honey.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion, video demonstration.	
Unit II/ 12 Hours	**Lac culture**: lac insect & its life cycle, cultivation of lac insect, host plants, processing & uses of lac. **Sericulture**: sericulture and type of silk, silkworms & their host plants, mulberry silkworm culture, life history of silkworm, natural enemies of silkworm and their control.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, Latest research paper discussion, video demonstration.	
Unit III/ 10 Hours	**Dairy management:** dairy industry, introduction to common dairy animals, techniques of dairy management, milk and milk products, different diseases of cattle. **Poultry farming:** poultry industries, breeds of fowl, housing & equipment, deep litter system, layers & broilers, nutritive value of egg & meat, incubation & hatching of eggs.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, Latest research paper discussion, video demonstration.	

Unit IV/ 10 Hours	**Leather Industry**: Animals of leather industry, Processing of skin, flaying, Curing, salting and tanning Enemies of skin industry **Vermiculture:** biology of *Eiseniafetida*, rearing of earthworms, equipment & devices used in vermiculture, vermicompost technology, vermiwash collection, Economics of Vermiculture Enemies of earthworm	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, Latest research paper discussion, video demonstration.	

Modes of transaction
Lecture cum Demonstration; Problem solving approach, Self-Learning, Inquiry training, Co-operative learning, and Flipped learning

Tools used: PPT, Animations, YouTube, Google Drive, Google Classroom

Suggested Readings:

1. Shukla G.S. &Upadhyay V.B. (2016). Economic Zoology, Rastogi Publications
2. Jabde P.V. (2008). Text Book of Applied Zoology, Discovery Publishing House
3. Bhatnagar, R.K. and Palta, R. K. (2012). Earthworm-Vermi Culture and Vermi Composting. Kalyani Publishers India.
4. Carter, G. A. (2008). Beekeeping, Biotech Books, New Delhi
5. Sathe, T. V. and Jadhav, A. D. (2012). Sericulture and Pest Management, Daya Publishing House, New Delhi.
6. Jhingran, V. G. (2006). Fish and Fisheries of India, Hindustan Publishing Company India.

Web Resources:

1. https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php
2. https://biology.homeomagnet.com/apiculture/
3. https://www.notesonzoology.com/insects/lac-culture-of-insects-zoology/6565
4. https://www.dairyknowledge.in/article/digital-dairy-management
5. https://www.britannica.com/topic/poultry-farming
6. https://www.vedantu.com/biology/vermiculture

Course Code: ZOL.582
Course Title: Hematology
Course type: Discipline Elective
Total Hours: 45

Course learning outcomes (CLO): After going through the course students will be able to
CLO1: Understand blood composition in healthy and disease condition.
CLO2: Describe structure and function of vascular system and analyze ECG.
CLO3: Illustrate platelet physiology and signaling mechanism.
CLO4: Distinguish vascular disorders and identify therapeutics for vascular disorders.

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 12 Hours	**Blood components**: Blood cells, Blood grouping, Hematopoiesis, composition of blood, plasma proteins, anemia, edema, clotting, anticlotting, blood transfusion.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, literature discussion, video demonstration.	
Unit II/ 12 Hours	**Circulatory system:** Introduction, structure and function of the vascular system. Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principles and significance, cardiac cycle.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, literature discussion, video demonstration.	
Unit III/ 10 Hours	**Cardiovascular Biology**: Basic cardiovascular physiology, cardiovascular system including blood coagulation system, platelet biology, hemostasis and thrombosis and signaling pathways involved in thrombus biology.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, literature discussion, video demonstration.	
Unit IV/ 11 Hours	**Vascular Disorders:**Thrombotic thrombocytopenic purpura (TTP), Hemophilia, Deep Vein Thrombosis (DVT), stroke, Vascular dysfunction in various pathophysiological states including endothelial dysfunction, inflammation, atherosclerosis and diabetes, therapy for vascular diseases.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, group learning.	

Modes of transaction

Lecture cum Demonstration, Problem solving approach, Seminars, Group discussions, Collaborative learning, tutorials, E-tutoring, mobile teaching, experimentation, and Self-Learning

Tools used: PPT, Animations, WhatsApp, Journal of Visualized Experiments (JoVE), YouTube, Google Drive.

Suggested Readings:

7. Joshi, Rakesh. (2021). A Concise Textbook of Clinical Pathology, Hematology & Blood Banking.
8. Essentialsinhematologyand clinicalpatology by NayakRamadas.
9. Basic of Hematology by MR. Fakir Chand.
10. Minar, E. and Schillinger, M. (2013). Peripheral Vascular Disease: Basic & clinical perspectives. Future Medicine Ltd.
11. Rasmussen, T.E., Clouse, W. D., and Tonnessen, B.H. (2008). Handbook of Patient Care in Vascular Diseases. Lippincott Williams & Wilkins. 5th Edition.
12. Grover, Steven P, and Nigel Mackman. "Intrinsic Pathway of Coagulation and Thrombosis." Arteriosclerosis, thrombosis, and vascular biology vol. 39,3 (2019): 331-338. doi:10.1161/ATVBAHA.118.312130.

Compulsory Foundation Course

L	T	P	Cr
3	0	0	3

Course Code: ZOL.557
Course Name: Basic Statistics for Sciences
Course type: Compulsory Foundation
Total Hours: 45

Course learning outcomes: On completion of this course, students will be able to:
CLO1: Describe Statistical tools used in Life Sciences
CLO2: Interpret statistical variables and distributions
CLO3: Apply statistical parameters to available data
CLO4: Distinguish between parametric and non-parametric statistics

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 10 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.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
II / 11 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	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
III / 12 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	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
IV / 12 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.	**CLO4**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	

Transaction Mode:

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

The following tools shall be used in teaching and practicals:
Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Pagano, M. and Gauvreau, K. (2018). Principles of Biostatistics. Chapman and Hall/CRC, 2nd edition.
2. Rosner, B. (2015). Fundamentals of Biostatistics. Brooks Cole. 8th edition.
3. Das. D and Das. A. (2003). Statistics in Biology and Psychology. Academic Press, 3rd edition.
4. P. G. Hoel, Introduction to Mathematical Statistics, 1997.
5. Relevant research articles and digital resources

- **Or -**

L	T	P	Cr
4	0	0	4

Biostatistics and Mathematical Biology – MOOC - by Prof. Felix Bast @ *https://onlinecourses.swayam2.ac.in/cec24_bt01/preview*

Inter-Disciplinary Course

L	T	P	Cr
2	0	0	2

Course Code: ZOL.515
Course Title: Fundamentals of Cell Biology
Course type: Inter Disciplinary

Total hours: 30

Course learning outcomes: After going through the course, the learners will be able to
CLO1: Origin of Life, Life at the cellular and molecular level
CLO2: Define the basic unit of cell structure and function: Origin of Prokaryotes and Eukaryotes
CLO3: Membrane models and transport of micro-molecules and macro-molecules across the cell membrane
CLO4: Cell organelles and their role in different physiological processes

Unit/ Hours	Contents	Mapping with course Learning Outcome
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.	**CLO1**
	Learning activities: Brainstorming, Paper discussion, Asking Questions	
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.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III / 8 Hours	**Membrane Structure and Function:** Biomembrane at a glance**,** membrane models: structure and composition, and membrane transport.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / 7 Hours	**Structural Organization of Intracellular Organelles:** Introduction of subcellular organelles: lysosomes, ribosomes, peroxisomes, golgi apparatus, endoplasmic reticulum, nucleus, mitochondria, and chloroplast.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	

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:

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. (2022). Molecular Biology of the Cell. 7th Edition. Garland publishers, Oxford.
2. Celis, J. E. (2006). Cell Biology: A Laboratory Handbook, Vol 1, 2, 3. Academic Press, UK.
3. Gupta, P. K. (2018). Cytology, Genetics and Evolution (BC-7). Rastogi publications, Meerut, India.
4. Karp, G. (2020). Cell and Molecular Biology: Concepts and Experiments. 9th Edition, John Wiley & Sons. Inc. New Delhi, India.
5. Gupta, P. K. (2017). Cell and Molecular Biology. 5th edition, Rastogi publications, Meerut, India.
6. James, D. W., Baker, T.A., Bell, S.P., Gann, A. (2009). Molecular Biology of the Gene. Benjamin Cummings, USA.
7. Johnson, A., Lewis, J., Raff, M. (2007). Molecular Biology of the Cell. Garland Science, USA.
8. Lodish, H., Berk, A., Chris, A. K. and Krieger, M. (2016). Molecular Cell Biology. 8th Edition, W.H. Freeman, USA.
9. Alberts, B., Heald. R. and and Johnson A. (2022) Molecular Biology of the Cell Seventh edition. WW Norton & Co. Publisher
10. **https://epgp.inflibnet.ac.in/Home**
11. **https://www.vlab.co.in/**
12. **https://lms.cup.edu.in/course/index.php?categoryid=76**

L	T	P	Cr
2	0	0	2

Course Code: ZOL.528
Course Title: Basics in Neuroscience
Course type: Inter Disciplinary
Total hours: 30

Course learning outcomes (CLO): After going through the course the learners will be able to

CLO1: Describe the role of human nervous system and its control over the entire body

CLO2: Explain the properties of individual cells to their function in organized neural circuits and systems
CLO3: Develop testable scientific hypotheses and generate research plans to test these hypotheses

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 7 Hours	**Introduction to Nervous System:** Basic anatomy, parts of central nervous system & peripheral nervous system.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes	
II / 8 Hours	**Introduction to Neurons:** The neuron doctrine, Nissl and Golgi stains, components of neurons, classification and types of neurons, cytology of neurons, dendrite's structure and function, axons structure and functional aspects, ultrastructure, myelination and synapses.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions, Paper discussions	
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.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
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.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	

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:

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. Purves, D., Augustine, G. and Fitzpatrick, D. (2018) Neuroscience 6th Edition OUP USA Publisher
6. Kandel, E. R. (2021) Principles of Neural Science. 6th edition. McGraw Hill Medical Publisher
7. Peplow, P. Martinez, B. and Gennarell T. A. (2022) Neurodegenerative Diseases Biomarkers: Towards Translating Research to Clinical Practice: 173 (Neuromethods) Springer-Verlag New York Inc.; Publisher
8. https://epgp.inflibnet.ac.in/Home
9. https://www.vlab.co.in/
10. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
0	1	0	0

Course Code: ZOL.XXX
Course Title: Individualized Education Plan
Total Hours: 30

Course learning outcomes (CLO): Students will be able to

CLO1: learn the concept and educational measurement approaches and difficulties in learning process

CLO2: Describe their various assessment techniques and resources and recent technologies.

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 10 Hours	Concept and preparation of diverse needs, Educational approached and measure the diverse needs; Definition and characteristics of students with difficulties; environmental, cultural, and ecological difficulties. Functional assessment for development of compensatory skills, enrichment of academic skills; Types of various resources – exploring and utilizing the services, Role of technology for meeting diverse needs of learners; mobilizing appropriate sources.	**CLO1 & CLO2**

SEMESTER – III

L	T	P	Cr
3	0	0	3

Course Name: Developmental Biology
Course Code: ZOL.551
Course type: Core
Total Hours: 45

Course learning outcomes: On completion of this course, students will be able to:
CLO1: Describe mammalian development
CLO2: Illustrate developmental processes of vertebrates i.e. Blastulation, Gastrulation and different morphological movements
CLO3: Differentiate extra-embryonic developments and regenerative mechanism

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 12 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	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
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	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
III / 11 Hours	**Later embryonic development:** Central nervous system and the epidermis; Neural crest cells and axonal specificity; Endoderm, Mesoderm and Ectoderm.	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 10 Hours	**Regeneration:** Tertrapod limb development, metamorphosis, regeneration and ageing, teratogenesis.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

Transaction Mode:

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

Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

The following tools shall be used in teaching and practicals:

Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Lewis, W. (2011). Developmental biology: a very short introduction. Oxford University Press, 1st edition.
2. Hake, S. and Wilt, F. (2003). Principles of Developmental Biology. W.W. Norton & Company, New York, USA.
3. Lewin, R. (2004). Human Evolution - An Illustrated Introduction. WileyBlackwell, USA.
4. Baressi, M.J.F., Scott, F. and Gilbert, S. F. (2018). Developmental Biology. Sinauer Associates, Inc. USA. 11th edition.
5. Relevant research articles and digital resources

L	T	P	Cr
3	0	0	3

Course Name: Endocrinology
Course Code: ZOL.572
Course type: Core
Total Hours: 45

Course learning outcomes: On completion of this course, students will be able to:
CLO1: Define the role of the endocrine system in maintaining homeostasis and different feedback mechanism
CLO2: Describe different types of reproductive hormones and disorders associated with these hormones
CLO3: Explain the knowledge of the major endocrine disorders and future challenges
CLO4: Develop an advanced knowledge on future clinical problems of the endocrine system

Units/ Hours	Contents ----- endocrine & exocrine glands, hormones and pheromones as chemical messengers	Mapping with Course Learning Outcome
I / 12 Hours	**General Introduction to Hormone:** History, endocrine & exocrine glands, hormones and pheromones 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).	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
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 knockout/condional knockout/wild type animals	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
III / 11 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 hormones Neurohypophysis: synthesis and storage of oxytocin and vasopressin	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 12 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).	**CLO4**

	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

Transaction Mode:

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

The following tools shall be used in teaching and practicals:
Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

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 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.
6. Relevant research articles and digital resources

Discipline Elective Courses:

L	T	P	Cr
3	0	0	3

Course Code: ZOL.552
Course Title: Cancer Biology
Course type: **Discipline Elective**
Total hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to
CLO1: Describe Cancer biology
CLO2: Explain cause and progression of Cancer
CLO3: Classify Cancer
CLO4: Distinguish different forms of Cancer treatment and therapies

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 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.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	
II / 11 Hours	**Basis of Cancer:**Epigenetics in 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.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions	
III / 12 Hours	**Oncogenesis and Apoptosis:** Intracellular proteolytic cascade, cascade of caspase proteins, adapter proteins, Bcl-2, IAP family proteins, Exosomes (extracellular vesicles) as cell signaling mediators, Extracellular control of cell division, tumor necrosis factor and related death signals.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / 11 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. Non-coding RNAs (miRNA/LncRNA) and exosomes as biomarkers tools.	**CLO3 & CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	

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, Selflearning, and Case studies.

The following tools shall be used in teaching:

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

Suggested Readings:

1. Dimmock, N. J., Easton A. J. and Leppard K. N. (2016) Introduction to Modern Virology - 7th Edition John Wiley & Sons, Ltd. Published 2016 by John Wiley & Sons, Ltd, US.
2. Ford, C. H. J., Casson, A. G. and Macdonald, F. (2004). Molecular Biology of Cancer – 2nd Edition 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.
7. Weinberg, R. A. (2023). The Biology of Cancer: Third International Edition. Garland Science, Tayor and Francis Group, New York and London.

Web Sources:

1. https://epgp.inflibnet.ac.in/Home
2. https://www.vlab.co.in/
3. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: **ZOL. 580**
Course Title: **Stem Cell Technology and Translational Research**
Course type: **Discipline Elective**
Total hours: **45**

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

CLO1: Define the basic knowledge about stem cell, types, and culturing techniques, recent technology, and application part.
CLO2: Explain the overall idea about regenerative medicine and its potential applications, translational research, and recent research study.
CLO3: Define the Human Induced Pluripotent stem cells (hiPSCs), Therapeutic approaches and recent research study.

CLO4: Describe the importance of ethical issues and it is associated with stem cell research.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / **Hours**	**Introduction to stem cells** Basics of stem cell biology, Definition, properties, proliferation, Classification, Sources, Stem cells- Culture Techniques, medical applications of stem cells, maintenance aspects in ethical and legal issues in use of stem cells.	**CLO1 & CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
II / **12** **Hours**	**Types of stem cells** Stem Cell biology and therapy, types of stem cell, Adult stem cell, Embryonic stem cells, hematopoietic stem cells, mesenchymal stem cells, cancer stem cells, induced pluripotent stem cells, the potential benefits of stem cell technology, translational research - recent research study	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III / **12** **Hours**	**Therapeutics and recent advances of stem cells** Introduction to induced pluripotent stem cells technology iPSCs; Reprogramming of iPSCs; transcriptional factors; difference between iPSCs and Human Induced Pluripotent stem cells (hiPSCs); Advantages and disadvantages of iPSCs; Application of iPSCs and HiPSCs, translational research; **Stem Cell storage and banking**; Recent research work	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
IV / **11** **Hours**	**Ethical Issues associated with stem cell-based regenerative medicine field** Regulatory and Ethical Considerations of stem cell, Assessing Human Stem Cell Safety, recent medical approaches with hiPSCs in neurodegenerative diseases; Ethical and regulatory issues in the use of stem cells such as Institutional Ethics Committee (IEC), Institutional Animal Ethics Committee (IAEC), Biosafety Committee.	**CLO4**

	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	

Mode of Transaction

The classroom learning/practical's/Video lecture/ project work would be based on: Lecture, Demonstration, Project Method, Seminars, Group discussions, Brainstorming, E- tutoring, Experimentation, Panel discussion and Case studies.

The following tools shall be used in teaching:

Textbooks, Gol e-learning platforms, PowerPoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Human Neural Stem Cells: From Generation to Differentiation and Application. 1st Edition, 2018. Leonora Buzanska. Springer.
2. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer, 2005
3. Advances in stem cell therapy: bench to bedside. El-Badri, Nagwa. Humana Press. 1st edition. 2016
4. Stem cells: an insider's guide. Knoepfler, P. World Scientific Publishing Company; 1st edition, 2013.
5. Essential of Stem Cell Biology, 3rd edition, Lanza R, et al, Elsevier Academic Press, 3rd Edition, 2013
6. Stem Cell Repair and Regeneration, Vol. 2, Habib NA, Levièar NY, Gordon M, Jiao L & Amp; FiskN, Imperial College Press; 1st edition, 2007.
7. Rodrigues, G. and Eileen, B. A. J. (2020) Concepts and Applications of Stem Cell Biology: A Guide for Students (Learning Materials in Biosciences). Springer Publisher
8. Birbrair, A. (2021) Recent Advances in iPSC Technology (Advances in Stem Cell Biology Book 5) Academic Press Publisher
9. Slack, J. M.W. (2018) The Science of Stem Cells. Wiley-Blackwell Publisher

Web Sources:

1. https://www.mayoclinic.org/tests-procedures/bone-marrow-transplant/in-depth/stem-cells/art-20048117.
2. Borowski M, Giovino-Doherty M, Ji Let al., authors; Laning J, editor. Basic pluripotent stem cell culture protocols. 2012 Jun 10. In: StemBook [Internet]. Cambridge (MA): Harvard Stem Cell Institute; 2008-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK133258/
3. CiRA-https://www.cira.kyoto-u.ac.jp/e/

L	T	P	Cr
3	0	0	3

Course Name: Reproductive Physiology
Course Code: ZOL.577
Course type: Discipline Elective
Total Hours: 45

***Course Learning Outcomes*:** On completion of this course, students will be able to
CLO1: Illustrate various reproductive disorders which are cause of major concern in modern times i.e. obesity, PCOS and IHH

CLO2: Provide in-depth knowledge of male and female reproductive systems along with the mechanistic aspects

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 11 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 different brain centers.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
II / 12 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.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
III / 11 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.	**CLO2**
	Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
IV / 11 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.	**CLO2**

	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	

Transaction Mode:

The classroom learning/practicals/project work would be based on:
Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

The following tools shall be used in teaching and practicals:
Textbooks, Gol e-learning platforms, Powerpoint, Educational Videos and Animations, TED Talks, Research and Review articles

Suggested Readings:

1. Norris and Carr (2016): Vertebrate Endocrinology (8thed, Vol 5, Academic Press)
2. Brooks and Marshall (1995): Essentials of Endocrinology Blackwell Science)
3. Larson and Williams (2012) Textbook of Endocrinology (10thed, Saunders)
4. Knobil and Neill (2018): Encyclopedia of Reproduction (Vol 1-4, Academic Press)
5. Strauss and Barbieri (2009): Reproductive Endocrinology (Saunders publications)
6. Knobil and Neill (2015): Encyclopedia of Reproduction (Vol 1-2, Academic Press)

L	T	P	Cr
3	0	0	3

Course Code: ZOL.554
Course Title: Neurobiology and Degenerative Pathophysiology
Course type: Discipline Elective
Total hours: 45

Course learning outcomes (CLO): After going through the course the learners will be able to
CLO1: Describe Human Nervous system and Neurobiology
CLO2: Illustrate major degenerative diseases affecting the nervous system
CLO3: Distinguish physiological and molecular features of human neurobiology and degeneration

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 Hours	**Nervous System:** Gross neuroanatomy of the human 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.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions	
II / 10 Hours	**Metabolic functions of the Brain**: Energy Requirements; Oxidative stress; Factors contributing to the neurodegeneration.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	
III / 13 Hours	**Neurodegenerative Diseases**: Alzheimer's disease (AD), mechanism of AD pathogenesis and pathophysiology, e.g. amyloid cascade hypothesis, tau, and the therapeutic approaches. Parkinson's disease (PD), its genetics - alpha synuclein, parkin, DJ1, PINK1, and LRRK2. Gene therapy for PD. Huntington's Disease, multiple sclerosis, clinical overview of frontotemporal degeneration (FTD) and amyotrophic lateral sclerosis (ALS). Review of recently completed clinical trials and treatment prospects.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Content Focus	
IV / 11 Hours	**Therapeutic intervention:** Current treatment strategies including Pharmaceutical and Natural products-based therapies for various human neurodegenerative diseases.	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	

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:

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.
8. Purves, D., Augustine, G. and Fitzpatrick, D. (2018) Neuroscience 6th Edition OUP USA Publisher
9. Kandel, E. R. (2021) Principles of Neural Science. 6th edition. McGraw Hill Medical Publisher
10. Peplow, P. Martinez, B. and Gennarell T. A. (2022) Neurodegenerative Diseases Biomarkers: Towards Translating Research to Clinical Practice: 173 (Neuromethods) Springer-Verlag New York Inc.; Publisher
11. https://epgp.inflibnet.ac.in/Home
12. https://www.vlab.co.in/
13. https://lms.cup.edu.in/course/index.php?categoryid=76

L	T	P	Cr
3	0	0	3

Course Code: ZOL.583
Course Title: Animal Parasitology
Course type: Discipline Elective
Total hours: 45

Course learning outcomes: After completion of the course the learners will be able to

CLO1: observe the biological basis of parasitic lifestyles including host responses and parasite

evasion of host defense mechanisms
CLO2: summarize the transmission, epidemiology, diagnosis, clinical manifestations, pathology,
treatment and control of various protozoan disease
CLO3: Evaluate strategies for the prevention, control, and treatment of parasitic infections, including drug therapies and vector control measures
CLO4:Describe the clinical manifestations, pathogenesis and prophylaxis of parasitic nematodes in humans

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 12 Hours	**General Introduction to Parasitology**: Parasites, host, zoonosis, host-parasite relationship, life cycle of parasites, sources of infection, modes of infection, pathogenesis, immunity in parasitic infection	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion, video demonstration.	
Unit II/ 12 Hours	**Protozoan parasites**: General features, structure, reproduction, life cycle, *Trypanosomabrucei, Leishmaniadonovani, Entamoebahistolytica*, *Plasmodium* -history and distribution, vectors, life cycle, types of malaria.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion, video demonstration.	
Unit III/ 11 Hours	**Cestode and trematode parasites**: *Taeniasolium, Echinococcusgranulosus, Schistosomahaematobium, Fasciola hepatica*, role of tegument in the digestion and uptake of nutrients, role of insects and fishes as vectors.	**CLO3 & CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion, video demonstration.	
Unit IV/ 10 Hours	**Nematodes parasites**: classification of nematodes, *Ascarislumbricoides, Wuchereriabancrofti, Ancylostomaduodenale, Enterobiusvermicularis, Trichinellaspiralis*.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion, video demonstration.	

Suggested Readings:

1. Ghosh, S. (2013). Paniker's Textbook of Medical Parasitology, 7th edition, Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Chatterjee, K.D. (1977). Parasitology, Chatterjee Medical Publishers, Calcutta, India.

3. Khurana, S. and Mewara, A (2021). Textbook Of Medical Parasitology, Orient Blackswan Pvt. Ltd.
4. Rej,S.K. and Roy, R. (2013).Simplified course on Parasitology and Immunology, New Central Book Agency(P) Ltd, London.
5. Roberts, L. S. and Janovy, J. (2009). Foundation of Parasitology, 8th edition, McGraw Hill Higher Education, Boston.
6. Relevant research papers and digital resources

Web Resources:

1. https://www.slideshare.net/rajud521/introduction-to-parasitology
2. https://www.ncbi.nlm.nih.gov/books/NBK8325/
3. https://www.slideshare.net/mappleorange/plasmodium-57862227
4. https://basicmedicalkey.com/cestodes/#:~:text=There%20are%20four%20medically%20important,Diphyllobothrium%20latum%2C%20and%20Echinococcus%20granulosus.
5. https://www.ncbi.nlm.nih.gov/books/NBK8037/
6. https://www.ncbi.nlm.nih.gov/books/NBK8261/

Modes of transaction
Lecture cum Demonstration; Problem solving approach, Self-Learning, Inquiry training, Co-operative learning, and Flipped learning

Tools used: PPT, Animations, YouTube, Google Drive, Google Classroom

L	T	P	Cr
3	0	0	3

Course Code: ZOL.584
Course Title: Pathophysiology of Cardiovascular Diseases
Course type: Discipline Elective
Total Hours: 45

Course learning outcomes (CLO): After going through the course students will be able to
CLO1: Understand fibrotic diseases and mechanism involved in fibrosis.
CLO2: Describe types of cardiovascular diseases (CVD).
CLO3: Illustrate proteins involved in cardiovascular diseases (CVD).
CLO4: Design *in vivo* models and therapeutic targets for cardiovascular diseases (CVD).

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 12 Hours	**Fibrotic disorders:** Cardiac fibrosis, Lung fibrosis, liver fibrosis, renal fibrosis, Fibrin, tissue factor, mechanism involved in fibrosis, markers of fibrosis.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, literature discussion, video demonstration.	
Unit II/ 12 Hours	**Pathophysiology of Cardiovascular diseases (CVD)**: vascular permeability, hypertension, leukocyte endothelial interactions, edema, heart attack, trauma, symptoms of CVD.	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, literature discussion, video demonstration.	
Unit III/ 11 Hours	**Coagulation proteins in cardiovascular diseases (CVD)**: Activated protein C (APC), Endothelial Protein C Receptor (EPCR), Thrombin, Factor X, Factor VIIa, plasmin, urokinase plasminogen activator (UPA).	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, group, discussion, literature discussion, video demonstration.	
Unit IV/ 10 Hours	***in vivo* models in cardiovascular diseases (CVD):**Ischemia, stasis and stenosis model, inhibitors of coagulation, intravital microscopy, current therapeutics for CVD.	**CLO4**
	Learning activities: Brainstorming, Presentation, Quizzes, group learning.	

Modes of transaction

Lecture cum Demonstration, Problem solving approach, Seminars, Group discussions, Collaborative learning, tutorials, E-tutoring, mobile teaching, experimentation, and Self-Learning

Tools used: PPT, Animations, WhatsApp, Journal of Visualized Experiments (JoVE), YouTube, Google Drive.

Suggested Readings:

1. Fibrotic Disorders and Small Molecules Breaking the Collagen Accumulation Cycle by Wardiere Inc.

2. Fibrosis Methods and Protocols, book (2017), by Laure Rittié.

3. Pathophysiology of Cardiovascular Disease, book (2004) edited by Naranjan S. Dhalla, Heinz Rupp, Aubie Angel, Grant N. Pierce.

4. Pathophysiology of heart diseases an introduction to cardiovascular medicine, seventh edition 2021 by Leonard S. Lilly.

5. Novel Pathogenesis and Treatments for Cardiovascular Disease (2023) by David C. Gaze.

6. Fibrosis in Disease, An Organ-Based Guide to Disease Pathophysiology and Therapeutic Considerations, (2019) by Monte S. Willis, Cecelia C. Yates, Jonathan C. Schisler.

Webresources

https://www.heart.org/en/health-topics/consumer-healthcare/what-is-cardiovascular-disease

https://www.thoracic.org/professionals/clinical-resources/disease-related-resources/idiopathic-pulmonary-fibrosis.php

Compulsory Foundation Courses:

L	T	P	Cr
3	0	0	3

Course Code: ZOL.556
Course Name: Research Methodology
Course type: Compulsory Foundation
Total Hours: 45

Course learning outcomes: On successful completion of the course, the student will be able to

CLO1 Write review of literature
CLO2: Classify various aspects of research methodology
CLO3: Design research experimentand Analyzing experimental data results
CLO4: Implement biosafety while carrying out research.
CLO5: Distinguish different types of Intellectual Property Rights and Describe the ways of protecting traditional knowledge from Biopiracy.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 Hours	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.	**CLO1 & CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
II / 11 Hours	Basic principles of experimental designs, data collection, processing, and interpretation. Basics of citation and bibliography/reference preparation styles, report presentation.	**CLO2 & CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
III / 11 Hours	Good laboratory practices (GLP), biosafety issues for using cloned genes in medicine, agriculture, industry. Genetic pollution, risk and safety assessment from genetically engineered organisms.	**CLO4**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
IV / 12 Hours	Ethical theories, ethical considerations during research, ethical issues related to animal testing and human project. Institutional Ethics Committee (IEC), Institutional Animal Ethics Committee (IAEC), Radiation safety committee, and Biosafety Committee. Intellectual property rights (IPRs), patents and copyrights, fair use, plagiarism and open access publishing.	**CLO4 & CLO5**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	

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, Selflearning, and Case studies.

The following tools shall be used in teaching and practical:

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

Suggested Readings:

1. Gupta, S. (2005). Research Methodology and Statistical Techniques. Deep & Deep Publications (p) Ltd. New Delhi, India.
2. Fleming, D. O. and Hunt, D. L. (2006). Biological Safety: Principles and Practices. American Society for Microbiology, USA.
3. Rockman, H. B. (2020). Intellectual Property Law for Engineers and Scientists 2nd Edition Wiley-IEEE Press, USA.
4. Shannon, T. A. (2009). An Introduction to Bioethics. Paulist Press, USA.
5. Kothari, C. R. and G. Garg (2014): Research Methodology: Methods and Techniques, 3rd ed., New Age International Pvt. Ltd. Publisher, India.
6. Kumar, R. (2014): Research Methodology – A Step-By-Step Guide for Beginners, 4th ed., Sage Publications, India.
7. Jerrold, H. Z. (2010): Biostatistical Analysis, Fifth ed., Pearson, United Kingdom.
8. Sokal, R. F and Rohlf, F. J. (2011): Biometry, Fourth Ed., W.H. Freeman Publishers, USA.

L	T	P	Cr
2	0	0	2

Course Title: Entrepreneurship
Course Code: ZOL.516
Course type: Compulsory Foundation
Total Hours: 15 Hours

Course learning outcomes: Students will be able to:

CLO1: Understand the basic concepts of entrepreneur, entrepreneurship and its importance.

CLO2: Comprehend the opportunities, challenges and strategies required in entrepreneurship.

CLO3: Develop capabilities of preparing proposals for starting small businesses. Bring new ideas, patents, technologies and innovative services to the market.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 7 Hours	Characteristics of an entrepreneur; Characteristics of entrepreneurship; entrepreneurial traits and skills; Innovation in diagnostics and therapeutics; Importance of women entrepreneurship and successful personalities; Types of entrepreneurial ventures in biological aspects; Case studies, discussion sessions and case report submission with successful science-based entrepreneurs	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
II / 7 Hours	Why to start a small business in biological aspects; How to start a small business; opportunity analysis, government funding sources, Establishing the venture - Project report preparation and submission– format for a preliminary project report, format for a detailed/final project report.	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
III / 8 Hours	Indian Government agencies, MSME, DBT, BIRAC, Make in India Road map fromFamiliarization with Entrepreneurial development programs of public and private agencies; International opportunities for fund mobilization, Technology assessment and technology transfer, Understanding regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).	**CLO2 & CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
IV / 8 Hours	Innovation and science-based ideas to business development within segments such as health & disease, agricultural and environmental. Science based innovative project related proposal submission	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	

Suggested Readings:

1. Arora, Renu (2008). Entrepreneurship and Small Business, Dhanpat Rai& Sons Publications.
2. Chandra, Prasaaan (2018). Project Preparation, Appraisal, Implementation, Tata Mc-Graw Hills.
3. Desai, Vasant (2019). Management of a Small Scale Industry, Himalaya Publishing House.
4. Jain, P. C. (2015). Handbook of New Entrepreneurs, Oxford University Press.
5. Srivastava, S. B. (2009). A Practical Guide to Industrial Entrepreneurs, Sultan Chand & Sons.
6. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge, Routledge Studies in Innovation, Organizations and Technology (2018) 1st ed. Onetti, A, &Zucchella, A, CRC press, Taylor and Francis group. ISBN: 9781138616905.
7. Innovation, Commercialization, and Start-Ups in Life Sciences. (2014) 1st ed. Jordan, JF, CRC Press. Taylor and Francis group, ISBN: 9781482210125.
8. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences (2008) Adams, DJ, Sparrow JC, Bloxham, Scion, ISBN:1904842364.

Modes of transaction:

-Lectures and tutorials.
-Group-work
-Ideathons and design sprints
-Brain-storming sessions
-Group activities-learning by doing

Tools to be used: PPT, Video, Google drive, etc.

Value Based Course:

L	T	P	Cr
2	0	0	2

Course Name: Scientific Writing
Course Code: ZOL.559
Course type: Value Based
Total Hours: 30

Course learning outcomes: On completion of this course, students will be able to

CLO1: Explain how scientific research is published (including the peer review process, open-access journals, and the embargo system)
CLO2: Describe when it is appropriate to use the different types of scientific literature such as primary literature, reviews, and textbooks
CLO3: Explain how scientific research is published (including the peer review process, open-access journals, and the embargo system)
CLO4: Analyze different online research tools (e.g. databases, e-journals, Google Scholar, Web of Science) to collect relevant information on a particular topic

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 8 Hours	Survey, Methods and collection of Literature and review articles, literature review process, types of articles, how to prepare the review article, content and importance of review article, how to prepare the case report and research articles, Peer-reviewed journal search and find the suitable Journal - online session	CLO1
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	
II / 8 Hours	Identifying and formulating a research problem, writing a research problem, Formulation of research questions, research gap, key question, Construction of a hypothesis, Steps in designing a research problem, research objectives and practical session to prepare the research problem; Preparation of research proposal for Internship and PhD program and independent funding	CLO2
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
III / 8 Hours	NCBI, Google Scholar, Research gate, PubMed, various publishers, Basics of citation and bibliography/reference preparation styles, recent advancement in the form of Zotero and End Note analysis	CLO3
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 6 Hours	Scientific ethics in writing the research/review and proposal, Scientific misconduct, plagiarism, various software's to detect the plagiarism, Patents and copyrights and practical session to detect the plagiarism.	CLO4
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

Transaction Mode:

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

Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brain storming, E- tutoring, Experimentation, Panel discussion, Tutorials, Debates and Case studies.

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

Suggested Readings:

1. Kumar, R. (2014): Research Methodology – A Step-By-Step Guide for Beginners, 4th ed., Sage Publications.
2. Pagano, M. and Gauvreau, K. (2018). Principles of Biostatistics. Chapman and Hall/CRC, 2nd edition.
3. Gupta, S. (2005). Research Methodology and Statistical Techniques. Deep & Deep Publications (p) Ltd. New Delhi.
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. Relevant research articles and digital resources

L	T	P	Cr
0	1	0	0

Course Code: ZOL.XXX
Course Title: Individualized Education Plan
Total Hours: 30

Course learning outcomes (CLO): Students will be able to
CLO1: learn the concept and educational measurement approaches and difficulties in learning process
CLO2: Describe their various assessment techniques and resources and recent technologies.

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 10 Hours	Concept and preparation of diverse needs, Educational approached and measure the diverse needs; Definition and characteristics of students with difficulties; environmental, cultural, and ecological difficulties. Functional assessment for development of compensatory skills, enrichment of academic skills; Types of various resources – exploring and utilizing the services, Role of technology for meeting diverse needs of learners; mobilizing appropriate sources.	**CLO1 & CLO2**

L	T	P	Cr
0	0	8	4

Course Code: ZOL.600
Course Title: Dissertation-Part I
Total hours: 120

Course learning outcomes:

CLO1: Critically analyze, interpret, synthesize existing scientific knowledge based on literature review
CLO2: Demonstrate an understanding of the selected scientific problem and identify the knowledge gap
CLO3: Formulate a hypothesis and design an experimental/theoretical work

Students will prepare a research proposal based on literature review and extensive student-mentor interactions involving discussions, meetings and presentations. Each student will submit a research/dissertation proposal of the research work planned for the M.Sc. dissertation with origin of the research problem, literature review, hypothesis, objectives and methodology to carry out the planned research work, expected outcomes and bibliography.

Students will have an option to carry out dissertation work in industry, national institutes or Universities in the top 100 NIRF ranking. Group dissertation may be opted, with a group consisting of a maximum of four students. These students may work using a single approach or multidisciplinary approach. Research projects can be

taken up in collaboration with industry or in a group from within the discipline or across the discipline.

Evaluation Criteria:

The evaluation of the dissertation proposal will carry 50% weightage by supervisor and 50% by HoD and senior-most faculty of the department.

Dissertation Proposal (Third Semester)		
	Marks	**Evaluation**
Supervisor, HoD and Senior-most faculty of the department	50	Dissertation proposal and presentation

Modes of transaction
Group discussions and presentations; Self-Learning; Experimentation

SEMESTER – IV

L	**T**	**P**	**Cr**
0	0	40	20

Course Code: ZOL.601
Course Title: Dissertation-Part II
Total hours: 600

Course learning outcomes:
CLO1: Demonstrate an in-depth knowledge of scientific research pertaining to the area of study
CLO2: Demonstrate experimental/theoretical research capabilities based on rigorous hands-on training
CLO3: Critically analyze, interpret and present the data in light of existing scientific knowledge to arrive at specific conclusions

CLO4: Develop higher order thinking skills required for pursuing higher studies (Ph.D.)/research-oriented career options

Students will carry out their research work under the supervision of a faculty member. Students will interact with the supervisors through meetings and presentations on a regular basis. After completion of the research work, students will complete the dissertation under the guidance of the supervisor. The dissertation will include literature review, hypothesis, objectives, methodology, results, discussion, and bibliography.

Evaluation Criteria:

The evaluation of dissertation in the fourth semester will be as follows: 50% weightage for continuous evaluation by the supervisor which includes regularity in work, mid-term evaluation, report of dissertation, presentation, and final viva-voce; 50% weightage based on average assessment scores by an external expert, HoD and senior-most faculty of the department. Distribution of marks will be based on report of dissertation (30%), presentation (10%), and final viva-voce (10%). The final viva-voce will be through offline or online mode.

Annexure – A: MOOCs courses - to opt any two courses from the list equivalent to 4 credits

Course (nptel.ac.in), Swayam - NPTEL, onlinecourses.nptel.ac.in

Course Name	Offered by	Duration	No. of Credits
Big Data Computing	By Prof. Rajiv Misra	8 weeks	2 credits
Tissue Engineering	Prof. VigneshMuthuvijayan	8 Weeks	2 credits
Transport Phenomena in Biological Systems	Prof. G. K. Suraishkumar	12 Weeks	3 credits
Introduction to Biomedical Imaging Systems	Prof. Arun K. Thittai	12 Weeks	3 credits
Introduction to Dynamical Models in Biology	Prof. Biplab Bose	4 Weeks	1 credit
Experimental Biotechnology	Prof. Vishal Trivedi	12 Weeks	3 credits
Introduction to Mechanobiology	Prof. Shamik Sen	8 Weeks	2 credits
Introduction to Proteomics	Prof. Sanjeeva Srivastava	8 Weeks	2 credits
Environmental Biotechnology	Prof. PinakiSar	12 Weeks	3 credits
Industrial Biotechnology	Prof. Debabrata Das	12 Weeks	3 credits
Wildlife Ecology	Prof. AnkurAwadhiya	12 Weeks	3 credits
Computational Neuroscience	Prof. SharbaBahdyopadhyay	12 weeks	3 credits