



SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCZOO01	Functional Anatomy and Physiology	4-0-1	120	04

Course Learning Outcomes:

On completing the course, the students will be able to:

- CLO1** Demonstrate understanding of cellular organization and biochemical basis of physiological processes
- CLO2** Analyse mechanisms of homeostasis and metabolic regulation in humans
- CLO3** Interpret structure-function relationships in blood physiology and associated clinical conditions
- CLO4** Evaluate physiological processes of major organ systems and their biochemical and homeostatic integration.
- CLO5** Analyse clinical diagnostic parameters and correlate them with physiological functions and disorders.
- CLO6** Apply principles of neurophysiology and autonomic regulation to explain systemic coordination and homeostasis imbalance in disease pathology

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Cellular and biochemical basis of clinical physiology: Concept of homeostasis and internal environment, feedback mechanisms and physiological regulation, Panchamahabhoota and cellular biophysics, Samatva, Agni, Tridosha as regulatory networks, Structure and function of cells related to physiological processes, Biochemical basis of cellular metabolism (carbohydrates, proteins, lipids), Role of enzymes in physiological reactions, Energy metabolism and ATP production; Oxidative stress and antioxidant defence mechanisms related to human health; Introduction to clinical biochemical markers (glucose, urea, creatinine, lipid profile)	Classroom Lecture (CL) Case-Based Learning (CBL) Seminars Collaborative Learning ICT-Enabled Learning	1,2
II	Blood physiology and clinical correlation: Composition and functions of blood; Hemopoiesis and regulation of blood cell formation, Ayurvedic concept of Rakta Dhatu, Hemoglobin structure and oxygen transport, Blood coagulation mechanisms	Classroom Lecture (CL) Case-Based Learning (CBL) Seminars ICT-Enabled Learning	2, 3
	and clotting factors, Biochemical basis of common blood disorders, Clinical aspects of anaemia and hemoglobinopathies, Blood biochemical parameters and diagnostic significance	Seminars ICT-Enabled Learning	



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III	<p>Systemic Physiology: Cardiovascular system: electrophysiology, hemodynamics, biochemical markers of myocardial injury (e.g., Troponins, BNP) and biochemical indicators of heart function; respiratory system: Mechanics of ventilation, alveolar gas exchange, and the biochemistry of hemoglobin-oxygen transport; Pranayama and controlled breathing, Renal physiology: Glomerular filtration, tubular processing, and the hormonal regulation (RAAS/ADH) of fluid and acid-base balance and biochemical regulation of fluid and electrolyte balance; Hepatobiliary Function: Metabolic pathways, Phase I/II detoxification, and biochemical indicators of hepatic clearance (ALT/AST, Bilirubin); Panchakarma-ancient detoxification</p>	<p>Classroom Lecture (CL) Case-Based Learning (CBL) Micro Project Problem based learning Seminars ICT-Enabled Learning</p>	3,4
IV	<p>Clinical diagnostics and neurophysiology integration: Nerve impulse, synapses, threshold value, action potential, Neurotransmitters; Ayurvedic concept of manas and mind-body connection, Vagus nerve and its relation to different organs (gut, heart, lung); Ojas and immunity, Clinical diagnostic tests related to organ function (LFT, KFT, lipid profile); Physiological basis of lifestyle disorders: role of oxidative stress, adrenaline secretions (cortisol), lymphatic system, inflammation, detoxification (liver and kidney); role of dinacharya and yoga in stress regulation</p>	<p>Seminars Case based learning (CBL) Institutional visit Seminars Collaborative Experiential Simulation Reflective Practices</p>	4,5,6

- **Assessment Methodologies**

(A) **Internal Assessment**

a. **Internal Formative assessment (30 marks)**

- (a) **Quiz (2 quizzes): 10 marks**
- (b) **Seminar: 05 marks**
- (c) **Assignment: 05 marks**
- (d) **Regularity: 05 marks**
- (e) **Group Learning: 05 marks**

b. **Internal Summative Assessment: Mid-term tests (20 marks)**

(B) **External Assessment: End of Term Examination (50 marks)**

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2	28	1	1	10	12
II	2,3	28	1	1	10	12
III	3,4	32	1	1	10	12
IV	4,5,6	32	1	1	12	14
		120	04	04	42	50



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CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	2	1	1	1	1	-	-	-	-	-	-
CLO 2:	3	3	2	1	1	2	-	-	-	-	-	-
CLO 3:	3	2	3	2	1	2	-	2	-	-	-	-
CLO 4:	3	3	3	2	2	3	-	2	-	1	1	1
CLO 5:	3	3	3	3	2	3	2	3	2	1	1	1
CLO 6:	3	2	3	1	1	3	2	2	2	1	1	1

Values to CLO-PLO matrix are assigned by **judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50%
2	End-Semester Examination	Written Exam	50%

• **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Guyton and Hall Textbook of Medical Physiology	John E. Hall & Michael E. Hall	5 th Edition (2025/26)	Elsevier
2	Lehninger Principles of Biochemistry	David L. Nelson & Michael M. Cox	8 th Edition (2021/22)	W. H. Freeman
3	Ganong's Review of Medical Physiology	Kim E. Barrett et al.	6 th Edition (2019/21)	McGraw Hill
4	Rodak's Hematology: Clinical Principles and Applications	Elaine Keohane et al.	7 th Edition (2025)	Elsevier
5	Clinical Biochemistry: A Laboratory Guide	a Devi & Aman Chauhan	1 st Edition (2023)	CRC Press
6	Ayurvedic Physiology (Kriya Sharira)	Shiv Kumar Gaur	Revised Edition 2023	haukhambha Orientalia

• **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	Human Physiology NPTEL	https://nptel.ac.in/courses/102106340
2	Anatomy and Physiology: Lab simulations	https://www.humanbiomedia.org/lab-simulations/
3	Virtual Physiology	https://www.virtual-physiology.com/



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Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCZOO02	Principles of Immunology	4-0-1	120	04

Course Learning Outcomes:

On completing the course, the students will be able to:

- CLO1** Interpret the concepts of immunogenicity and antigenicity, and relate fundamental principles of immunology to biological systems.
- CLO2** Differentiate innate and acquired immunity, and explain their roles in host defence mechanisms.
- CLO3** Analyze the structural organization and functional roles of humoral and cellular components in immune responses.
- CLO4** Evaluate the contribution of the immune system in maintaining health and its involvement in disease conditions.
- CLO5** Examine immunological disorders such as autoimmunity, immunodeficiency, and hypersensitivity in terms of mechanisms and outcomes.
- CLO6** Design immunological strategies based on vaccine principles for effective disease prevention and control.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Immune System and its components: Innate immunity: components and defensive barriers of innate immunity. Adaptive immune system: Components and attributes of acquired immunity, humoral and cell-mediated immunity, Instructional and clonal selection theory; active and passive immunity, primary and secondary immune response. Cells and Tissues of the Immune System Role of ancient Indian contributors to prophylaxis	Classroom Lecture (CL) Case-Based Learning (CBL) Seminars Collaborative Learning ICT-Enabled Learning Reflective Practices	1,2
II	Antigens, Immunogens and Antibodies: Antigens and immunogens; factors affecting immunogenicity; antigenic determinants (B- and T-cell epitopes); concepts of antigen	Classroom Lecture (CL) Case-Based Learning	2,3



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	recognition by B- and T-cells. Structure and function of different classes of antibodies., Antigen Antibody reactions	(CBL) Seminars	
III	Antigen Processing and Presentation: Structure and functions of MHC (MHC I & MHC II); endogenous and exogenous pathways of antigen processing and presentation; Complement System: Properties and functions of cytokines; Pathways of complement activation and its biological consequences; Cytokines and regulation	Classroom Lecture (CL) Case-Based Learning (CBL) Seminars ICT-Enabled Learning	3,4
IV	Role of the immune system in the prevention of Diseases: Transplantation immunology, Hypersensitivity Types and mechanisms with suitable examples, autoimmunity, immune dysfunctions, and immunodeficiency with suitable examples; Vaccines and their types.	Classroom Lecture (CL) Seminars Case-Based Learning (CBL)	5,6

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30 marks)

- (a) **Quiz (2 quizzes): 10 marks**
- (b) **Seminar: 05 marks**
- (c) **Assignment: 05 marks**
- (d) **Regularity: 05 marks**
- (e) **Group Learning: 05 marks**

b. Internal Summative Assessment: Mid-term tests (20 marks)

(B) External Assessment: End of Term Examination (50 marks)

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2	30	1	1	10	12
II	2,3	30	1	1	12	14
III	3,4	30	1	1	10	12
IV	5,6	30	1	1	10	12
		120	04	04	42	50



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Master of Science in Zoology (Semester-I)

CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	2	-	-	-	-	-	-	-	1	-	-
CLO 2:	3	2	2	-	-	-	-	-	-	1	-	-
CLO 3:	3	2	2	-	2	-	-	-	-	-	-	-
CLO 4:	3	2	3	-	-	2	2	-	2	-	-	-
CLO 5:	3	2	3	-	-	2	2	-	2	-	-	-
CLO 6:	3	2	2	2	-	3	2	-	2	-	2	2

Values to **CLO-PLO** matrix are assigned by **judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50
2	End-Semester Examination	Written Exam	50

• **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Kuby immunology	Owen, J. A., Punt, J., &Stranford, S. A.	8 th Edn 2019	WH Freeman and company
2	Cellular and molecular immunology	Abbas, A. K., Lichtman, A. H., & Pillai, S.	9 th Edn 2018	Elsevier Health Sciences.
3	Immunology (8th Edn)	Male, D., Brostoff, J., Roth, D., & Roitt, I.	8 th Edn 2012	Elsevier Health Sciences.
4	Janeway's Immunobiology	Murphy, K., & Weaver, C.	9 th Edn 2016	Garland Science.
5	Immunology, Infection and Immunity	Gerlad B. Pier, Jeffrey B. Lyczak & Lee M Wetzler	2004	ASM Press
6	Fundamentals of Immunology	William. E. Paul	7 th Edn 2013	Lippincott Williams & Wilkins
7	Ayurveda and Immunology	Chauhan, N. S.	2015	Scientific Publishers



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- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Immunology	https://onlinecourses.nptel.ac.in/noc26_bt42/preview
2	Advanced Immunology	https://www.immunopaedia.org.za/online-courses/
3	Advanced Immunology	https://www.aai.org/Education/Courses



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Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCZOO03	Molecular Cell Biology	4-0-1	120	04

Course Learning Outcomes:

On completing the course, the students will be able to:

- CL01** Select and justify appropriate microscopic or cytometric technique for a given cell biology research problem.
- CL02** Explain the structure-function correlation of major cell organelles and extracellular components.
- CL03** Analyse how cells communicate, adhere, move, and generate energy in response to environmental cues.
- CL04** Evaluate the molecular regulation of cell division, programmed cell death, and neoplastic transformation.
- CL05** Design a small research hypothesis or experiment related to cell biology using standard laboratory techniques.
- CL06** Critically review primary literature and communicate scientific findings in written/oral formats.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Advanced Techniques in Cell Biology Microscopy: Bright field, dark field, phase contrast, DIC, fluorescence (widefield and confocal), super-resolution microscopy (STED, PALM, STORM). Electron Microscopy: SEM, TEM, sample preparation, immunogold labelling. Scanning Probe Microscopy: AFM, STM – principles and biological applications. Flow Cytometry & Cytophotometry: Principles, sorting, FACS, applications in cell cycle, apoptosis, and surface markers. Emerging Tools: Live-cell imaging, single-cell analysis, and AI in image analysis, Virtual lab module on microscope simulation.	Interactive lectures Seminars ICT tools	1,2,5,6



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<p>II</p>	<p>Structural Organization of Cell and Extracellular Matrix Nucleus: Nuclear lamina, pore complex, nucleocytoplasmic transport. Endomembrane System: ER (rough/smooth), Golgi, lysosomes, protein sorting, vesicular transport (COP-coated, clathrin-mediated). Energy Organelles: Mitochondria (dynamics, mtDNA, ROS), chloroplasts (thylakoid, stroma, photosynthesis overview), peroxisomes. Extracellular Matrix and Cell Walls: Composition and organisation of ECM (collagen, elastin, integrins), Components and structure of cell walls- Plants, Fungal and Bacterial. Cell-Cell Interactions: Adhesion proteins (cadherins, selectins), tight junctions, gap junctions, plasmodesmata, desmosomes. Agni as metabolic energy and dhatu stability as tissue integrity</p>	<p>Interactive lectures Seminars</p>	<p>2,3,5,6</p>
<p>III</p>	<p>Cell Membrane, Cytoskeleton and Signalling Plasma Membrane: Fluid mosaic model, lipid rafts, transport mechanisms (passive, active, ABC transporters, ion channels). Endocytosis and Exocytosis: Phagocytosis, pinocytosis, receptor-mediated endocytosis (clathrin and caveolae). Cytoskeleton: Microfilaments: Actin polymerization, treadmilling, myosin motors, cell movement. Microtubules: structure, dynamic instability, kinesin/dynein, cilia/flagella (9+2 arrangement, IFT). Intermediate filaments: types, nuclear lamins. Cell Signalling: Receptors (GPCR, RTK, ion channels), second messengers (cAMP, IP3/DAG, Ca²⁺), MAPK/ERK, PI3K/Akt pathways, signalling in development and differentiation.</p>	<p>Interactive lectures Seminars Flipped Classroom</p>	<p>3,5,6</p>
<p>IV</p>	<p>Cell Division Cycle, Death and Cancer Biology Cell Cycle: Phases (G1, S, G2, M), CDKs/cyclins, checkpoint control (p53, Rb), APC/C, cytokinesis. Programmed Cell Death: Apoptosis (extrinsic/intrinsic pathways), caspases, Bcl-2 family, necroptosis (RIPK1/RIPK3), pyroptosis. Cancer Biology: Types (carcinoma, sarcoma, leukemia/lymphoma). Hallmarks of cancer. Types (carcinoma, sarcoma, leukemia/lymphoma). Hallmarks of cancer</p>	<p>Interactive lectures Seminars Flipped Classroom Group discussion</p>	<p>4,5,6</p>



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	<p>Oncogenes (Ras, Myc) and tumor suppressors (p53, BRCA1/2). Role of telomerase, metastasis, and tumor microenvironment. Oxidative stress, metabolic dysregulation and antioxidant systems in modern biology; and Dosha-Agni-Dhatu-Mala imbalance in Indian Knowledge Systems (IKS)-conceptual comparison and critical perspective</p>		
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- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30 marks)

- (a) **Quiz (2 quizzes): 10 marks**
- (b) **Seminar: 05 marks**
- (c) **Assignment: 05 marks**
- (d) **Regularity: 05 marks**
- (e) **Group Learning: 05 marks**

b. Internal Summative Assessment: Mid-term tests (20 marks)

(B) External Assessment: End of Term Examination (50 marks)

- **Weightage of Learning Efforts for External Assessment**

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1,2,5,6	30	1	2	08	11
II	2,3,5,6	30	1	2	15	15
III	3,5,6	30	-	2	12	14
IV	4,5,6	30	-	2	08	10
		120	02	08	40	50

CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	2	3	2	3	1	2	1	1	1	1	2
CLO 2:	3	2	1	1	2	1	1	1	1	-	-	2
CLO 3:	3	3	2	2	2	2	1	1	2	1	1	2
CLO 4:	3	2	2	2	2	2	2	1	2	1	1	2
CLO 5:	2	3	3	2	3	1	2	2	1	2	2	2
CLO 6:	2	2	1	3	1	1	1	3	2	2	2	3



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Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO in relation to the PLOs.**

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Written Exam, Class Regularity, Group learning	50
2	End-Semester Examination	Written Exam	50

• **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Molecular Biology of the Cell.	Alberts, B. et al.	7th Ed. (Indian reprint) (2022)	W. W. Norton
2	The Cell: A Molecular Approach	Cooper, G.M.	8th Ed (2019)	ASM Press
3	Molecular Cell Biology	Lodish, H. et al.	9th Ed (2021)	W H Freeman
4	Cell Biology, Genetics, Molecular Biology.	Verma, P.S. & Agrawal, V.K.	(2020)	S. Chand
5	Cell Biology	Purohit, S.S.	(2018)	Agrobios
6	Charaka Samhita	Sharma, P. V.	Reprint (2014)	Chaukhambha Orientalia

• **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Microscope simulator	https://myscope.training/TEM_simulator.html
2	Virtual Microscope Laboratory	https://virtuallabs.nmsu.edu/micro.php
3	Laboratory Xchange: Virtual Simulation lab	https://www.labxchange.org/library?t=Tag%3Alife%20science



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Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCZOO04	Bioanalytical Laboratory	0-8-0	120	04

Course Learning Outcomes (CLOs)

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

- CLO1** Demonstrate safe laboratory practices and accurately prepare reagents, buffers, and solutions while performing essential biochemical calculations.
- CLO2** Perform spectrophotometric analyses and interpret absorbance spectra for qualitative and quantitative characterization of biomolecules.
- CLO3** Apply chromatographic techniques (TLC, HPTLC, gel filtration, and affinity chromatography) to separate and analyse biomolecules.
- CLO4** Separate and characterise proteins and other macromolecules using electrophoretic techniques (native PAGE, SDS-PAGE) and density gradient centrifugation.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	<ol style="list-style-type: none">1. Orientation to general laboratory safety and good laboratory practices.2. Micropipette, Balance, pH meter calibration and proficiency testing3. Biochemical calculations and Preparation of reagents4. Determination of λ_{max} and validation of Beer-Lamberts law.5. Titration of amino acid and determination of pKa of Glycine6. Estimation of DNA by DPA method7. Estimation of protein by Folins Lowry Method8. Estimation of proteins by Bradford's Method9. Separation of amino acids by thin layer chromatography and HPTLC.10. Purification of analytes by Flash Chromatography11. UV-Visible spectral analysis of Nucleic acids and aromatic amino acids.12. Separation of proteins by native and SDS PAGE13. Separation of proteins by Gel permeation chromatography14. Separation of glycoproteins by Affinity chromatography15. Analysis of glycine and tyrosine by FTIR spectroscopy.16. Separation of analytes by density gradient centrifugation	<p>Interactive lectures</p> <p>Experiential learning</p> <p>Problem Based Learning</p> <p>Collaborative Learning</p>	1 to 5



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- Assessment Methodologies

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

- i. Regularity :05 marks
- ii. Performance in Laboratory: 05 marks
- iii. Laboratory Record: 05
- iv. Group Learning: 05
- v. Spotting/Quiz: 05
- vi. Viva Voce: 05

b. Internal Summative

Assessment Problem based learning: 20

(B) External Assessment: 50 marks

- Weightage of Learning Efforts for External Assessment

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 5	120	10	10	30	50

- CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	1	3	2	3	1	3	1	1	-	1	2
CLO 2:	2	2	2	3	3	1	1	2	1	-	1	2
CLO 3:	2	2	3	2	3	1	1	1	1	-	1	2
CLO 4:	2	2	3	2	3	1	1	1	1	-	1	2
CLO 5:	2	2	3	3	2	2	1	2	2	-	1	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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Master of Science in Zoology (Semester-I)

● Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50%
2	End-Semester Examination	Practical Exam (Approach, Performance, Interpretation and Spots/Viva)	50%

● Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Standard Methods of Biochemical Analysis.	Thimmaiah S. K.	2012	Kalyani Publishes
2	An introduction to practical Biochemistry	David T. Plummer	3 rd Edn 1987	McGraw Hill book company
3	Biochemical Methods	S. Sadasivam and A. Manickam	2 nd Edn 1996	New Age International Publishers
4	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	8th Edn 2018	Cambridge University Press
5	Biophysical Chemistry (Part II: Techniques for the Study of Biological Structure and Function)	Charles R. Cantor & Paul R. Schimmel	1980 (reprint)	W.H. Freeman
6	Practical Biochemistry: Principles and Techniques	Keith Wilson & John Walker	7 th Edn 2010	Cambridge University Press
7	Protein Purification: Principles and Practice	Robert K. Scopes	3 rd Edn 1994	Springer
8	Gel Electrophoresis of Proteins and Nucleic Acids	R. Westermeier	4 th Edn 2016	Walter de Gruyter



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9	Introduction to Spectroscopy	Donald L. Pavia	5 th Edn 2015	Cengage Learning
10	Laboratory Safety for Chemistry Students	Robert H. Hill & David C. Finster	2nd Edn 2016	Wiley

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	JoVE (Journal of Visualized Experiments)	jove.com
2	LabXchange	labxchange.org
3	Biochemistry Free & Easy	biochem.science.oregonstate.edu
4	NIH Principles of Chromatography	chromatography.nih.gov



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Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCZ005	Cell Biology and Immunology Laboratory Techniques	0-8-0	120	04

Course Learning Outcomes (CLOs)

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

- CLO 1** Apply fundamental laboratory techniques to quantify, separate, and analyse nucleic acids using UV spectrophotometry and agarose gel electrophoresis.
- CLO 2** Demonstrate proficiency in microscopy techniques (bright field, phase contrast, fluorescence) and interpret cellular structures including cytoskeleton, mitotic, and meiotic stages.
- CLO 3** Perform and interpret cell viability assays and cell counting using hemocytometer, along with differential staining and leukocyte analysis.
- CLO 4** Analyse and interpret immunological and serological assays (e.g., ELISA, Widal, RPR, SRID, immunoelectrophoresis, Western blotting) for diagnostic applications.
- CLO 5** Interpret flow cytometry data and correlate findings with cellular characteristics and disease conditions
- CLO 6** Evaluate clinical case studies (hepatic and renal disorders) and develop scientific understanding through a mini-project involving literature review on signalling pathways or organelle dysfunction.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	<ol style="list-style-type: none">1. Quantification of nucleic acids by UV spectrophotometry and its separation by agarose gel electrophoresis2. Study of microscopic techniques: bright field, phase contrast, fluorescence (demonstration).3. Cell viability assay (trypan blue exclusion) and counting using hemocytometer.4. Observation of cytoskeleton in onion epidermal cells / cheek cells using stains.5. Study of mitosis and meiosis.6. Flow cytometry data interpretation (simulated or real dataset).7. Differential staining8. Polytene chromosomes9. Blood Grouping10. Differential Leukocyte Count and Total Leukocyte Count11. Widal Test	<p>Interactive lectures</p> <p>Experiential learning</p>	1 to 5



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	12. Rapid Plasma Reagin (RPR) Test 13. Single Radial Immunodiffusion (SRID) 14. Ouchterlony Double Diffusion 15. Rocket Immuno-Electrophoresis 16. Counter Current Immunoelectrophoresis 17. Enzyme-Linked Immunosorbent Assay (ELISA) – DOT and plate 18. Immunoprecipitation 19. Western Blotting 20. Case-based studies: Hepatic and renal disorders 21. Mini-project: Literature review on a mechanism of any organelle disorder.	Problem Based Learning Collaborative Learning	
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• **Assessment Methodologies**

(A) Internal Assessment (50 marks)

a. Internal Formative assessment (30 marks)

- i. **Regularity :05 marks**
- ii. **Performance in Laboratory: 05 marks**
- iii. **Laboratory Record: 05**
- iv. **Group Learning: 05**
- v. **Spotting/Quiz: 05**
- vi. **Viva Voce: 05**

b. Internal Summative Assessment Problem based learning: 20

(B) External Assessment: 50 marks

• **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
	1 to 5	120	10	10	30	50

• **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	2	3	2	3	-	1	1	-	-	1	1
CLO 2:	3	2	3	1	3	-	1	2	-	-	1	1
CLO 3:	2	2	3	2	3	-	2	2	-	-	1	1
CLO 4:	3	2	3	2	3	1	2	2	1	-	1	1
CLO 5:	2	2	2	3	2	1	1	2	1	-	1	1



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CLO 6	3	3	2	3	2	2	2	3	2	1	3	3
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Values to **CLO-PLO** matrix are assigned by **judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

● **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Laboratory Performance, Laboratory Records, Team work, Viva Voce Regularity, Problem Solving.	50
2	End-Semester Examination	Practical Exam (Approach, Performance, Interpretation and Spots/Viva)	50

● **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Microbiology: A Laboratory Manual	James G. Cappuccino, Natalie Sherman	12 th Edn 2020	Pearson
2	Benson's Microbiological Applications	Alfred E. Brown	14 th Edn 2015	McGraw-Hill
3	Molecular Cloning: A Laboratory Manual	Joseph Sambrook, David W. Russell	4 th Edn 2012	Cold Spring Harbor Laboratory Press
4	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson, John Walker	8 th Edn 2018	Cambridge University Press
5	Molecular Biology of the Cell	Bruce Alberts et al.	6 th Edn 2015	Garland Science
6	Essential Cell Biology	Bruce Alberts et al.	5 th Edn 2019	Garland Science
7	Analytical Biochemistry	David J. Holme, Hazel Peck	3 rd Edn 1998	Pearson



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8	Biophysical Chemistry	A. Upadhyay, K. Upadhyay, N. Nath	Latest Edn	Himalaya Publishing House
9	Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	8 th Edn 2021	W.H. Freeman
10	Fundamental Techniques in Microbiology	Christopher H. Collins et al.	2 nd Edn 2004	Wiley-Blackwell
11	Textbook of Medical Laboratory Technology	Godkar, P., B., Godkar, D., P.	3 rd Edn 2021	Bhalani Publishing House

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	JoVE (Journal of Visualized Experiments)	jove.com
2	LabXchange	labxchange.org
3	Biochemistry Free & Easy	biochem.science.oregonstate.edu
4	NIH Principles of Chromatography	chromatography.nih.gov



Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEZOO01	Biosafety and Bioethics	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

- CLO1** Analyze biosafety levels (BSL 1–4) and containment strategies to determine appropriate protocols for handling novel or high-risk biological agents, including radioisotope use.
- CLO2** Evaluate the adequacy of India's regulatory framework and international agreements in managing risks associated with environmental release or commercial approval of GMOs/LMOs.
- CLO3** Create an ethical decision-making framework that integrates core bioethics principles to resolve a complex dilemma involving human or animal research, referencing ICMR, CPCSEA, and CECHR guidelines.
- CLO4** Critique real-world cases of biopiracy (e.g., neem, turmeric, basmati) and biodiversity loss, proposing alternative ethical and policy-based solutions that balance conservation, indigenous rights, and development.
- CLO5** Synthesize principles of biosafety, GMO regulation, and bioethics to formulate a justified position on an emerging issue.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Biosafety Principles of Biosafety. Biohazard and Biosecurity: Concepts and components. WHO Risk Group Classification of Microorganisms Biocontainment: good laboratory practices and techniques, safety equipment, types of containment (physical and biological). AERB/RSD/RES guidelines and safety measures for using radioisotopes in laboratories. Biosafety levels (BSL 1, 2, 3, 4), barriers (physical and secondary). Management of biohazardous waste. WTO and other international agreements related to biosafety.	Classroom Lecture (CL); Seminars; Collaborative Learning; Group Learning; ICT enabled learning	1



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II	<p>Genetically modified organism: concerns and challenges</p> <p>GMOs/LMOs: GOI definition: Genetically Modified Organisms (GMOs) and Living Modified Organisms (LMOs), GRAS microorganisms.</p> <p>Biosafety guidelines and regulations: Biosafety guidelines of India. Constitution and Role of Institutional Biosafety Committees (IBSC), Review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMO in India Risk Analysis, and Assessment for Environmental release of GMOs, Cartagena Protocol. Biosafety assessment procedures for biotech foods and related products, case studies of relevant Indian GMOs (Bt cotton, Bt Brinjal). Biosafety assessment of pharmaceutical products including drugs/vaccines.</p>	Classroom Lecture (CL); Seminars; Collaborative Learning; ICT - Enabled Learning	2
III	<p>Bioethics: Principles and Practices</p> <p>Role of ethics committees and Institutional Review Boards National Ethical Guidelines (ICMR Guidelines). Committee for Control and Supervision of Experiments on Animals (CCSEA) guidelines for conducting animal experiments in India. Central Ethics Committee on Human Research (CECHR) guidelines. Environmental and Global Bioethics: Biodiversity conservation ethics and Biopiracy issues.</p> <p>Emerging ethical issues: AI and big data ethics in Biology and Health care.</p>	Classroom Lecture (CL); Seminars; Collaborative Learning; Case-based learning (CBL).	3,4,5

- **Assessment Methodologies**

(A) **Internal Assessment**

a. **Internal Formative assessment (15 marks)**

(a) **Quiz: 05 marks**

(b) **Seminar: 05 marks**

(c) **Group Learning/Assignment: 05 marks**

b. **Internal Summative Assessment (10 marks)**

c.

(B) **End of Term Examination: 25 marks**



Master of Science in Zoology (Semester-I)

● **Weightage of Learning Efforts for External Assessment**

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	18	-	01	07	08
II	2,5	20	01	01	07	09
III	3,4,5	22	01	01	06	08
		60	02	03	20	25

● **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	1	2	1	1	1	1	1	2	1	3	3	3
CLO 2:	1	3	2	1	1	2	1	2	2	3	3	2
CLO 3:	1	3	1	2	1	2	1	2	2	3	2	2
CLO 4:	1	2	3	2	2	2	1	2	1	3	3	2
CLO 5:	1	2	2	3	1	2	1	2	2	3	2	2
CLO 6:	1	2	1	2	1	1	1	3	2	3	3	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

● **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage(%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50%
2	End-Semester Examination	Written Exam	50%

● **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	An introduction to ethical, safety & IPR issues in Biotechnology	Nambisan, P	1st, 2017	Academic Press
2	Bioethics and biosafety	Sateesh, K. S.,	1 st , 2014	I.K. International publishing house



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3	Bioethics and Biosafety in Biotechnology	Krishna, V. S.	1 st 2007	New Age International
4	Biosafety in Industrial Biotechnology	Hamebleton P. M.,	1 st 1994	Blackie Academic & Professional, Bishopbrodge

● Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Ethics Review of Human Research	https://onlinecourses.swayam2.ac.in/e-learning/preview/aic20_ge08
2	Committee for control and supervision of experiments on animals	https://ccsea.gov.in/Auth/index.aspx
3	Central Ethics Committee on Human Research	https://ethics.ncdirindia.org/CECHR_Details.aspx
4	Indian Biosafety Knowledge Portal	https://ibkp.dbt.gov.in/



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEZOO02	Entrepreneurship Fundamentals	2-0-0	60	02

This course has been designed in consultation with Wadhvani Foundation and will be offered using LMS in collaboration with Wadhvani Foundation.

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

- CLO1** Develop an entrepreneurial mindset and appreciate the concepts of entrepreneurship, cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership
- CLO2** Comprehend the process of problem-opportunity identification through design thinking, identify market potential and customers while developing a compelling value proposition solution
- CLO3** Analyse and refine business models to ensure sustainability and profitability
- CLO4** Build Prototype for Proof of Concept and validate MVP of their practice venture idea
- CLO5** Create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Entrepreneurship Fundamentals and Context Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skillsets, attributes and networks while on campus.	Classroom Lecture (CL); Seminars; Collaborative Learning; Group Learning; ICT enabled learning	1



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<p>II</p>	<p>Problem and Customer Identification Understanding and analysing the macro-Problem and Industry perspective, technological, socio economic and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problem using Design thinking principles. Analysing problem and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping</p>	<p>Classroom Lecture (CL); Seminars; Collaborative Learning; ICT - Enabled Learning</p>	<p>1, 2</p>
<p>III</p>	<p>Solution design and Prototyping Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition. Developing Problem-solution fit in an iterative manner. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating value, features and benefits. Initial testing for proof-of-concept and iterate on the prototype.</p>	<p>Classroom Lecture (CL); Seminars; Collaborative Learning; Case-based learning (CBL).</p>	<p>1,2,3,4</p>
<p>IV</p>	<p>Opportunity Assessment and Sizing Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity</p>	<p>Interactive Classroom Lecture, Venture Activity</p>	<p>1,3</p>
<p>V</p>	<p>Business and Financial Model, Go-to-Market Plan Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach. Business planning: components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analysing financial performance. Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.</p>	<p>Interactive Classroom Lecture, Group discussion, Collaborative learning</p>	<p>1,5</p>
<p>VI</p>	<p>Scale Outlook and Venture Pitch readiness Understand and identify potential and aspiration for scale vis a vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.</p>	<p>Expert Talks, Group discussion, Collaborative learning</p>	<p>6</p>



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● Assessment Methodologies

(A) Internal Assessment

a. Internal Formative assessment (15 marks)

(a) Quiz: 05 marks

(b) Seminar: 05 marks

(c) Group Learning/Assignment: 05 marks

b. Internal Summative Assessment (10 marks)

(B) End of Term Examination: 25 marks

● Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	09	01	01	03	04
II	1,2	09	-	01	03	04
III	1,2,3,4	10	01	-	03	04
IV	1,3	10	-	-	03	04
V	1,5	11	-	-	04	05
VI	6	11	-	-	05	04
		60	02	02	21	25

● CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	1	2	1	1	1	1	1	2	1	3	3	3
CLO 2:	1	3	2	1	1	2	1	2	2	3	3	2
CLO 3:	1	3	1	2	1	2	1	2	2	3	2	2
CLO 4:	1	2	3	2	2	2	1	2	1	3	3	2
CLO 5:	1	2	2	3	1	2	1	2	2	3	2	2
CLO 6:	1	2	1	2	1	1	1	3	2	3	3	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

● Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50%
2	End-Semester Examination	Written Exam	50%



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• Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/ Year	Publisher
1	Entrepreneurship	Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha	11, 2020	McGrawHill
2	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses.	Ries E.	2011	Crown Business
3	Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers.	Osterwalder, A., & Pigneur, Y.	2010	John Wiley & Sons
4	Start with Why	Simon Sinek	2011	Penguin Books
5	Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation	Brown Tim	2019	Harper Business
6	The Dolphin and the Shark: Stories on Entrepreneurship	Namita Thapar	2022	Penguin Books Limited
7	Effectuation: Elements of Entrepreneurial Expertise,	Saras D. Sarasvathy	2008	Elgar Publishing Ltd

• Online Resources (Open Source)

Sr.No.	Description of Resource(s)	Weblink
1	NPTEL – Entrepreneurship Essentials	https://nptel.ac.in/courses/110105145
2	Startup India Learning Program (Free certification modules)	https://www.startupindia.gov.in/content/sih/en/learning.html
3	NSDC – Entrepreneurship Skill Development Resources	https://nsdcindia.org/foundation-courses
4	Y Combinator – Startup Library (Free videos & guides)	https://www.ycombinator.com/library
5	Business Model Canvas (Strategyzer) – Interactive tool	https://www.strategyzer.com/canvas/business-model-canvas
6	Design Thinking for Social Innovation (IDEO U – Free resources)	https://www.ideou.com/blogs/inspiration/design-thinking-for-social-innovation



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Master of Science in Zoology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEZOO03	Principles of Ecology	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

- CLO1** Analyse population dynamics by applying mathematical models (exponential, logistic, and r/K selection) and constructing life tables to predict population viability and extinction risks in metapopulations.
- CLO2** Evaluate the concepts of habitat and ecological niche to interpret community structure, species diversity patterns, and the mechanisms that maintain ecosystem stability.
- CLO3** Critically analyse the evolutionary and ecological consequences of species interactions-including competition, predation, and various forms of symbiosis-on community organization.
- CLO4** Quantify energy transfer efficiency across trophic levels and model the flux of matter through major biogeochemical cycles (C, N, P) across diverse terrestrial and aquatic ecosystems.
- CLO5** Synthesize the processes of primary and secondary succession to predict how ecosystems recover from natural and anthropogenic disturbances, including the role of keystone species.
- CLO6** Assess the impact of global change drivers (climate change, land-use change, and invasive species) on ecosystem services and formulate evidence-based strategies for sustainable management.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Fundamentals of Ecology and Population Ecology Introduction to Ecology: Levels of organization: individual, population, community, ecosystem, biosphere; Abiotic and biotic factors, Ecological adaptations; Population Ecology: Population attributes: density, natality, mortality, dispersal, Population distribution and age structure, Sex ratio and life history strategies (r and K selection); Population Growth and Regulation: Exponential and logistic growth models, Carrying capacity and biotic potential, Density-dependent and density-independent factors, Population regulation mechanisms; Advanced Population Concepts: Life tables and survivorship curves, Metapopulations: habitat fragmentation, connectivity, extinction risk	Classroom Lecture (CL) Problem-Based Learning (PBL) Seminars (Student-led)	1



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II	<p>Community Ecology and Species Interactions: Community Organization: Concept of habitat and ecological niche, Community structure and organization, Species diversity and ecosystem stability; Species Interactions: Competition (intra- and interspecific), Predation and herbivory, Mutualism, commensalism, parasitism; Community Dynamics: Food chains and food webs, Trophic levels and ecological pyramids, Keystone and dominant species; Ecological Succession: Types: primary and secondary succession, Causes and processes, Community development and stability</p>	<p>Classroom Lecture (CL)</p> <p>Problem-Based Learning (PBL)</p> <p>Seminars (Student-led)</p>	2,3, 5
III	<p>Ecosystem Structure and Function: Energy flow in ecosystems, Primary productivity and trophic efficiency, Ecosystem structure and functioning, Biogeochemical Cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle, Water cycle; Ecosystem Types: Forest, grassland, desert ecosystems, Aquatic ecosystems, Agro-ecosystems and plantations, Structure and functional features; Human Impacts on Ecosystems: Land use and land-cover change, Climate change and global warming, Pollution and invasive species, Ecosystem services and sustainability</p>	<p>Classroom Lecture (CL)</p> <p>Problem-Based Learning (PBL)</p> <p>Seminars (Student-led)</p>	4,6

• **Assessment Methodologies**

(A) **Internal Assessment**

a. **Internal Formative assessment (15 marks)**

(a) **Quiz: 05 marks**

(b) **Seminar: 05 marks**

(c) **Group Learning/Assignment: 05 marks**

b. **Internal Summative Assessment (10 marks)**

(B) **End of Term Examination: 25 marks**

• **Weightage of Learning Efforts for External Assessment**

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1	18	0	1	7	8
II	2, 3, 5	20	1	1	7	9
III	4, 6	22	1	1	6	8
		60	02	03	20	25



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● **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	3	2	3	1	3	1	2	3	-	1	2
CLO 2:	3	3	2	2	1	3	1	2	3	-	1	2
CLO 3:	3	3	2	2	1	3	1	2	3	-	1	2
CLO 4:	3	3	2	3	1	3	1	2	3	-	1	2
CLO 5:	3	3	2	2	1	3	2	2	3	1	2	2
CLO 6:	3	3	2	2	1	3	2	3	3	2	2	3

Values to **CLO-PLO** matrix are assigned by **judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

● **Assessment and Evaluation**

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50%
2	End-Semester Examination	Written Exam	50%

● **Suggested Learning Materials Books:**

Sr.No	Title	Author(s)	Edition/Year	Publisher
1	Ecology	Begon, M. et al	1996	Blackwell Science, Cambridge, USA
2	Fundamentals of Ecology	Odum, E.P., Barrett, G., W.	2005	Thomson Brooks/Cole, Belmont, CA
3	Textbook of Plant Ecology	Ambasth, R.S., Ambasth, N.K.	2017	Students Friends Publishers, Varanasi
4	Ecology: Global Insights and Investigations	Peter D. Stiling	2 nd Edn 2015	McGraw-Hill
5	A Textbook on Ecology and Environmental Science	Mahendran P., P., Rajan, P., M	2008	tech Publishing Academy
6	Ecology and Environment	Sharma, P.D.,	2001	Rastogi Publications

● **Online Resources (Open Source)**

Sr.No.	Description of Resource(s)	Weblink
1	Fundamentals of Ecology	https://onlinecourses.nptel.ac.in/noc25_ge14/preview?utm
2	Wildlife Ecology	https://onlinecourses.nptel.ac.in/noc22_bt55/preview?utm



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEZOO04	Pharmaceutical Microbiology	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

- CLO1** Explain fundamental concepts of microbiology and classify microorganisms relevant to pharmaceutical sciences.
- CLO2** Describe the mechanisms of action of antimicrobial agents and analyse the development of antibiotic resistance.
- CLO3** Apply sterilization, disinfection, and aseptic techniques in pharmaceutical manufacturing.
- CLO4** Evaluate microbial contamination, spoilage, and preservation strategies in pharmaceutical products.
- CLO5** Interpret microbiological quality control tests and regulatory requirements in pharmaceutical industries.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Fundamentals of Microbiology and Chemotherapeutic Agents: History and significance of microbiology in pharmacy; Classification of microorganisms: bacteria, fungi, viruses; Microbial morphology: bacterial cell structure; Microbial growth: nutritional requirements, physical factors (pH, temperature, osmotic pressure), bacterial growth curve Introduction to chemotherapeutic agents: history and development; Types of antimicrobial agents: antibacterial, antifungal, antiviral, antiprotozoal, anticancer agents; Classification of antibiotics: synthetic, semisynthetic, natural Mechanism of action of antimicrobial agents (cell wall, protein synthesis, nucleic acid inhibition)	Classroom Lecture (CL) Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning	1,2



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II	Control of Microorganisms and Antimicrobial Strategies: Sterilization principles and methods: Physical (Moist heat - autoclaving), dry heat, radiation, filtration. Chemical: (gaseous sterilization -ethylene oxide). Validation of sterilization: biological and chemical indicators. Disinfectants: Disinfectant evaluation (phenol coefficient, Kelsey-Sykes test). Antibiotic resistance: development and mechanisms. New therapeutics: Antimicrobial peptides (history, properties, mode of action, applications), Phage and therapeutic applications, Plant-based antimicrobial agents	Classroom Lecture (CL) Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning	2,3
III	Pharmaceutical Microbiology in Industry and Quality Control: Environmental monitoring and aseptic processing: Cleanroom classification (Grade A–D), HEPA filters; Sources of contamination (air, personnel, water – WFI), Monitoring methods (settle plates, air samplers, surface methods). Microbial contamination and spoilage of pharmaceutical products: Sources, factors affecting growth, impact on formulations. Microbiological quality control tests: Sterility testing (membrane filtration, direct inoculation), Microbial limit tests (MLT), Endotoxin testing (LAL test). Preservatives in pharmaceutical products: Principles, ideal properties, evaluation and stability, Preservative efficacy testing (PET). Regulatory aspects: Pharmacopoeias: IP, BP, USP, Good Laboratory Practices (GLP), Good Manufacturing Practices (GMP, c GMP)	Classroom Lecture (CL) Seminars Case-Based Learning (CBL), ICT-Enabled Learning, Collaborative Learning, Industrial visit	3,4,5

- **Assessment Methodologies**

(A) **Internal Assessment**

a. **Internal Formative assessment (15 marks)**

(a) **Quiz: 05 marks**

(b) **Seminar: 05 marks**

(c) **Group Learning/Assignment: 05 marks**

b. **Internal Summative Assessment (10 marks)**

(B) **End of Term Examination: 25 marks**



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• Weightage of Learning Efforts for External Assessment

Unit	Aligned Cos	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	1, 2	18	1	1	6	8
II	2, 3	20	1	1	6	8
III	3, 4, 5	22	-	-	9	9
		60	02	02	21	25

• CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	2	2	1	1	1	2	2	1	2	-	1	2
CLO 2:	1	2	2	1	3	2	3	1	1	-	1	2
CLO 3:	1	2	2	1	3	2	3	1	1	-	1	2
CLO 4:	2	3	2	2	1	3	3	2	3	1	2	2
CLO 5:	2	3	1	1	1	3	3	2	3	1	2	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50



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Master of Science in Zoology (Semester-I)

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Hugo and Russell's <i>Pharmaceutical Microbiology</i>	Ed. Brendan F. Gilmore and Stephen P. Denyer	9 th ed. 2023	Wiley Blackwell
2	Pelczar, Chan, and Krieg <i>Microbiology – For fundamental microbial biology.</i>	NOEL R. KRIEG MICHAEL J. PELCZAR JR, E.C.S. CHAN	5 th ed 2023	Affiliated East West Press Pvt Ltd
3	The United States Pharmacopoeia (USP) –			
4	Pharmaceutical Microbiology	Chandrakant <u>Kokate</u>	18 th ed. 2023	Nirali Prakashan
5	Pharmaceutical Microbiology -	Tim Sandle	2015	Woodhead Publishing series
6	A Textbook of Pharmaceutical Microbiology	Prahlad Singh	2011	IK International Publishing House Pvt. Ltd

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Pharmaceutical Microbiology Manual	https://share.google/6ajeZ7OWwyJC2Xp67



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEZOO05	Mathematics for Biologists	2-0-0	60	02

Course Learning Outcomes (CLOs)

On completing the course, the students will be able to:

- CLO1 Demonstrate conceptual understanding of number systems, logarithmic, and exponential functions for application in scientific contexts.
- CLO2 Apply appropriate mathematical functions and graphical techniques to analyse and interpret biological data.
- CLO3 Employ trigonometric and complex number concepts to solve problems in scientific and biological domains.
- CLO4 Analyse rates of change in biological systems using principles of differential calculus.
- CLO5 Apply integral calculus to evaluate total change, area, and volume in relevant scientific applications.
- CLO6 Utilise algebraic methods, including matrices and determinants, to solve systems of equations in biological contexts.

Unit	Course Content	Learning Pedagogies *	CLO(s)
I	Fundamental Mathematical Concepts for Scientific Analysis: Number systems: Rational, Irrational, and Real numbers; Scientific notation and orders of magnitude; Logarithmic functions: Natural vs common logarithm; Exponential functions and their applications in science; Properties of logarithmic and exponential functions; Functions in biology: Types and graphical representation; Dependent and independent variables in biochemical analysis	Classroom Lecture (CL), Problem- Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	1,2
II	Mathematical Tools and Representations in Biology: Trigonometric functions and identities; Complex numbers: Imaginary numbers and Argand plane representation; Algebra of complex numbers and scientific applications; Slope of functions and their interpretation; Introduction to calculus through geometric concepts	Classroom Lecture (CL), Problem- Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	3



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III	<p>Calculus and Algebraic Techniques in Biological Systems: Limits and continuity (from first principles), Differential calculus: First and second derivatives; Applications in biology: Growth rate analysis, Spectroscopy (peak/trough identification), Curvature analysis, Integral calculus: Indefinite and definite integrals, Applications of integration: Area, volume, and total change, Simultaneous equations (two and three variables), Introduction to matrices and determinants</p>	<p>Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning</p>	4,5, 6
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- **Assessment Methodologies**

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		60	02	03	20	25

- **CLOs – PLOs Matrix**

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CLO 2:	1	3	2	3	1	2	-	2	2	-	1	2
CLO 3:	1	2	1	2	-	1	-	1	1	-	-	2
CLO 4:	2	3	2	3	1	2	-	2	2	-	1	2
CLO 5:	2	3	2	3	1	2	-	2	2	-	1	2
CLO 6:	1	3	2	3	1	2	-	2	1	-	1	2



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● Assessment and Evaluation

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1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Group Learning, Written Exam	50
2	End-Semester Examination	Written Exam	50

● Suggested Learning Materials Books:

Sr.No	Title	Author(s)	Edition/Year	Publisher
1	Introduction to Mathematics for Life Scientists	E. Batschelet	2 nd ed. 2008	Springer
2	Textbooks of Mathematics for classes XI and XII.		3 rd ed.2003	NCERT, New Delhi
3	Mathematics for the Life Science	Glenn Ledder	2013	Springer
4	Handbook of Mathematics for Biosciences and Paramedical Students	PUNDIR, S. K.	2016	CBS Publisher and Distributors
5	Basic Mathematics for the Biological and Social Sciences	F.H.C. Marriott	1970	Elsevier

● Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Fundamental Mathematical Concepts for Scientific Analysis	egyankosh.ac.in/bitstream/123456789/46811/1/Unit-10.pdf



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2	Fundamental Mathematical Concepts for Scientific Analysis	NPTEL / Swayam https://onlinecourses.nptel.ac.in/noc20_bt13/preview
3	Biocalculus	https://uotechnology.edu.iq/dep/bme/english/Pages/Lectures/mathmatix/2stage
4	Trigonometry	https://www.khanacademy.org/math/trigonometry
5	Algebra	https://www.khanacademy.org/math/algebra
6	BioMaths	http://elearn.psgcas.ac.in/nptel/courses/video/102101003/L01.html