Central University of Punjab

M.Sc. Zoology

Batch: 2025 – 2027

Department of Zoology

For Curriculum Audit & 12th BoS

Course Structure of the Programme
M.Sc. Zoology

Semester – I

Course Code	Course Title	Type of course	L	T	P	Cr	SDG
	Core Courses						
MZOL.516	Cell & Molecular Biology	**Core**	3	0	0	3	3,4,9
MZOL.517	Biochemistry	**Core**	3	0	0	3	3,12
MZOL.518	Animal Evolution & Developmental Biology	**Core**	3	0	0	3	13,14,15
MZOL.519	Ecology &Animal Behavior	**Core**	3	0	0	3	13,14,15
MZOL.520	Lab Course - I	**SKEC**	0	0	10	5	3,9
	Discipline Elective (Opt any one from here or Allied Sciences; Biochemistry, Microbiology, Computational Biology, Human Genetics and Molecular Medicine, Computational Sciences)						
MZOL.521	Animal Parasitology	**DE**	3	0	0	3	3
MZOL.522	Medical Genetics	**DE**	3	0	0		3,4,9
MZOL.523	Vascular Biology	**DE**	3	0	0		3
MZOL.524	Reproductive Physiology	**DE**	3	0	0		3,5
MZOL.525	Animal Cell Culture and Applications	**DE**	3	0	0		3,9
	Remedial Teaching						
MZOL.XXX	Individualized Education Plan (Non-credited course)	--	0	2	0	0	4
	Total Credits					**20**	

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SKEC: Skill Enhancement Course; SDG: Sustainable Development Goals

SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 12: Responsible Consumption and Production; SDG 13: Climate action; SDG 14: Life below water; SDG 15: Life on land

Semester – II

Course Code	Course Title	Type of course	L	T	P	Cr	SDG
	Core Courses						
MZOL.526	Animal Physiology	**Core**	3	0	0	3	3,12
MZOL.527	Immunology	**Core**	3	0	0	3	3,9,10
MZOL.528	Endocrinology	**Core**	3	0	0	3	3,5,10
MZOL.529	Lab Course– II	**SKEC**	0	0	8	4	3,4,6
MZOL.596	Field visit/ Industrial visit	**SKEC**	0	0	0	1	3,4,6
	Ability Enhancement						
MZOL.530	Research Methodology & Basic Statistics for Sciences	**AE**	2	0	0	2	3,4,9
	Interdisciplinary / Multidisciplinary (ID/MD) Courses (for students of other departments)						
MZOL.506	Fundamentals of Cell Biology	**IDC**	2	0	0	2	3,9
MZOL.507	Basics in Neurobiology	**IDC**	2	0	0		3,5,10
	Value Based Course						
MZOL.511	Techniques in Life Sciences	**VBC**	2	0	0	2	3,4
	Remedial Teaching						
MZOL.XXX	Individualized Education Plan (Non-credited course)	--	0	2	0	0	4
	Total Credits					**20**	

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; DE: Discipline Elective Course; IDC: Interdisciplinary Course; SkEC: Skill Enhancement Course; SDG: Sustainable Development Goals

SDG 3: Good Health and Well-being; SDG 4: Quality Education; SDG 5: Gender Equality; SDG 6: Clean water and sanitation; SDG 9: Industry, Innovation, and Infrastructure; SDG 10: Reduced Inequality; SDG 14: life below water; SDG 15: Life on land

Semester – III

Course Code	Course Title	Type of course	L	T	P	Cr
MZOL.599-1	Dissertation – Part I	**SKEC**	-	-	40	20
	Total Credits					**20**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; SKEC: Skill Enhancement Course

Semester – IV

Course Code	Course Title	Type of course	L	T	P	Cr
MZOL.599-2	Dissertation- Part II	**SKEC**	0	0	40	20
	Total Credits					**20**

L: Lectures; T: Tutorials; P: Practical; Cr: Credits; SKEC: Skill Enhancement 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	%age
1	Core	7 x 3 = **21**	26.2
2.	Skill enhancement (Practical & Dissertation /Internship)	5 + 5 + 20 + 20 = **50**	62.5
3.	Discipline Elective	**03**	3.8
4.	Interdisciplinary/Multidisciplinary Course (ID/MD)	**02**	2.5
5.	Foundation Course (Ability Enhancement / Compulsory Foundation)	**02**	2.5
6.	Value based	**02**	2.5
	Total Credits	**80**	

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) for continuous assessment.

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

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

C. End-Term Exam: Based on Subjective Type Tests [50 Marks]: Descriptive (upto 100%), Objective (upto 30%)

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 from 2025-2026 session onwards

<table>
<tr><td colspan="3">Core, Discipline Elective, and Compulsory Foundation Courses</td><td colspan="3">IDC, VAC, Entrepreneurship, Innovation and Skill Development Courses
(≤2 credits) or any other theory course of ≤2 credits</td></tr>
<tr><td></td><td>Marks</td><td>Evaluation</td><td>Marks</td><td colspan="2">Evaluation</td></tr>
<tr><td>Internal Assessment</td><td>25</td><td>Various methods</td><td>-</td><td colspan="2">-</td></tr>
<tr><td>Mid-semester test (MST)</td><td>25</td><td>Descriptive</td><td>50</td><td colspan="2">Descriptive (upto 100%)
Objective (upto 30%)</td></tr>
<tr><td>End-semester exam (ESE)</td><td>50</td><td>Descriptive (upto 100%), Objective (upto 30%)</td><td>50</td><td colspan="2">Descriptive (upto 100%)
Objective (upto 30%)</td></tr>
<tr><td colspan="3">Dissertation Proposal (Third Semester)</td><td colspan="3">Dissertation (Fourth Semester)</td></tr>
<tr><td></td><td>Marks</td><td>Evaluation</td><td></td><td>Marks</td><td>Evaluation</td></tr>
<tr><td>Supervisor</td><td>50</td><td>Dissertation proposal and presentation</td><td>Supervisor/ co-supervisor(s)</td><td>50</td><td>Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva- voce</td></tr>
<tr><td>HoD and senior- most faculty of the department</td><td>50</td><td>Dissertation proposal and presentation</td><td>External expert</td><td>50</td><td>Report of dissertation (25), presentation (10), novelty/ originality (5) and final viva-voce (10).</td></tr>
<tr><td colspan="6">Field Visit/ industrial visit</td></tr>
<tr><td colspan="6">Total marks: 50
Detailed report submission and presentation: 70%
viva-voce: 30%</td></tr>
</table>

Marks for internship shall be given by the supervisor/internal mentor and external mentor.

SEMESTER – I

L	T	P	Cr
3	0	0	3

Course Code: MZOL.516
Course Title: Cell & Molecular Biology
Course type: Core
Total Hours: 45

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

CLO1: Recall and differentiate the structural and functional characteristics of prokaryotic and eukaryotic cells.

CLO2: Describe and explain the roles of macromolecules, membranes, and organelles in Cell and Molecular Biology.

CLO3: Apply fundamental knowledge of cell physiology to analyze disease processes involving impaired signaling pathways.

CLO4: Illustrate and analyze the structure and function of chromosomes, chromatin, and chromatids, and evaluate mechanisms regulating DNA replication and repair.

CLO5: Summarize, compare, and design models explaining RNA biology, transcriptional processes, post-transcriptional modifications, and their implications in diseases.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Cell, Sub-cellular Structures and their Functions:** Evolution of the cell, molecules to cell, prokaryotes and eukaryotes, models of membrane structure and its components, membrane transport (types such as passive, active transport, transport of small molecules and membrane transport of macromolecules), lysosomes, ribosomes, peroxisomes, Golgi apparatus, endoplasmic reticulum and its types, Structure and function of mitochondria and nucleus.	**CLO1 & CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Paper discussion	
II / 11 Hours	**Cytoskeleton, Cell Communication and Cell Cycle and Regulation:** 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, mitosis and meiosis, cell cycle and their regulation, cell signaling and signaling networks, post-translational modifications and cell signaling.	**CLO2 & CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions	

III / 11 Hours	**Chromosomes, Chromatids, and DNA biology:** Historical event of chromosomes; definition, types of chromosomes, chromatin and its regulation, chromatid, arrangement of 23 pairs of human chromosomes by banding position, structure of DNA (Watson and Crick's model), types of DNA, DNA replication, epigenetics and its regulation, DNA repair pathways, recent research work.	**CLO4**
	Learning activities: Brainstorming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	
IV / 11 Hours	**RNA Biology, Transcription and Translation** 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; prokaryotic and eukaryotic transcription and translation, post-translational modifications (phosphorylation, acetylation, methylation), OMICS, Recent research work.	**CLO5**
	Learning activities: Brainstorming, problem solving, oral presentations, online resources including e-books, videos and research publications, Quizzes	

Mode of Transaction

The classroom learning/practical/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, videos, blogs, multimedia packages, TED talks, e-content.

Suggested Readings:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., & Watson, J. D. (2022). Molecular biology of the cell (7th ed.). Oxford: Garland Publishers.
2. Hardin, J., & Lodolce, J. (2020). Becker's world of the cell (10th ed.). New York: Pearson.
3. Celis, J. E. (2006). Cell biology: A laboratory handbook (Vols. 1–3). London: Academic Press.
4. Gupta, P. K. (2018). Cytology, genetics and evolution (BC-7). Meerut: Rastogi Publications.
5. Karp, G. (2020). Cell and molecular biology: Concepts and experiments (9th ed.). New Delhi: John Wiley & Sons.
6. Gupta, P. K. (2017). Cell and molecular biology (5th ed.). Meerut: Rastogi Publications.
7. Ozkan, E., & Lacerda, M. P. (2022). Genetics, cytogenetic testing and conventional karyotype. In StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK563293/
8. James, D. W., Baker, T. A., Bell, S. P., & Gann, A. (2009). Molecular biology of the gene. San Francisco: Benjamin Cummings.

9. Johnson, A., Lewis, J., & Raff, M. (2007). Molecular biology of the cell. New York: Garland Science.
10. Lodish, H., Berk, A., Kaiser, C. A., & Krieger, M. (2016). Molecular cell biology (8th ed.). New York: W.H. Freeman.
11. Alberts, B., Heald, R., & Johnson, A. (2022). Molecular biology of the cell (7th ed.). New York: W.W. Norton & Company.

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: MZOL.517
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: Recall and define the fundamental principles and basics of biochemistry, including key molecules and their roles in biological systems.

CLO2: Illustrate a thorough understanding of the intersection between biology and chemistry, analyzing their relationship in biochemical processes.

CLO3: Explain advanced aspects of biochemistry, such as nutrition and metabolism, and evaluate their association with human physiology and diseases.

CLO4: Develop a comprehensive understanding of both theoretical and practical aspects of modern biochemistry, and apply this knowledge to solve complex chemical problems.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 12 Hours	**Biomolecules Structures and Functions:** Structure & function of carbohydrates, lipids, proteins, and nucleic acids. Bioenergetics & thermodynamics, biophysical & biochemical techniques (UV-Vis, fluorescence, circular dichroism, NMR, SDS-PAGE, 2D-PAGE, western blot, mass spectrometry, chromatography, HPLC, GC).	**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 essential 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, oxidation of saturated and unsaturated fatty acids, and lipid metabolism disorders.	**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	**CLO4**

	pyrimidine nucleotides, disorders of purine and pyrimidine metabolism.	
	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, Videos, Blogs, Multimedia packages, TED Talks, e-content.

Suggested Readings:

1. Shukla, A. N. (2009). Elements of enzymology. New Delhi: Discovery Publishing.
2. Nelson, D. L., & Cox, M. M. (2021). Lehninger principles of biochemistry (8th ed.). New York: W. H. Freeman & Company.
3. Singh, S., & Goyal, R. (2021). Lippincott's illustrated reviews: Biochemistry (8th ed., South Asian edition). New Delhi: Wolters Kluwer (India) Pvt. Ltd.
4. Botham, K. M., McGuinness, O. P., & Weil, P. A. (2022). Harper's illustrated biochemistry (32nd ed.). New York: McGraw-Hill Education.
5. Voet, D., Voet, J. G., & Pratt, C. W. (2018). Voet's principles of biochemistry (5th ed.). Hoboken, NJ: Wiley.
6. Berg, J. M., Tymoczko, J. L., & Stryer, L. (2023). Biochemistry (10th ed.). New York: W. H. Freeman.

Web sources:

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

L	T	P	Cr
3	0	0	3

Course Code: MZOL.518

Course Name: Animal Evolution & Developmental Biology

Course type: Core

Total Hours: 45

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

CLO1: Describe and analyze the origin of life, microevolutionary forces driving diversity, evolutionary trends, and evaluate the applications of evolution in agriculture, disease, and research.

CLO2: Identify and explain modern methods of animal systematics, analyze patterns of animal biodiversity, and critically assess the taxonomy and research on non-chordates and chordates.

CLO3: Recall and describe the key stages of mammalian development, and compare developmental stages across species to recognize variations.

CLO4: Illustrate and apply the developmental processes of vertebrates, including blastulation, gastrulation, and morphogenetic movements, and design models representing these stages for better conceptual understanding.

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 12 Hours	**Evolution:** Geological time scale, macroevolutionary concepts and processes, microevolutionary: Darwinism and the origin of species, natural selection, sexual selection, genetic drift & mutation, gene flow, Hardy Weinberg equilibrium, 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 / 11 Hours	**Systematics:** Binomial nomenclature; phylogenetic tree construction; biodiversity and conservation. Non-chordates and economic importance of non-chordates in today's life. Chordates and economic importance of chordates in today's life.	**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	**Beginning of a new organism:** Principles of development, gametogenesis: spermatogenesis and oogenesis in mammals; types of eggs and egg membranes, fertilization: external (amphibians) and internal (mammals), fast and slow blocks to polyspermy and mechanism	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Latest research paper discussion	

IV / 11 Hours	**Early and late embryonic development:** Types and patterns of cleavage; its types and significance, blastulation and gastrulation, different movements occur during gastrulation, cell-cell communication, stem cells, metamorphic events and its hormonal regulation in amphibians. role of guidance cue molecules during early and late development of brain	**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, youtube, google classroom, ted talks, research and review articles

Suggested Readings:

1. Emlen, D. J., & Zimmer, C. (2020). Evolution: Making sense of life (3rd ed.). Macmillan Learning.
2. Bergstrom, C. T., & Dugatkin, L. A. (2023). Evolution (3rd ed.). W. W. Norton & Company.
3. Kotpal, R. L. (2020). Modern textbook of zoology: Vertebrates (5th ed.). Rastogi Publications.
4. Kotpal, R. L. (2019). Modern textbook of zoology: Invertebrates (12th ed.). Rastogi Publications.
5. Barresi, M. J. F., & Gilbert, S. F. (2023). Developmental biology (13th ed.). Oxford University Press.
6. Wilt, F. H., & Hake, S. (2004). Principles of developmental biology. W. W. Norton & Company.
7. Lewin, R. (2005). Human evolution: An illustrated introduction (5th ed.). Wiley-Blackwell.
8. Barresi, M. J. F., & Gilbert, S. F. (2019). Developmental biology (12th ed.). Sinauer Associates, an imprint of Oxford University Press.
9. Relevant research articles and digital resources.

Web Resources:

1. http://pressbooks-dev.oer.hawaii.edu/explorationsbioanth/chapter/__unknown__-3/
2. http://openstax.org/books/concepts-biology/pages/11-1-discovering-how-populations-change
3. http://evolution.berkeley.edu/teach-resources/
4. http://www.youtube.com/watch?v=8-KF0rnhKTU

L	T	P	Cr
3	0	0	3

Course Code: MZOL.519

Course Name: Ecology & Animal Behavior

Course type: Core

Total Hours: 45

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

CLO1: Describe and explain the interactions among organisms and their physical environment, including concepts of energy flow and ecosystem functioning.

CLO2: Analyze and differentiate population dynamics, species interactions, and biodiversity conservation strategies across diverse ecosystems.

CLO3: Evaluate animal behavioral patterns by critically assessing innate and learned behaviors, sensory modalities, and communication systems.

CLO4: Synthesize and interpret social structures, reproductive strategies, and evolutionary theories to explain their influence on animal behavior and fitness.

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 10 Hours	**Ecosystem Structure and Function:** Abiotic and biotic components of ecosystem; energy flow: food chains, food webs, ecological pyramids; productivity: primary and secondary productivity; energy flow models in different ecosystems; niche: fundamental vs realized niche, niche overlap and partitioning; ecological amplitude and limiting factors; indicator species, keystone species, and umbrella species; habitat fragmentation and edge effects.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
II / 12 Hours	**Population Ecology and Biodiversity conservation:** Characteristics of populations, population growth models: exponential and logistic growth, carrying capacity; population regulation: density-dependent and independent factors; species interactions; ecological succession: primary and secondary succession, climax communities; levels of biodiversity: genetic, species, and ecosystem diversity; biodiversity hotspots; conservation strategies: *in-situ* and *ex-situ*, IUCN categories, red data book, CITES, Ramsar Convention.	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	

III / 11 Hours	**Ethology and Sensory Ecology:** Instinct vs learning; innate behaviour, fixed action patterns; Learning: Habituation, classical conditioning, operant conditioning, insight learning, neural basis of learning and memory; Sleep and arousal; Biological rhythms: Circadian and circannual rhythms; Sensory modalities in animals: Visual, auditory and chemical; Kin recognition and alarm signaling; migration.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 12 Hours	**Social Behaviour and Reproductive Strategies:** Social structure in animals: Solitary vs social species; Altruism and kin selection: Hamilton's rule; Cooperative behaviour: Eusociality in insects and cooperative breeding in birds/mammals; Dominance hierarchies and territorial behavior; Sexual selection: Intra- and intersexual selection, mate choice; Mating systems; Reproductive success and fitness; Parental investment and care strategies; Communication in mating and territoriality; Life history strategies (r/K selection theory).	**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, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Panel discussion, Tutorials, Problem solving, Debates, Self-learning, 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. Odum, E. P., & Barrett, G. W. (2004). Fundamentals of ecology (5th ed.). Boston, MA: Brooks/Cole.
2. Krebs, C. J. (2009). Ecology: The experimental analysis of distribution and abundance (6th ed.). San Francisco, CA: Benjamin Cummings.
3. Begon, M., Townsend, C. R., & Harper, J. L. (2021). Ecology: From individuals to ecosystems (5th ed.). Hoboken, NJ: Wiley.
4. Alcock, J. (2013). Animal behavior: An evolutionary approach (10th ed.). Sunderland, MA: Sinauer Associates.
5. Scott, G. (2004). Essential animal behavior. Oxford, UK: Wiley-Blackwell.
6. Agarwal, V. K. (2013). Animal behaviour (Ethology). Meerut, India: S. Chand Publishing.

Web Resources:

1. https://open.umn.edu/opentextbooks/textbooks/751
2. https://www.academia.edu/35341193/Ecology_Ecosystem_study_materials

L	T	P	Cr
0	0	10	5

Course Code: MZOL.520
Course Title: Lab Course -I
Course type: Skill-Based
Total Hours: 150

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

CLO1: Explain the principles of laboratory safety, good laboratory practices, and the foundational techniques in buffer preparation, microscopy, histology, and biochemical analysis.

CLO2: Apply laboratory instrumentation methods, biochemical assays (for proteins, lipids, carbohydrates, and nucleic acids), and cell biology techniques (like trypsinization, MTT assay, and karyotyping) to experimental investigations.

CLO3: Analyze biological diversity using ecological indices and differentiate between various animal phyla based on morphological and taxonomical features.

CLO4: Critically evaluate cell division stages (mitosis and meiosis), chromosomal studies and interpret experimental results in the context of molecular diagnostics.

CLO5: Design and perform independent experiments combining ecological, biochemical, and cytogenetic techniques to solve real-world biological problems, and propose innovative solutions based on field and laboratory data.

1. Laboratory Safety and Good Laboratory Practices
2. Laboratory instrumentation
3. Preparation of buffers and solutions
4. General characteristics of each phylum of animal kingdom along with their classification up to the 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)

23. Tour of the campus (CU Punjab) to explore the biodiversity.
24. Visiting AIIMS, Bathinda hospital to perform the dry lab work and observation.

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 and practical:

PPT, Videos, Blogs, Multimedia packages, TED Talks, e-content

Suggested Readings:

1. Seidman, L. A., & Moore, C. J. (2022). *Basic laboratory methods for biotechnology* (4th ed.). San Diego, CA: Academic Press.
2. Wilson, K., & Walker, J. (Eds.). (2022). *Principles and techniques of biochemistry and molecular biology* (8th ed.). Cambridge, UK: Cambridge University Press.
3. Nelson, D. L., & Cox, M. M. (2021). *Lehninger principles of biochemistry* (8th ed.). New York, NY: W. H. Freeman and Company.
4. Begon, M., Townsend, C. R., & Harper, J. L. (2021). *Ecology: From individuals to ecosystems* (5th ed.). Hoboken, NJ: Wiley-Blackwell.
5. Roberts, L. S., Janovy, J., & Nadler, S. A. (2021). *Foundations of parasitology* (10th ed.). New York, NY: McGraw Hill.
6. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2022). *Molecular biology of the cell* (7th ed.). New York, NY: Garland Science.
7. Tortora, G. J., Funke, B. R., & Case, C. L. (2022). *Microbiology: An introduction* (13th ed.). Boston, MA: Pearson.
8. Sambrook, J. (2006). *The condensed protocols from molecular cloning: A laboratory manual.* Cold Spring Harbor, NY: CSHL Press.
9. Sambrook, J., & Russell, D. W. (2012). *Molecular cloning: A laboratory manual* (4th ed., 3-vol. set). Cold Spring Harbor, NY: CSHL Press.

Web Resources:

10. https://epgp.inflibnet.ac.in/Home
11. https://www.vlab.co.in/
12. https://lms.cup.edu.in/course/index.php?categoryid=76

Discipline Elective

L	T	P	Cr
3	0	0	3

Course Code: ZOL.521
Course Title: Animal Parasitology
Course type: Discipline Elective
Total Hours: 45

Course Learning Outcomes (CLOs): After going through the course the learners will be able to

CLO1: Explain and analyze the mechanisms of host-parasite interactions, immune responses, and evasion strategies used by parasites to adapt to their hosts.
CLO2: Observe and apply knowledge of the mode of transmission, pathogenesis, and life cycle of important parasites, and interpret how these factors affect disease progression.
CLO3: Identify parasite vectors and evaluate their role in disease transmission, assessing their impact on epidemiology and public health.
CLO4: Utilize modern diagnostic tools and control strategies to develop and apply solutions for disease prevention in public health and veterinary parasitology.

Units/ Hours	Contents	Mapping with Course Learning Outcome
I/ 10 Hours	**Introduction to Parasitology and Host-Parasite Relationships:** Types of parasites: ectoparasites, endoparasites, obligate, facultative; parasitism vs. other symbiotic relationships (commensalism, mutualism); host types: definitive, intermediate, paratenic, reservoir; structural and physiological adaptations in parasites; host immune response to parasitic infections; mechanisms of immune evasion by parasites.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Case Studies	
II/ 12 Hours	**Protozoan and Helminth Parasites of Medical and Veterinary Importance: Protozoa:** Morphology, life cycle, pathogenesis, diagnosis: *Entamoeba histolytica* and *Plasmodium* spp. Helminths: Life cycle, pathogenesis, diagnosis and treatment: *Taenia solium*, Nematodes: *Ascaris lumbricoides, Wuchereria bancrofti*	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit and Case Studies	

III/ 11 Hours	**Arthropod Vectors and Parasites:** Insect vectors: *Anopheles*, *Culex*, *Aedes*, *Phlebotomus*, *Glossina*, fleas, lice, and their role in disease transmission, mechanical vs. biological transmission, integrated vector management and control strategies.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit and Case Studies	
IV/ 12 Hours	**Diagnosis, Control, and Emerging Trends in Parasitology:** Diagnostic methods: Microscopy, serological, molecular tools (PCR, ELISA); antiparasitic drugs and their mechanisms (e.g., antimalarials, anthelmintics); drug resistance in parasites; control and prevention strategies: sanitation, vaccination, vector control; emerging parasites and global parasitic threats; role of climate change and globalization in parasite epidemiology.	**CLO4**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit and Case Studies.	

Transaction Mode:

Lecture, Demonstration, Project Method, Seminars, Group discussions, Field visits, Brainstorming, E- tutoring, Dialogue Mode, Mobile teaching, Collaborative learning, Panel discussion, Tutorials, Debates, Self-learning, and Case studies.

The following tools shall be used in teaching:

Textbooks, Powerpoint, Educational Videos, Animations, Research and Review articles

Suggested Readings:

1. Chatterjee, K. D. (2019). Parasitology: Protozoology and helminthology (13th ed.). New Delhi, India: CBS Publishers & Distributors.
2. Arora, D. R., & Brij Bala. (2018). Medical parasitology (5th ed.). New Delhi, India: CBS Publishers & Distributors.
3. Roberts, L. S., & Janovy, J. (2008). Foundations of parasitology (8th ed.). New York, NY: McGraw Hill.
4. Markell, E. K., & Voge, M. (2006). Medical parasitology (9th ed.). Philadelphia, PA: W.B. Saunders.
5. Ghosh, S. (2019). *Parasitology* (3rd ed.). Kolkata, India: Academic Publishers.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7151227/
2. https://www.frontiersin.org/articles/10.3389/fimmu.2020.577802/full
3. https://www.ncbi.nlm.nih.gov/books/NBK8325/
4. https://www.cdc.gov/dpdx/amebiasis/index.html
5. https://www.cdc.gov/parasites/malaria/index.html
6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9053602/
7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7967700/

L	T	P	Cr
3	0	0	3

Course Code: **MZOL.522**
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 students with a foundational understanding of the classical history of genetics, including Mendelian laws, inheritance patterns, chromosomes, and genetic influences, to support their curriculum development and knowledge enrichment.

CLO2: Equip students with comprehensive knowledge of medical genetics, genetic variations leading to diseases, rare genetic conditions, and techniques to diagnose and understand a patient's medical condition based on genetic information.

CLO3: Examine and analyze cytogenetic studies to explore the structure of chromosomes, identify chromosomal anomalies, and evaluate the implications of chromosomal mutations for inheritance.

CLO4: Describe prenatal and postnatal genetic techniques, including genetic counseling and recent diagnostic methods, while evaluating ethical challenges and recent advancements 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), 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. Liehr, T. (2023). Cytogenetics and molecular cytogenetics (1st ed.). Boca Raton, FL: Taylor & Francis.
2. McGowan-Jordan, J., Hastings, R. J., & Moore, S. (2020). ISCN 2020: An international system for human cytogenomic nomenclature 2020. Basel, Switzerland: S. Karger AG.
3. Snustad, D. P., & Simmons, M. J. (2012). Principles of genetics (6th ed.). Hoboken, NJ: John Wiley & Sons.
4. Griffiths, A. J. F., Doebley, J., Peichel, C., & Wassarman, D. A. (2020). An introduction to genetic analysis (12th ed.). New York, NY: W. H. Freeman.
5. Gelehrter, T. D., Collins, F. S., & Ginsburg, D. (1998). Principles of medical genetics. Philadelphia, PA: Lippincott Williams & Wilkins.
6. Rimoin, D. L., Connor, J. M., & Pyeritz, R. E. (2002). Principles and practice of medical genetics (3rd ed.). New York, NY: Churchill Livingstone.

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

Course Code: MZOL.523
Course Title: Vascular biology
Course type: Discipline Elective
Total Hours: 45

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

CLO1: Understand and analyze the composition of blood in both healthy and disease conditions, exploring the functions and components of blood in maintaining health.
CLO2: Describe the structure and function of the vascular system, and analyze an electrocardiogram to understand heart rhythms and cardiovascular health.
CLO3: Illustrate platelet physiology and the signaling mechanisms involved in platelet activation and aggregation, and apply this knowledge to understand hemostasis.
CLO4: Distinguish between various vascular disorders, evaluate their pathophysiology, and identify therapeutics used for the management and treatment of these disorders.

Units/ Hours	Contents	Mapping with course Learning Outcome
I/ 12 Hours	**Blood components**: Blood cells, Blood grouping, Hematopoiesis, composition of blood, plasma and serum proteins, anemia, hemostasis, edema, clotting, anticlotting, blood transfusion.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, group discussion, literature discussion, video demonstration.	
II/ 12 Hours	**Coagulation biology:** Introduction to coagulation pathway. 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.	
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.	
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

The following tools shall be used in teaching:

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

Suggested Readings:

1. Geiger, M. (2019). Fundamentals of vascular biology (1st ed.). Cham, Switzerland: Springer.
2. Joshi, R. (2021). A concise textbook of clinical pathology, hematology & blood banking. New Delhi, India: Jaypee Brothers Medical Publishers.
3. Ramadas, N. (2020). Essentials in hematology and clinical pathology. New Delhi, India: Jaypee Brothers Medical Publishers.
4. Chand, M. R. F. (2015). Basics of hematology. New Delhi, India: CBS Publishers & Distributors.Minar, E., & Schillinger, M. (2013). Peripheral vascular disease: Basic & clinical perspectives. London, UK: Future Medicine Ltd.
5. Rasmussen, T. E., Clouse, W. D., & Tonnessen, B. H. (2008). Handbook of patient care in vascular diseases (5th ed.). Philadelphia, PA: Lippincott Williams & Wilkins.

Web Resources:

1. Grover, S. P., & Mackman, N. (2019). Intrinsic pathway of coagulation and thrombosis. Arteriosclerosis, Thrombosis, and Vascular Biology, 39(3), 331–338. https://doi.org/10.1161/ATVBAHA.118.312130
2. https://pubmed.ncbi.nlm.nih.gov/?term=vascular+biology

L	T	P	Cr
3	0	0	3

Course Code: MZOL.524

Course Name: Reproductive Physiology

Course type: Discipline Elective

Total Hours: 45

***Course Learning Outcomes*:** On completion of this course, students will be able to

CLO1: Understand and analyze the regulation of the HPG (hypothalamic-pituitary-gonadal) axis, anterior and posterior pituitary hormones, neuroendocrine systems, and neurosecretion.

CLO2: Analyze the roles of neurogenesis, pruning, and brain plasticity in homeostasis and sexual behavior, and evaluate their impact on reproductive function and endocrine disorders.

CLO3: Understand spermatogenesis, hormonal regulation, and the roles of Sertoli and Leydig cells. Analyze the structure and function of the epididymis and male accessory sex glands, and evaluate causes of male sterility.

CLO4: Understand oogenesis, ovulation, and hormonal regulation. Analyze the menstrual cycle, reproductive cycles, and female accessory sex glands, and evaluate ART principles, protocols, and gamete cryopreservation.

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 11 Hours	**Introduction**: HPG axis, regulation of anterior and posterior pituitary hormones, 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. puberty and cellular and molecular mechanism of puberty.	**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 and POI.	**CLO2**
	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; sertoli 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.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion.	
IV / 11 Hours	**Female reproductive system**: Oogenesis and hormonal regulation; mechanism of ovulation and hypothalamic control; 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.	**CLO4**
	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, 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. Norris, D. O., & Carr, J. A. (2020). Vertebrate endocrinology (6th ed.). San Diego, CA: Academic Press.
2. Holt, R. I. G., & Hanley, N. A. (2021). Essential endocrinology and diabetes (7th ed.). Chichester, UK: Wiley-Blackwell.
3. Melmed, S., Auchus, R. J., Goldfine, A. B., Rosen, C. J., & Kopp, P. A. (Eds.). (2024). Williams textbook of endocrinology (15th ed.). Philadelphia, PA: Elsevier.
4. Skinner, M. K. (Ed.). (2018). Encyclopedia of reproduction (2nd ed., Vols. 1–6). San Diego, CA: Academic Press.
5. Strauss, J. F., Barbieri, R. L., Dokras, A., Williams, C. J., & Williams, S. Z. (Eds.). (2023). Yen & Jaffe's reproductive endocrinology (9th ed.). Philadelphia, PA: Elsevier.

Web Recourses:

1. https://www.khanacademy.org/science/biology/human-biology/endocrine-system/a/overview-of-the-endocrine-system
2. https://www.coursera.org/courses?query=endocrinology
3. https://medlineplus.gov/hormones.html
4. https://www.journals.elsevier.com/endocrinology-and-metabolism-clinics-of-north-america

L	T	P	Cr
3	0	0	3

Course Code: MZOL.525
Course Title: Animal Cell Culture & Applications
Course type: Discipline Elective
Total hours: 45

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

CLO1: Recall the principles of Good Laboratory Practices (GLP) and sterilization techniques, and describe the biology of animal cells and their culture requirements.

CLO2: Analyze different cell culture types (primary, tissue, organ culture) and evaluate the process of cell line immortalization and characterization.

CLO3: Apply cell culture techniques in the context of gene therapy, stem cell therapy, and vaccine production, and assess their role in disease research.

CLO4: Evaluate the translational research applications of animal cells in organoids, 3D-spheroids, and rodent models, emphasizing their impact on cancer and neurodegenerative disease research.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 11 Hours	**Introduction to Animal Cell Culture:** Historical background. Good Laboratory Practices (GLP), ICMR and DBT (GOI) guidelines; sterilization methods and techniques. Biology of animal cell and cell-cell interactions, growth environment and culture requirements. 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.	**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.	**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). Applications of organoid and 3D-spheroid cultures in health care; rodent and murine models in scientific research associated with cancer and neurodegenerative diseases.	**CLO4**

	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, 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, Videos, Blogs, Multimedia packages, TED Talks, e-content

Suggested Readings:

1. Freshney, R. I. (2021). Culture of animal cells: A manual of basic technique and specialized applications (8th ed.). Wiley-Blackwell. Hoboken, NJ.
2. Davis, J. M. (2008). Basic cell culture (2nd ed.). Oxford University Press. New Delhi, India.
3. Davis, J. M. (2011). Animal cell culture. John Wiley & Sons Ltd. Hoboken, NJ.
4. Butler, M. (2004). Animal cell culture and technology. Taylor & Francis. New York, NY.
5. Rastogi, V. B., & Rastogi, N. (2023). Animal cell culture and technology. MedTech Science Press. New Delhi, India.

Web Resources:

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

Remedial Teaching

L	T	P	Cr
0	2	0	0

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

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

CLO1: Understand the concept of educational measurement approaches, analyze the challenges in the learning process, and evaluate their impact on student learning.
CLO2: Describe various assessment techniques and resources, apply recent technologies in educational evaluation, and analyze their effectiveness in improving learning outcomes.

Units/ Hours	Contents	Mapping with course Learning Outcome
Unit I/ 30 Hours	Concept and preparation of diverse needs, educational approaches 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

Code: MZOL.526

Course Name: Animal Physiology

Course type: Core Course

Total Hours: 45

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

CLO1: Understand the mechanisms of digestion, absorption, and hormonal control in nutrient metabolism, and analyze their role in maintaining homeostasis.

CLO2: Explain urine formation, nephron function, and osmoregulatory adaptations across environments, and discuss the neural regulation of gas exchange and respiratory function.

CLO3: Describe different muscle types and the molecular mechanisms of contraction and energy utilization, and apply this knowledge to physiological contexts.

CLO4**:** Analyze temperature regulation strategies in homeotherms and poikilotherms, and explain physiological stress responses, including the role of adrenal hormones and heat shock proteins in stress adaptation.

Units/Hours	Contents	Mapping with Course Learning Outcome
I / 10 Hours	**Digestive Physiology:** Physiology of digestion and absorption of macronutrients; hormonal regulation of digestion; liver and pancreas functions; hunger mechanism, metabolic energy balance and BMR.	**CLO1**
	Learning Activities: Brainstorming, presentation, quizzes, group discussion, latest research paper discussions	
II / 12 Hours	**Excretory physiology:** Excretory products and their evolution; Structure and function of nephron; mechanism of urine formation and osmoregulation (marine, freshwater, terrestrial adaptations) and neural regulation. **Respiratory physiology:** Exchange of gases, oxygen and carbon dioxide transport, neural and chemical regulation of respiration.	**CLO2**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, latest research paper discussions	

III / 11 Hours	**Musculoskeletal System:** Bones of the skeleton; Muscle types: skeletal, smooth, cardiac; Molecular mechanism of muscle contraction: actin-myosin interaction; Muscle fatigue and rigor mortis; Energy sources for muscle contraction.	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, latest research paper discussions	
IV / 12 Hours	**Thermoregulation and Stress Physiology:** Temperature regulation in homeotherms and poikilotherms: Thermogenic mechanisms (shivering, non-shivering): Acclimatization and adaptation to temperature extremes: Stress response: role of adrenal cortex and medulla: Heat shock proteins and oxidative stress.	**CLO4**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, latest research paper discussions	

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, 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 practicals:

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

Suggested Readings:

1. Guyton, A. C. (2021). Textbook of medical physiology (14th ed.). Elsevier India Pvt. Ltd. New Delhi, India.
2. Hill, R. W., Wyse, G. A., & Anderson, M. (2016). Animal physiology (4th ed.). Sinauer Associates Inc. Sunderland, MA, USA.
3. Murray, R. K. (2009). Harper's illustrated biochemistry. Jaypee Publishers. New Delhi, India.
4. Tyagi, P. (2016). A textbook of animal physiology. Dominant Publishers and Distributors. New Delhi, India.
5. Vaz, M. (2020). Guyton & Hall textbook of medical physiology: Third South Asia Edition. Elsevier Health Science. New Delhi, India.
6. Tortora, G. J., & Derrickson, B. H. (2017). Tortora's principles of anatomy and physiology (15th ed.). Wiley Publisher. Hoboken, NJ, USA.
7. Netter, H. F. (2022). Netter atlas of human anatomy: Classic regional approach (8th ed.). Elsevier Health Sciences Division. Philadelphia, PA, USA.

Web resources:

1. Relevant research articles and digital resources
2. https://epgp.inflibnet.ac.in
3. https://www.vlab.co.in/
4. https://lms.cup.edu.in/course/index

L	T	P	Cr
3	0	0	3

Course Code: MZOL.527

Course Title: Immunology

Course type: Core

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

CLO1: Define the basics of the immune system, examine its components and their roles in defense mechanisms.

CLO2: Illustrate the components and molecules of immunity, and analyze their interactions within the immune response.

CLO3: Explain various immune responses at the cellular level, and evaluate how these responses work together to protect the host.

CLO4: Develop a thorough knowledge of immune-based diagnosis and therapy, and apply this understanding to 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, 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. **Immunooncology**- Tumor immunology, and immunotherapy, Immune evasion mechanisms in cancer, various cell-based therapies like CAR-T, NK, and macrophages. checkpoint inhibitors in cancer.	**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, **Immunological Techniques** ELISA, Flow cytometry, immunoprecipitation, antigen and antibody reactions, agglutination-precipitation, immunoflourescence and western blot, 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, Brainstorming, 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, Videos, Blogs, Multimedia packages, TED Talks, e-content

Suggested Readings:

1. Kindt, T. J., Osborne, B. A., & Goldsby, R. A. (2007). Kuby immunology (7th ed.). W.H. Freeman. New York, USA.
2. Abbas, A. K. (2008). Cellular and molecular immunology. CBS Publishers & Distributors. New Delhi, India.
3. Murphy, K., & Weaver, C. (2016). Janeway's immunobiology (9th ed.). Garland Science. New York, USA.
4. Delves, P. J., Roitt, I. M., & Seamus, J. M. (2006). Roitt's essential immunology (Essentials series). Blackwell Publishers. Oxford, UK.
5. Elgert, K. D. (2009). Immunology: Understanding the immune system. Wiley-Blackwell. Hoboken, NJ, USA.
6. Paul, W. E. (2012). Fundamental immunology. Raven Press. Sioux Falls, SD, USA.
7. Punt, J., Stranford, S., & Jones, P. (2018). Kuby immunology (8th ed.). W.H. Freeman & Co. New York, USA.
8. Abbas, A. K. (2021). Cellular and molecular immunology (10th ed., South Asia Edition). Elsevier. New Delhi, India.

Web Resources:

1. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-542j-immunology-fall-2009/
2. https://openstax.org/books/anatomy-and-physiology/pages/20-1-the-immune-system
3. https://biomanbio.com/HTML5GamesandLabs/Immune_System.html
4. https://www.nap.edu/catalog/2150/immunology

L	T	P	Cr
3	0	0	3

Course Code: MZOL.528
Course Name: Endocrinology
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, explain different feedback mechanisms, and analyze their impact on physiological balance.
CLO2: Describe various reproductive hormones, explain their functions, and evaluate disorders associated with these hormones in different physiological conditions.
CLO3: Explain major endocrine disorders, analyze their underlying mechanisms, and assess future challenges in diagnosing and treating these disorders.
CLO4: Develop advanced knowledge of clinical problems related to the endocrine system and propose strategies to address emerging challenges in endocrine health.

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 12 Hours	**General Introduction to Hormone:** History of endocrinology, endocrine & exocrine glands, hormones and pheromones as chemical messengers, olfactory system and chemosensory network, various stimulus for hormone release: difference between, neurotransmitters neurosecretion and neurohormone and their mechanism of action **Hormones:** Structure, function, regulation of biosynthesis degradation and release, juxtracrine and paracrine action, hormones receptors, analogues and antagonists	**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/conditional knockout/wild type animals	**CLO2**

	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
III / 11 Hours	**HPG Axis and Hormone Feedback System:** The hypothalamo-hypophyseal gonadal axis, hypothalamo-vascular system, hormone transport across BBB, change in homeostasis, feedback system (including short, long and ultra-feedback system), mechanism of hormone action in different cell populations, neurohypophysis: synthesis and storage of oxytocin and vasopressin	**CLO3**
	Learning Activities: Brainstorming, Presentation, Quizzes, group discussion, Field visit	
IV / 12 Hours	**Reproductive disorders and other endocrine organs:** Delayed or early puberty, chronic anovulatory disorders including polycystic ovary disease (PCOD), primary ovarian insufficiency (POI), Kallmann syndrome, premature ovarian failure and menopause, male reproductive disorders and IHH; other organs with endocrine function: heart (ANP), kidney (erythropoietin), liver (angiotensinogen, IGF-1), adipose tissue (leptin, adiponectin), stomach (Ghrelin).	**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. Norris, D. O., & Carr, J. A. (2020). Vertebrate endocrinology (6th ed.). Academic Press. City: San Diego, CA.
2. Nelson, D. L., Cox, M. M., & Hoskins, A. A. (2021). Lehninger principles of biochemistry (8th ed.). Macmillan Learning. City: New York, NY.
3. Widmaier, E. P., Raff, H., & Strang, K. T. (2023). Vander's human physiology: The mechanisms of body function (16th ed.). McGraw-Hill Education. City: New York, NY.
4. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., & Yaffe, M. (2024). Molecular cell biology (9th ed.). W.H. Freeman & Company. City: New York, NY.
5. Goswami, P. (Ed.). (2020). Endocrinology and molecular cell biology (2nd ed.). Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati. City: Guwahati, India.
6. Relevant research articles and digital resources.

Web Resources:

1. https://www.khanacademy.org/science/biology/human-biology/endocrine-system/a/the-endocrine-system
2. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-140-principles-of-human-physiology-spring-2007/
3. https://www.endocrine.org/education-and-training

L	T	P	Cr
0	0	8	4

Course Code: MZOL.529
Course Title: Lab Course - II
Course type: Skill-Based
Total hours: 120

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

CLO1: Understand and apply the techniques used in measuring vital parameters spirometry, and the use of assays to assess physiological functions.

CLO2: Demonstrate proficiency in molecular biology techniques, and analyze experimental results for gene expression studies.

CLO3: Explain the methodologies and synthesize knowledge on advanced techniques such as immunohistochemistry, stem cell maintenance, and the use of animal models in scientific research.

CLO4: Evaluate ecological and biological studies using methods such as the quadrat method for community analysis, identification of life cycles in organisms and application of diagnostic techniques in industrial and agricultural settings.

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. Gene cloning: Primer designing, Restriction digestion, ligation, transformation and screening.
10. DigiFrog: Online animal dissection modules
11. Animal handling: mice/rat/rabbit (tutorials only)
12. Animal Perfusion (tutorials only)
13. Immunohistochemistry
14. Blood Micronucleus test
15. Mitochondrial DNA isolation
16. mtDNA copy number variations
17. cDNA synthesis and RT-PCR analysis
18. Cell cycle monitoring by flow cytometry
19. Life cycle of Caenorhabditis Elegans
20. Caenorhabditis Elegans, culture, maintenance, and locomotion assay
21. Differentiate the N2 (wild) and the Transgenic model of Caenorhabditis Elegans
22. Microscopic examination of human parasite life cycles (amoeba, cestodes, nematodes, and plasmodium)
23. Life cycles of Silkworm
24. 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 the 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, 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 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.
2. Sambrook, J., & Russell, D. W. (2000). Molecular Cloning: A Laboratory Manual (3 Vol-set) (3rd ed.). CSHL Press.
3. Hofmann, A. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8th ed.). Cambridge University Press.

Web Resources:

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
0	0	0	1

Course Code: MZOL.596
Course Title: Field Visit/Industrial visit
Course type: SKEC
Teaching hours: 30

Course learning outcomes (CLO): After the field visit, learners will be able to:

CLO1: Learn the basics of exploration/field-based study and research

CLO2: Utilize taxonomic and molecular techniques to document indigenous fauna and contribute to the biodiversity studies.

CLO3: Enrich the knowledge about various biotechnology-based studies / human diseases / molecular diagnostics and applied Zoology-based research outcomes.

CLO4: Students will gain practical skills and entrepreneurial insight through experiential learning, bridging theory with industry-aligned applications as envisioned in NEP-2020

A 5-day field trip shall be organized to explore the indigenous fauna of a biodiversity-rich region, with a focus on animal diversity, taxonomy and the application of modern Zoological and molecular-level techniques. Students will conduct field surveys in groups, employing both classical taxonomic methods and molecular approaches to study and document local fauna. The trip shall include visits to the relevant academic and research institutes working on human diseases, biotech companies and Zoology-based industries to provide students with an exposure to the industry practices in molecular diagnostics and applications in entrepreneurship. Students have to submit a comprehensive field visit report detailing their field or industrial visit, along with the geotagged photographs. The report shall be evaluated by the departmental committee and graded based on the performance, participation, and report quality.

Ability Enhancement Course

L	T	P	Cr
2	0	0	2

Course Code: MZOL.530
Course Name: Research Methodology & Basic Statistics for Science
Course type: Foundation
Total Hours: 30

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

CLO1: Demonstrate the ability to identify, analyze, and formulate research problems through a comprehensive literature review (Application, Analysis, and Synthesis).

CLO2: Apply good laboratory practices and biosafety guidelines, evaluate ethical considerations in research involving animals and GMOs, and demonstrate understanding of ethical research protocols (Application, Evaluation, Knowledge).

CLO3: Apply statistical parameters to available data, interpret statistical results, and make evidence-based decisions based on data analysis (Application, Analysis, Evaluation).

CLO4: Distinguish between parametric and non-parametric statistics, evaluate when to apply each based on the data type and research question, and justify the choice of statistical methods

Units/ Hours	Contents	Mapping with Course Learning Outcome
I / 10 Hours	Literature survey and review, sources of literature, understanding a research problem, steps in formulation of a research problem, formulation of research objectives, conducting case studies, basic principles of experimental designs and construction of a hypothesis. Basics of citation and bibliography/reference preparation styles, report presentation.	**CLO1**
	Learning Activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion and Self-learning, and Case studies	
II / 11 Hours	Good laboratory practices (GLP), what is BSL and biosafety issues for using cloned genes, genetically modified organisms, ethical considerations during research, various types of ethical issues related to animal testing and human related projects. Intellectual property rights (IPRs), plagiarism and Publishing concepts.	**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:** Measures of central tendency, Linear regression and correlation (Karl Pearson's and Spearman's), Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and normal 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	**Parametric tests**: z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA). **Non-Parametric tests:** 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, 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. Pagano, M., & Gauvreau, K. (2018). Principles of biostatistics (2nd ed.). Chapman and Hall/CRC, Boca Raton, FL.
2. Rosner, B. (2015). Fundamentals of biostatistics (8th ed.). Brooks Cole, Belmont, CA.
3. Das, D., & Das, A. (2003). Statistics in biology and psychology (3rd ed.). Academic Press, San Diego, CA.
4. Hoel, P. G. (1997). Introduction to mathematical statistics. Wiley, New York, NY.
5. Relevant research articles and digital resources

Web Resources:

1. https://guides.lib.utexas.edu/c.php?g=1060589&p=7710319
2. https://cleverx.com/blog/how-to-formulate-research-problems
3. https://pmc.ncbi.nlm.nih.gov/articles/PMC7173453/
4. https://www.cdc.gov/labs/pdf/SF__19_308133-A_BMBL6_00-BOOK-WEB-final-3.pdf
5. https://www.analyticsvidhya.com/blog/2021/06/hypothesis-testing-parametric-and-non-parametric-tests-in-statistics/
6. https://datatab.net/tutorial/parametric-and-non-parametric-tests

Inter-Disciplinary Course

L	T	P	Cr
2	0	0	2

Course Code: MZOL.506
Course Title: Fundamentals of Cell Biology
Course type: Interdisciplinary
Total hours: 30

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

CLO1: Understand and explain the origin of life, emphasizing the cellular and molecular processes that contributed to the emergence of life forms. (Bloom's Level: Understand, Explain)

CLO2: Define and describe the basic structure and function of cells, focusing on the origin and evolution of prokaryotes and eukaryotes. (Bloom's Level: Remember, Understand)

CLO3: Analyze and explain the membrane models and the mechanisms of transport for micro-molecules and macro-molecules across the cell membrane. (Bloom's Level: Analyze, Explain)

CLO4: Examine the function and roles of cell organelles in various physiological processes, highlighting their contributions to cellular homeostasis and overall organismal function.

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 includes 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, Videos, Blogs, Multimedia packages, TED Talks, e-content.

Suggested Readings:

1. Alberts, B., Bray, D., Lews, J., Raff, M., Roberts, K., & Watson, J. D. (2022). Molecular biology of the cell (7th ed.). Garland Publishers, Oxford.
2. Celis, J. E. (2006). Cell biology: A laboratory handbook (Vols. 1–3). Academic Press, UK.
3. Gupta, P. K. (2018). Cytology, genetics and evolution (BC-7). Rastogi Publications, Meerut, India.
4. Karp, G. (2020). Cell & molecular biology: Concepts and experiments (9th ed.). John Wiley & Sons, Inc., New Delhi, India.
5. Gupta, P. K. (2017). Cell & molecular biology (5th ed.). 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., & Krieger, M. (2016). Molecular cell biology (8th ed.). W.H. Freeman, USA.
9. Alberts, B., Heald, R., & Johnson, A. (2022). Molecular biology of the cell (7th ed.). W.W. Norton & Co.

Web Resources

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
2	0	0	2

Course Code: MZOL.507
Course Title: Basics in Neurobiology
Course type: Inter-Disciplinary
Total hours: 30

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

CLO1: Understand the anatomy of the nervous system, including the structure and function of the Central Nervous System (CNS) and Peripheral Nervous System (PNS), as well as the major brain regions.

CLO2: Classify neurons based on their structure and function, and explain the roles of glial cells and astrocytes in neural function.

CLO3: Analyze the processes of action potential generation and the role of neurotransmitters, both excitatory and inhibitory, in signal transmission across neurons. Evaluate the impact of neurohormones and the blood-brain barrier on drug delivery to the brain.

CLO4: Investigate various neurological diseases and assess their pathophysiology and potential treatments.

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 7 Hours	**Introduction to Nervous System:** Central Nervous System (CNS) and Peripheral Nervous System (PNS); anatomy of brain (occipital lobe, temporal lobe, parietal lobe, frontal lobe, cerebral cortex, cerebellum, hypothalamus, thalamus, hippocampas and mid- brain), basic patterns of brain and spinal cord connections	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes	
II / 8 Hours	**Introduction to Neurons:** components of neurons (soma, dendrites and axon), classification of neurons (structural based: multipolar, bipolar, and unipolar neurons; functional based: sensory neurons, motor neurons and interneurons) and types of nerve cells (glial and astrocytes).	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Asking Questions, Paper discussions	
III / 8 Hours	**Action Potential & Neurotransmitters:** Action potential, neurotransmitters: excitatory neurotransmitters & inhibitory neurotransmitters, their mode of actions, neurohormones, Blood Brain Barrier and transport of drugs/molecules across BBB	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Discussions and Group Learning	

IV / 7 Hours	**Neurological Disease's:** Neurodevelopmental disease's (attention-deficit/hyperactivity disorder (ADHD), autism, ASD), neurodegenerative disease's (Alzheimer's, Parkinson's, Amyotrophic Lateral Sclerosis (ALS) and Huntington's disease), Epilepsy, mitochondrial disorders (MELAS, Leber hereditary optic neuropathy (LHON))	**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. Mittal, P., & Agrawal, N. (2024). Altered Metabolism: A Major Contributor of Comorbidities in Neurodegenerative Diseases (1st ed.). Springer Nature.
2. Peplow, P., Martinez, B., & Gennarell, T. A. (2022). Neurodegenerative Diseases Biomarkers: Towards Translating Research to Clinical Practice (Vol. 173, Neuromethods). Springer-Verlag. New York, USA.
3. Jankovic, J., Hallett, M., & Okun, M. S. (2022). Principles and Practice of Movement Disorders (3rd ed.). Elsevier Health Sciences Division.
4. Guyton, A. C. (2007). Textbook of Medical Physiology (11th ed.). Elsevier India Pvt. Ltd. New Delhi, India.
5. Hill, R. W., Wyse, G. A., & Anderson, M. (2008). Animal Physiology (Sinauer Associates Inc.). Sunderland, USA.
6. Tyagi, P. (2009). A Text Book of Animal Physiology. Dominant Publishers and Distributors. New Delhi, India.
7. Levitan, I. B., & Kaczmarek, L. K. (2015). The Neuron: Cell & Molecular Biology (4th ed.). Oxford University Press. New York, USA.
8. Purves, D., Augustine, G., & Fitzpatrick, D. (2018). Neuroscience (6th ed.). Oxford University Press. New York, USA.
9. Kandel, E. R. (2021). Principles of Neural Science (6th ed.). McGraw-Hill Medical. New York, USA.

Web Resources:

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

Value Based Course

L	T	P	Cr
2	0	0	2

Course Code: MZOL.511
Course Title: Techniques in Life Sciences
Course type: Value Based course
Total hours: 32

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

Unit/ Hours	Contents	Mapping with course Learning Outcome
I / 8 hours	**Analytical tools:** Perfusion, fixation, different cryopreservation methods, different techniques of section cutting, microscopy: history, light microscopy, phase contrast microscopy, fluorescent microscopy, confocal microscopy, SEM and TEM and live cell imaging.	**CLO1**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
II / 7 Hours	**Basic Molecular Biology Techniques:** isolation, purification and analysis of protein and nucleic acids, electrophoresis: sample preparation for membrane extraction, electrophoresis: principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), types and applications, western blotting techniques: Radioimmunoassay (RIA), Different enzyme-linked immunosorbent Assay (ELISA) and immunoprecipitation	**CLO2**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
III / 8 Hours	**Polymerase chain reaction (PCR):** Principle, electrophysiological techniques like Patch clamp immunochemical techniques, Southern, Northern, *In-situ* hybridization, COMET assay, FISH, probe-based FISH technique, spectral karyotype, Comparative Genomic Hybridization (CGH & aCGH)	**CLO3**
	Learning activities: Brainstorming, Presentation, Quizzes, Group discussion, Latest research paper discussion	
IV /7 Hours	**Immunological and Cell Culture Techniques:** Cell and tissue culture techniques: primary and secondary cultures. MTT assay, calculation of IC_{50} value, flow cytometry, wound scratch assay, transfection for RNA silencing/overexpression	**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, Videos, Blogs, Multimedia packages, TED Talks, e-content

Suggested Readings:

1. Owen, J., Punt, J., & Stranford, S. (2023). Kuby immunology (8th ed.). W.H. Freeman and Company.
2. Gupta, P. K. (2020). Elements of biotechnology (4th ed.). Rastogi Publications, Meerut, India.
3. Kothari, C. R. (2019). Research methodology: Methods and techniques (2nd revised ed.). New Age International (P) Ltd., New Delhi, India.
4. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. (Eds.). (2024). Lewin's GENES X (11th ed.). Jones & Bartlett Learning, Burlington, MA, USA.
5. Nelson, D. L., Cox, M. M., & Hoskins, A. A. (2021). Lehninger principles of biochemistry (8th ed.). Macmillan Learning, New York, NY, USA.
6. Primrose, S. B., & Twyman, R. (2025). Principles of gene manipulation and genomics (8th ed.). Wiley-Blackwell, Chichester, UK.
7. Sawhney, S. K., & Singh, R. (2014). Introductory practical biochemistry (1st ed.). Narosa Publishing House, New Delhi, India.
8. Wilson, K., & Walker, J. (2018). Principles and techniques of biochemistry and molecular biology (8th ed.). Cambridge University Press, Cambridge, UK.

Web Resources:

1. https://pmc.ncbi.nlm.nih.gov/articles/PMC5988420/
2. https://www.researchgate.net/publication/328266869_Cryo-laser_scanning_confocal_microscopy_of_diffusible_plant_compounds
3. https://www.zeiss.com/content/dam/rms/countries/united-states/downloads/life-science/sem-and-xray/en_wp_shuttle-and-find_corrmic-protocols.pdf
4. https://pmc.ncbi.nlm.nih.gov/articles/PMC5997132/
5. https://pnas.org/doi/10.1073/pnas.0807883106
6. https://www.researchgate.net/figure/MTT-assay-following-PD-L1-siRNA-transfection-in-MDA-MB-231-cells-A-PD-L1-siRNA_fig4_349749833
7. https://pmc.ncbi.nlm.nih.gov/articles/PMC9165548/

Remedial Teaching

L	T	P	Cr
0	2	0	0

Course Code: MZOL.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/ 30 Hours	Concept and preparation of diverse needs, educational approaches 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
0	0	40	20

Course Code: ZOL.599-1

Course Title: Dissertation-Part I
Total hours: XXX
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. As part of their learning, students will present a synopsis of a topic they have researched. This will involve summarizing recent advancements in the field, discussing theoretical underpinnings, and presenting real-world applications. The synopsis presentation will include literature review, hypothesis, objectives, methodology and bibliography.

SEMESTER –IV

L	T	P	Cr
0	0	40	20

Course Code: ZOL.599-2

Course Title: Dissertation-Part II

Total hours: XXX

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.