



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 Biochemistry (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIC01	Molecular Biology	4-0-1	120	04

Course Learning Outcomes:

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

CLO 1: Correlate the structural, conformational, and topological features of DNA with its biological functions.

CLO 2: Explain DNA-protein interactions and their role in genome organization and expression.

CLO 3: Describe the molecular organization of prokaryotic and eukaryotic genomes and chromatin dynamics.

CLO 4: Analyze the molecular mechanism, fidelity, and regulation of DNA replication in prokaryotes and eukaryotes.

CLO 5: Discuss the molecular details of transcription, translation, and their regulation across domains of life.

CLO 6: Design and interpret experiments to study gene structure, function, and expression.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	DNA physical properties, Topology & Protein Interactions Helix parameters of B-, A-, Z- forms of DNA, DNA Denaturation, Renaturation & Cot curves, Supercoiling and mode of action of Topoisomerases, DNA-binding motifs (helix-turn-helix, zinc finger, leucine zipper); ssDNA binding proteins. , Molecular visualization using PyMOL/NCBI structure database.	Interactive lectures, Seminars, ICT enabled	1, 2
II	Genome Organization & DNA Replication Prokaryotic genome: nucleoid structure, looping, and supercoiling, Eukaryotic genome: nucleosome organization, histones, chromatin condensation (heterochromatin vs euchromatin), nucleosome assembly post-replication, DNA replication in prokaryotes: initiation, replisome assembly, elongation, termination, DNA polymerases (I, II, III) and proofreading, Eukaryotic replication: origins, licensing, polymerases α , δ , ϵ , telomeres, Inhibitors of replication (e.g., aphidicolin, hydroxyurea, novobiocin); Case study – inhibitors as anticancer/antiviral agents.	Interactive lectures, Flipped classroom, Seminars, Literature review	2, 3, 4



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III	Transcription & RNA Processing RNA polymerases (prokaryotic vs eukaryotic), Promoter architecture: -10/-35 box, TATA box, CpG islands, Transcription initiation complex assembly in prokaryotes (σ factor) and eukaryotes (TFIID, TFIIF, etc.), Elongation and termination (ρ -dependent/independent in bacteria; polyA signal in eukaryotes), RNA processing: capping, splicing, polyadenylation, alternative splicing, RNA editing, In silico promoter prediction	Interactive lectures, Flipped classroom, Seminars, ICT enabled	5, 6
IV	Translation & Genetic Code tRNA structure, aminoacylation, wobble hypothesis, Ribosome structure (70S vs 80S) and functional sites, Genetic code: features, degeneracy, universality, exceptions, Translation mechanism: initiation (prokaryotic Shine-Dalgarno vs eukaryotic cap-dependent), elongation, termination, ribosome recycling	Interactive lectures, Flipped classroom, Seminars	5,6
V	Regulation of Gene Expression Prokaryotic regulation: operon concept (lac, trp, ara) – with mutational analysis, Global regulatory networks: stringent response, SOS response, cAMP-CRP, stringent response, Heat shock response., Eukaryotic regulation: chromatin remodeling, transcription factors, Post-transcriptional regulation: RNAi, miRNA, alternative splicing regulation, Translational control: eIF2 phosphorylation, iron-responsive elements (IREs), Virtual lab simulation of lac operon	Interactive lectures, Flipped classroom, Seminars ICT enabled	5, 6

Assessment Methodologies

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**

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

External Assessment: End of Term Examination (50 marks)



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• Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
				Understanding (U)	Application/ Analyse & above (A)	
I	1, 2	24	1	1	08	10
II	2, 3, 4	32	1	1	10	12
III	5, 6	24	1	1	08	10
IV	5, 6	20	-	-	08	08
V	5, 6	20	1	1	08	10
		120	04	04	42	50

CLOs – PLOs Matrix

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



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● 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 Gene	Watson, J. D. et al.	7th Ed., 2017	Pearson
2	Lewin's Genes XII.	Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T.	2017	Jones & Bartlett.
3	Molecular Biology: Genes to Proteins.	Tropp, B. E	4th Ed., 2012	Laxmi Publications.
4	DNA Structure and Function.	Sinden, R. R.	1994	Gulf Professional Publishing.

● Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Molecular biology NPTEL	https://nptel.ac.in/courses/102103341
2	Molecular visualization	https://pymol.org/
3	Virtual lab simulation (HHMI Biointeractive)	https://www.biointeractive.org/



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIC02	Physiological Biochemistry	4-0-1	120	04

Course Learning Outcomes:

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

- CLO 1:** Explain the principles of bioenergetics and thermodynamics in biological systems, including energy transformations, ATP generation, and mitochondrial function.
- CLO 2:** Analyze the regulation of major metabolic pathways, including glycolysis, TCA cycle, gluconeogenesis, pentose phosphate pathway, and glycogen metabolism, in maintaining energy homeostasis.
- CLO 3:** Evaluate the regulation of lipid and nitrogen metabolism, including fatty acid oxidation and biosynthesis, cholesterol metabolism, transamination, deamination, and the urea cycle.
- CLO 4:** Interpret the role of key signalling pathways and metabolic intermediates in controlling metabolic processes.
- CLO 5:** Assess the integration of metabolism across different organs such as the liver, adipose tissue, muscle, kidney, and brain in maintaining metabolic homeostasis.
- CLO 6:** Discuss the links between intermediary metabolism and cellular functions, including epigenetics, immune responses, oxidative stress, cancer metabolism, and metabolic adaptations under physiological conditions such as fasting and starvation.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Introduction to Metabolism	Classroom Lecture (CL), Seminars, Problem-Based Learning (PBL), Collaborative Learning, ICT-Enabled Learning	1, 2
	Bioenergetics: An Introduction to Biological Thermodynamics Chemical Bonds and Molecules: Forces within and between molecules, concepts of internal energy, enthalpy, and entropy, First and second laws of thermodynamics, the application of thermodynamic principles to biological systems, Mitochondrial Respiratory Chain, Q cycle, ATP Synthase Complex and Biological oxidations ATP Cycle.		
II	Integrated Metabolism I Principles of metabolic control: Regulation and function of metabolic pathways in energy generation. Regulation of blood glucose homeostasis; Hormonal regulation (Insulin, Glucagon, Epinephrine) of blood glucose. Regulation of Glycolysis, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, glycogenesis and glycogenolysis; Interaction of PPP intermediates with glycolysis. Regulation of Fatty acid oxidation and biosynthesis,	Classroom Lecture (CL), Seminars, Problem-Based Learning (PBL), Collaborative ICT-Enabled Learning	2, 3



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III	<p>Metabolic integration and coordination I</p> <p>Key Signaling pathways: Insulin/PI3K/Akt, AMPK, mTORC1</p> <p>Major Metabolic Intermediates as Signals: Lactate/Succinate, Acetyl-CoA, Fructose 2,6 bis-phosphate, Citrate, and α-Ketoglutarate, β-hydroxybutyrate.</p> <p>Links of Intermediary metabolism to other cellular functions such as epigenetics, immune cell differentiation, and cell death; Cancer cell metabolism.</p>	Classroom Lecture (CL), Seminars, Problem-Based Learning (PBL), Collaborative Learning, ICT-Enabled Learning	2, 4
IV	<p>Metabolic integration and coordination II</p> <p>The role of the liver in the distribution of nutrients and maintaining homeostasis, metabolic functions, and metabolic flexibility of the liver, maintenance of cholesterol levels, bile acid synthesis; detoxification; Transamination and its regulation, Regulation of Deamination, and Urea cycle, Nitrogen balance, Liver function tests.</p> <p>Adipose tissue metabolism, Storage and supply of fat, Regulation of lipase, futile cycle of fat between adipose tissue and liver.</p> <p>Biochemistry of Muscle; Fuel metabolism in muscles; Energy metabolism in muscles; ATP maintenance.</p> <p>Metabolic pathways in kidneys: acid-base regulation, nitrogen metabolism; renal function tests.</p> <p>Metabolism in the brain, biosynthesis of neurotransmitters, Neurotransmitters and intermediary metabolism Connections: Neurotransmitters derived from metabolic intermediates: Glutamate, GABA, and Glycine -metabolic roles of neurotransmitters.</p>	Classroom Lecture (CL), Problem-Based Learning (PBL), Reflective Practices, Inquiry-Based Learning, Self-Directed Learning	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)**



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Master of Science in Biochemistry (Semester-I)

- Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
				Understanding (U)	Analyse & above (A)	
I	1, 2	24	3	4	5	10
II	2, 4, 5	32	2	5	7	14
III	3, 4	32	2	5	7	14
IV	4, 5	36	2	6	2	12
		120	9	20	21	50

CLOs–PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1	3	2	1	2	2	1	-	1	2
CLO 2	3	3	1	3	2	1	-	1	2
CLO 3	3	3	1	3	2	1	1	1	2
CLO 4	2	3	2	3	2	2	1	1	2
CLO 5	3	3	2	3	3	2	1	2	2
CLO 6	2	3	3	3	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, Written Exam, Class Regularity, Group learning	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	Harper's Illustrated Biochemistry	Victor Rodwell, David Bender	31st ed. (2018)	McGraw-Hill Education, Ahmedabad
2	Lehninger Principles of Biochemistry	Nelson David L. and Cox Michael M.	4th ed. (2011)	Macmillan Publishers, United States
3	Guyton and Hall Textbook of Medical Physiology	John E. Hall	13th ed. (2016)	Elsevier, India
4	Principles of Anatomy and Physiology	Gerard J. Tortora, Bryan H. Derrickson	15th ed. (2017)	Wiley, United States
5	Essential Physiological Biochemistry	Stephen Reed	1st edition 2009	Wiley Lack-Well, UK

- Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Bioenergetics	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cy24
2	Cellular Metabolism	https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_bt30
3	Integration of Metabolism and Regulation	https://pll.harvard.edu/course/principles-biochemistry-1/2026-05



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Master of Science in Biochemistry (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIC03	Molecular Cell Biology	4-0-1	120	04

Course Learning Outcomes:

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

- CLO 1:** Select and justify appropriate microscopic or cytometric technique for a given cell biology research problem.
- CLO 2:** Explain the structure-function correlation of major cell organelles and extracellular components.
- CLO 3:** Analyze how cells communicate, adhere, move, and generate energy in response to environmental cues.
- CLO 4:** Evaluate the molecular regulation of cell division, programmed cell death, and neoplastic transformation.
- CLO 5:** Design a small research hypothesis or experiment related to cell biology using standard laboratory techniques.
- CLO 6:** Critically review primary literature and communicate scientific findings in written/oral formats.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p>Module 1: Advanced Techniques in Cell Biology</p> <p>Microscopy: Bright field, dark field, phase contrast, DIC, fluorescence (widefield & confocal), super-resolution microscopy (STED, PALM, STORM).</p> <p>Electron Microscopy: SEM, TEM, sample preparation, immunogold labeling.</p> <p>Scanning Probe Microscopy: AFM, STM – principles and biological applications.</p> <p>Flow Cytometry & Cytophotometry: Principles, sorting, FACS, applications in cell cycle, apoptosis, and surface markers.</p> <p>Emerging Tools: Live-cell imaging, single-cell analysis, and AI in image analysis.</p> <p>Virtual lab module on microscope simulation.</p>	Interactive lectures Seminars ICT tools	1,2,5,6
II	<p>Structural Organization of Cell & Extracellular Matrix</p> <p>Nucleus: Nuclear lamina, pore complex, nucleocytoplasmic transport.</p> <p>Endomembrane System: ER (rough/smooth), Golgi, lysosomes, protein sorting, vesicular transport (COP-coated, clathrin-mediated).</p>	Interactive lectures Seminars	2,3,5,6



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	<p>Energy Organelles: Mitochondria (dynamics, mtDNA, ROS), chloroplasts (thylakoid, stroma, photosynthesis overview), peroxisomes.</p> <p>Extracellular Matrix & Cell Walls: Composition (collagen, elastin, integrins), plant cell wall (cellulose, pectin, lignin), bacterial cell wall (peptidoglycan – relevance to microbiology).</p> <p>Cell-Cell Interactions: Adhesion proteins (cadherins, selectins), tight junctions, gap junctions, plasmodesmata, desmosomes.</p>		
III	<p>Cell Membrane, Cytoskeleton & Signaling</p> <p>Plasma Membrane: Fluid mosaic model, lipid rafts, transport mechanisms (passive, active, ABC transporters, ion channels).</p> <p>Endocytosis & Exocytosis: Phagocytosis, pinocytosis, receptor-mediated endocytosis (clathrin and caveolae).</p> <p>Cytoskeleton: Actin: polymerization, treadmilling, myosin motors, cell movement. Microtubules: structure, dynamic instability, kinesin/dynein, cilia/flagella (9+2 arrangement, IFT). Intermediate filaments: types, nuclear lamins.</p> <p>Cell Signaling: Receptors (GPCR, RTK, ion channels), second messengers (cAMP, IP3/DAG, Ca²⁺), MAPK/ERK, PI3K/Akt pathways, signaling in development & differentiation.</p>	Interactive lectures Seminars Flipped Classroom Classroom	3,5,6
IV	<p>Cell Division Cycle, Death & Cancer Biology</p> <p>Cell Cycle: Phases (G1, S, G2, M), CDKs/cyclins, checkpoint control (p53, Rb), APC/C, cytokinesis.</p> <p>Programmed Cell Death: Apoptosis (extrinsic/intrinsic pathways), caspases, Bcl-2 family, necroptosis (RIPK1/RIPK3), pyroptosis.</p> <p>Cancer Biology: Types (carcinoma, sarcoma, leukemia/lymphoma). Hallmarks of cancer. Oncogenes (Ras, Myc) and tumor suppressors (p53, BRCA1/2). Role of telomerase, metastasis, and tumor microenvironment.</p>	Interactive lectures Seminars Flipped Classroom Group discussion	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**

Group Learning: 05 marks

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



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(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
				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
CLO1	3	3	2	3	2	2	1	1	2
CLO2	3	2	1	2	2	1	-	1	2
CLO3	3	3	2	3	3	2	1	2	2
CLO4	3	3	2	3	3	2	1	2	2
CLO5	2	3	2	3	3	3	2	2	3
CLO6	2	3	3	3	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	-



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- 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.

- 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 Biochemistry (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIC04	Cellular and Molecular Microbiology Laboratory Techniques	0-8-0	120	04

Course Learning Outcomes:

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

- CLO 1:** Isolate and characterize pure microbial cultures and analyze growth kinetics, including determination of specific growth constants and saturation constants (Ks) under different substrates.
- CLO 2:** Isolate, quantify, and assess the purity of genomic and plasmid DNA using spectroscopic and electrophoretic methods.
- CLO 3:** Perform chromatographic separations, biochemical assays, and subcellular fractionation to interpret molecular and cellular processes.
- CLO 4:** Apply microscopy (bright field, phase contrast, fluorescence) and flow cytometric data analysis to study cell structure, viability, and division.
- CLO 5:** Conduct literature-based research and communicate findings through formal reports and presentations.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	<ol style="list-style-type: none">1. Isolation of plasma membrane2. Growth curve of <i>E. coli</i> and determination of specific growth rate constants and Ks on different substrates (glucose, lactose, glycerol)3. Isolation of genomic DNA from <i>E. coli</i>4. Isolation of plasmid DNA from <i>E. coli</i> (alkaline lysis method)5. Determination of quality of DNA/RNA by UV spectrophotometry and agarose gel electrophoresis6. Amino acid separation and quantification using TLC/HPTLC7. Induction and assay of beta-galactosidase8. Study of microscopic techniques: phase contrast, fluorescence (demonstration).9. Cell viability assay (trypan blue exclusion) and counting using hemocytometer.10. Observation of cytoskeleton in onion epidermal cells / cheek cells using stains.11. Study of plasmolysis and cell wall integrity in cells.	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5



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	12. Isolation of plasma membrane 13. Growth curve of <i>E. coli</i> and determination of specific growth rate constants and Ks on different substrates (glucose, lactose, glycerol) 14. Isolation of genomic DNA from <i>E. coli</i> 15. Isolation of plasmid DNA from <i>E. coli</i> (alkaline lysis method) 16. Determination of quality of DNA/RNA by UV spectrophotometry and agarose gel electrophoresis 17. Amino acid separation and quantification using TLC/HPTLC 18. Induction and assay of beta-galactosidase 19. Study of microscopic techniques: phase contrast, fluorescence (demonstration). 20. Cell viability assay (trypan blue exclusion) and counting using hemocytometer. 21. Observation of cytoskeleton in onion epidermal cells / cheek cells using stains. 22. Study of plasmolysis and cell wall integrity in cells. 23. Study of mitosis and meiosis. 24. Demonstration of apoptosis using yeast or onion root tip (chemical induction). 25. Flow cytometry data interpretation (simulated or real dataset). 26. Mini-project: Literature review on a signaling pathway or organelle disorder.		
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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: 05marks**
- iii. **Laboratory Record: 05**
- iv. **Group Learning: 05**
- v. **Spotting/Quiz: 05**

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
				Understanding (U)	Application/ Analyse & above (A)	
	1 to 5	120	10	10	30	50



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Master of Science in Biochemistry (Semester-I)

• CLOs – PLOs Matrix

CLOs/ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO1	3	3	1	2	2	2	--	1	2
CLO2	3	2	1	2	1	2	-	-	1
CLO3	3	3	1	2	2	2	-	-	1
CLO4	3	3	1	2	2	2	-	-	2
CLO5	2	3	3	3	3	2	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	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	12th Ed., 2020	Pearson
2	Benson's Microbiological Applications	Alfred E. Brown	14th Ed., 2015	McGraw-Hill
3	Molecular Cloning: A Laboratory Manual	Joseph Sambrook, David W. Russell	4th Ed., 2012	Cold Spring Harbor Laboratory Press



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4	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson, John Walker	8th Ed., 2018	Cambridge University Press
5	Molecular Biology of the Cell	Bruce Alberts et al.	6th Ed., 2015	Garland Science
6	Essential Cell Biology	Bruce Alberts et al.	5th Ed., 2019	Garland Science
7	Analytical Biochemistry	David J. Holme, Hazel Peck	3rd Ed., 1998	Pearson
8	Biophysical Chemistry	A. Upadhyay, K. Upadhyay, N. Nath	Latest Ed.	Himalaya Publishing House
9	Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	8th Ed., 2021	W.H. Freeman
10	Fundamental Techniques in Microbiology	Christopher H. Collins et al.	2nd Ed., 2004	Wiley-Blackwell

● Online Resources (Open Source)

Sr.No.	Description of Resource(s)	Weblink
1	Addgene – Protocols for plasmid DNA isolation, PCR, gel electrophoresis	https://www.addgene.org/protocols/
2	HHMI BioInteractive – Interactive animations on molecular biology & cell processes	https://www.biointeractive.org
3	NCBI – Databases (GenBank), BLAST, literature (PubMed)	https://www.ncbi.nlm.nih.gov
4	OpenWetWare – Open lab protocols and experimental methods	https://openwetware.org
5	MIT OpenCourseWare – Free lectures in microbiology & biochemistry	https://ocw.mit.edu
6	Nikon MicroscopyU – Microscopy tutorials & imaging techniques	https://www.microscopyu.com
7	Olympus Life Science – Fluorescence and advanced microscopy resources	https://www.olympus-lifescience.com



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIC05	Lab to Learning: Bioanalytical Techniques	0-8-0	120	04

Course Learning Outcomes (CLOs)

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

- CLO 1:** Demonstrate safe microbiology laboratory practices, perform biochemical calculations, and prepare reagents and solutions accurately for experimental work.
- CLO 2:** Perform spectrophotometric analysis and interpret spectral and analytical data for biomolecular characterization.
- CLO 3:** Perform and analyze separation of biomolecules using chromatographic methods (TLC, HPTLC, gel permeation, and affinity chromatography).
- CLO 4:** Separate and analyze proteins and other macromolecules using electrophoresis (native PAGE, SDS-PAGE) and density gradient centrifugation techniques.
- CLO 5:** Evaluate bacterial growth by correlating cell density measurements using spectrophotometric absorbance and standard plate count methods.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	<ol style="list-style-type: none">1. Orientation to the Biochemistry laboratory, 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. Estimation of DNA by DPA method6. Estimation of protein by Folins Lowry Method7. Estimation of proteins by Bradford's Method8. Separation of amino acids by thin layer chromatography and HPTLC.9. Titration of amino acid and determination of pKa of Glycine10. UV-Visible spectral analysis of Nucleic acids and aromatic amino acids.11. Separation of proteins by native and SDS PAGE12. Separation of proteins by Gel permeation chromatography13. Separation of glycoproteins by Affinity chromatography	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	1 to 5



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14. Analysis of glycine and tyrosine by FTIR spectroscopy. 15. Separation of analytes by density gradient centrifugation 16. Correlation of bacterial cell density by absorbance and standard plate count		
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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: 05marks**
- 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
				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
CLO1	3	1	1	2	1	3	2	2	2
CLO2	3	3	2	2	2	2	-	1	2
CLO3	3	3	2	3	2	2	-	1	2
CLO4	3	3	2	3	2	2	-	1	2
CLO5	3	3	3	3	3	2	1	1	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	-



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● 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, New Delhi, India
2	An introduction to practical Biochemistry	David T. Plummer	(2017)	McGraw Hill book company
3	Biochemical Methods	S. Sadasivam and A. Manickam	2 nd	New Age International (P) Limited, Publishers, India
4	Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson & John Walker	8th (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	7th (2010)	Cambridge University Press
7	Protein Purification: Principles and Practice	Robert K. Scopes	3rd (1994)	Springer
8	Gel Electrophoresis of Proteins and Nucleic Acids	R. Westermeier	4th (2016)	Walter de Gruyter
9	Introduction to Spectroscopy	Donald L. Pavia	5th (2015)	Cengage Learning
10	Laboratory Safety for Chemistry Students	Robert H. Hill & David C. Finster	2nd (2016)	Wiley



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- Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	JoVE (Journal of Visualized Experiments)	jove.com
2	Lab Xchange	labxchange.org
3	Biochemistry Free & Easy	https://biochem.oregonstate.edu/undergraduate/educational-resources
4	NIH Principles of Chromatography	chromatography.nih.gov



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIC01	Bioethics & Biosafety	2-0-0	60	02

Course Learning Outcomes (CLOs)

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

CLO1	Analyze biosafety levels (BSL1–4) 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 I CMR, 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	<p>Biosafety</p> <p>Principles of Biosafety.</p> <p>Biohazard and Biosecurity: Concepts and components.</p> <p>WHO Risk Group Classification of Microorganisms</p> <p>Biocontainment: good laboratory practices and techniques, safety equipment, types of containment (physical and biological).</p> <p>AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions to be taken.</p> <p>Biosafety levels (BSL 1, 2, 3, 4), barriers (physical and secondary).</p> <p>Management of biohazardous waste.</p> <p>WTO and other international agreements related to biosafety.</p>	<p>Classroom Lecture (CL); Seminars; Collaborative Learning; Group Learning; ICT enabled learning</p>	1



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II	<p>Genetically modified organism: concerns and challenges GMOs/LMOs: Government of India definition of genetically modified organisms (GMOs) and living modified organisms (LMOs), GRAS microorganisms. 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 such as drugs/vaccines etc</p>	Classroom Lecture (CL); Seminars; Collaborative Learning; ICT-Enabled Learning	2
III	<p>Principles and Practices Role of ethics committees and Institutional Review Boards National Ethical Guidelines (ICMR Guidelines) Research Ethics: 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. 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)**
- (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
				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



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• CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1:	3	3	1	3	2	2	2	3	2
CLO 2:	2	3	2	3	2	1	3	3	2
CLO 3:	2	3	2	3	2	2	3	2	2
CLO 4:	2	3	2	2	3	2	3	3	2
CLO 5:	3	3	2	3	3	2	3	3	3
CLO 6:	3	3	1	3	2	2	2	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	PADMA NAMBISAN	1,2017	ACADEMIC PRESS
2	BIOETHICS AND BIOSAFETY	M.K. SATEESH	1,2014	I.K. INTERNATIONAL PUBLISHING HOUDE PVT. LTD. NEW DELHI
3	BIOETHICS AND BIOSAFETY IN BIOTECHNOLOGY	V. SREE KRISHNA	1,2007	NEW AGE INTERNATIONAL LTD., NEW DELHI
4	BIOSAFETY IN INDUSTRIAL BIOTECHNOLOGY	P.HAMEBLETON MELLING	1, 1994	BLACKIE ACADEMIC & PROFESSIONAL, BISHOPBRODGE, GLASGOW, UK



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- 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	P2S01NEBIC02	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
- CLO6** Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Entrepreneurship Fundamentals & 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.	Interactive Classroom Lecture, Venture Activity, ICT enabled	1



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II	<p>Problem & 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 and assessing initial opportunity.</p>	Interactive Classroom Lecture, Collaborative learning, Experiential Learning	1,2
III	<p>Solution design & 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>	Collaborative Learning, ICT enabled	1,2,3,4
IV	<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>	Interactive Classroom Lecture, Venture Activity	1,3
V	<p>Business & 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>	Interactive Classroom Lecture, Group discussion, Collaborative learning	1,5



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VI	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.	Expert Talks, Group discussion, Collaborative learning	6
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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
				Understanding (U)	Application/Analyse & above (A)	
I	1	09	1	1	03	04
II	1,2	09	-	1	03	04
III	1,2,3,4	10	1	-	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
CLO 1:	2	3	2	2	3	3	2	1	3
CLO 2:	2	3	2	2	3	2	1	2	2
CLO 3:	2	3	2	3	3	2	1	2	2
CLO 4:	2	3	2	3	3	3	1	2	2
CLO 5:	2	3	2	3	2	2	1	2	2
CLO 6:	1	2	3	2	2	3	1	1	2



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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, 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	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 limited
5	Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation	Brown Tim	2019	Harper Business



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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.ideo.com/blogs/inspiration/design-thinking-for-social-innovation



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIC03	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) Micro-Projects Collaborative Learning, ICT-Enabled Learning	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) Problem-Based Learning (PBL) Seminars (Student-led) Micro-Projects Collaborative Learning, ICT-Enabled Learning</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) Problem-Based Learning (PBL) Seminars (Student-led) Micro-Projects Collaborative Learning, Case-based learning (CBL)</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 CLOs	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	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1:	3	3	1	2	2	1	1	2	1
CLO 2:	3	3	1	2	2	1	1	2	1
CLO 3:	3	3	2	2	2	1	1	2	1
CLO 4:	3	3	1	2	3	1	1	3	1
CLO 5:	3	3	2	2	3	1	2	3	2
CLO 6:	3	3	2	3	3	2	3	3	2

- **CLOs – PLOs Matrix** 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



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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	Agrotech 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	P2S01NEBIC04	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: Focuses on microbial control, resistance, and emerging therapeutic approaches; Sterilisation principles in the pharmaceutical industries; Methods of sterilisation: Physical: moist heat (autoclaving), dry heat, radiation, filtration; Chemical: gaseous sterilisation (ethylene oxide), disinfectants; Validation of sterilisation: biological and chemical indicators; Disinfectant evaluation: phenol coefficient, Kelsey-Sykes test; Antibiotic resistance: development and mechanisms; New therapeutics: Antimicrobial peptides (history, properties, mode of action, applications), Phage therapy: introduction, lytic cycle, 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: Covers industrial applications, contamination control, and regulatory aspects; Microbial contamination and spoilage of pharmaceutical products: Sources, factors affecting growth, impact on formulations; 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); 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, cGMP)	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

● Weightage of Learning Efforts for External Assessment

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning			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



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● CLOs – PLOs Matrix

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9
CLO 1:	3	2	1	2	2	1	1	1	2
CLO 2:	3	3	2	2	2	1	2	2	2
CLO 3:	3	3	2	3	2	2	2	2	2
CLO 4:	3	3	2	3	2	1	2	3	2
CLO 5:	3	3	2	3	2	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, 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	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	Error! Hyperlink reference not	18 th ed. 2023	Nirali Prakashan
5	Error! Hyperlink reference not valid. -	Error! Hyperlink	2015	Woodhead Publishing series



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6	Error! Hyperlink reference not valid. Error! Hyperlink	Error! Hyperlink reference not	2011	IK International Publishing House Pvt. Ltd
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- **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	P2S01NEBIC05	Mathematics Essentials 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	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	Classroom Lecture (CL), Problem-Based Learning (PBL), Experiential Learning, ICT-Enabled Learning	4-6
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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	1,2	18	0	1	7	8
II	3	20	1	1	7	9
III	4- 6	22	1	1	6	8
		60	02	03	20	25

- **CLOs – PLOs Matrix**

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



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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, 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
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



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