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 Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S01NCBIT01	Molecular Biology	4-0-1	120	04

Course Learning Outcomes:

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

CLO1: Correlate the structural, conformational, and topological features of DNA with its biological functions.

CLO2: Explain DNA-protein interactions and their role in genome organization and expression.

CLO3: Describe the molecular organization of prokaryotic and eukaryotic genomes and chromatin dynamics.

CLO4: Analyze the molecular mechanism, fidelity, and regulation of DNA replication in prokaryotes and eukaryotes.

CLO5: Discuss the molecular details of transcription, translation, and their regulation across domains of life.

CLO6: 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**

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, TFIIH, 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, deciphering 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, 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**

(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**	24	01	01	08	10
II	**2,3,4**	32	01	01	10	12
III	**5,6**	24	01	01	08	10
IV	**5,6**	20	-	-	08	08
V	**5,6**	20	01	01	08	10
		120	**04**	**04**	**42**	**50**

- **CLOs – PLOs Matrix**

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

- **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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Master of Science in Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S01NCBIT02	Biochemistry and Metabolism	4-0-1	120	04

Course Learning Outcomes:

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

CLO1: Analyze the principles of bioenergetics, thermodynamics, ATP metabolism, and redox reactions in cellular systems.

CLO2: Evaluate carbohydrate metabolism and glycobiology, including glycolysis, gluconeogenesis, glycogen metabolism, and regulatory mechanisms.

CLO3: Demonstrate understanding of amino acids and proteins by analysing structure, properties, folding, and stability using biochemical tools.

CLO4: Analyze lipid metabolism and biosynthetic pathways to understand their roles in cellular signalling and physiological functions

CLO5: Analyze and interpret nucleic acid metabolism, including nucleotide biosynthesis, regulation, and associated disorders.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Metabolism and energetics** Metabolism Overview: Catabolism and anabolism; central role of ATP; carbon fuels and their oxidation Energy Concepts: Energy-rich compounds, metabolic intermediates, and common biochemical reactions Thermodynamics: Laws of thermodynamics, entropy, Gibbs free energy, and biological significance ATP and Energy Transfer: ATP synthesis, hydrolysis, and role as energy currency Biological Oxidation: Redox reactions, redox potential, and key enzymes (dehydrogenases, oxygenases, hydrolases)	Classroom Lecture, Case-Based Learning, Problem-Based Learning, ICT-Enabled Learning	**1**
II	**Carbohydrates and Glycobiology** Monosaccharides and derivatives of sugars, polysaccharides, glycosaminoglycans, proteoglycans, protein glycosylation and its significance. Carbohydrates as Informational Molecules: The sugar code, Glycolysis and gluconeogenesis, Regulation of glycolysis, metabolic flux and its regulation by various metabolic pathways, Pentose phosphate pathway and its importance in biosynthetic reactions. Glycogen synthesis, breakdown and its regulation.	Classroom Lecture, Case-Based Learning, Problem-Based Learning, ICT-Enabled Learning	**2**

III	**Proteins and Amino Acids** Amino acids and Protein: Nomenclature, Classification, Structure, Chemical and Physical Properties of Amino Acids and Proteins, Alkali titration of amino acids, Sequence determination and characterisation of proteins. Confirmation of proteins – Ramachandran plots, Denaturation of proteins, Basic concepts of protein folding and stability, folding pathways, and the role of accessory proteins in protein folding. Determination of protein and Biomolecular structures	Classroom Lecture, Case-Based Learning, Problem-Based Learning, ICT-Enabled Learning,	**3**
IV	**Lipid Metabolism** Lipids as Signals, Cofactors and Pigments, Fatty acid biosynthesis- Acetyl CoA carboxylase, Desaturase and Elongase. Biosynthesis of triacylglycerols, phosphoglycerates, and sphingolipids. Biosynthetic pathways for terpenes, steroids and prostaglandins. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones. Ketone bodies- Formation and utilisation	Classroom Lecture, Case-Based Learning, Problem-Based Learning, ICT-Enabled Learning	**4**
V	**Nucleic acid metabolism** Biosynthesis and catabolism of purine and pyrimidine (De novo and salvage pathways), Synthesis of deoxyribonucleotides, Structure, molecular mechanism and regulation of ribonucleotide reductase, Inhibitors of nucleic acid biosynthesis, Disorders of nucleic acid metabolism	Classroom Lecture, Case-Based Learning, Problem-Based Learning, ICT-Enabled Learning	**5**

- **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**	24	01	01	08	10
II	**2**	28	01	01	08	10
III	**3**	24	01	01	08	10
IV	**4**	24	01	01	08	10
V	**5**	24	01	01	08	10
		120	**05**	**05**	**40**	**50**

- **CLOs – PLOs Matrix**

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

- **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	Lehninger's Principles of Biochemistry	David L. Nelson and Michael M. Cox	8th (2021)	W.H. Freeman and Co.
2	Voet's Biochemistry	Voet. D & Voet. J.G	Adapted Edition (2021)	John Wiley & Sons, Inc
3	Biochemistry: The Chemical Reactions of Living Cells (2-Volume Set)	David E. Metzler and Carol M. Metzler.	2003	Academic Press (Elsevier)
4	Principles of Biochemistry	Zubay G. L	4th ed. 1998	McGraw-Hill.
5	Biochemistry	Jeremy M. Berg, John L. Tymoczko, Lubert Stryer	7th ed. (2010)	W. H. Freeman and Co.

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Overview and Integration of Cellular Metabolism	https://onlinecourses.nptel.ac.in/noc24_cy47/preview
2	Metabolism	https://onlinecourses.nptel.ac.in/noc25_cy07/preview https://onlinecourses.nptel.ac.in/noc22_bt22/preview
3	Energetics	https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod3.pdf

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Master of Science in Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S01NCBIT03	Molecular Cell Biology	4-0-1	120	04

Course Learning Outcomes:

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

CLO1: Select and justify appropriate microscopic or cytometric technique for a given cell biology research problem.

CLO2: Explain the structure-function correlation of major cell organelles and extracellular components.

CLO3: Analyze how cells communicate, adhere, move, and generate energy in response to environmental cues.

CLO4: Evaluate the molecular regulation of cell division, programmed cell death, and neoplastic transformation.

CLO5: Design a small research hypothesis or experiment related to cell biology using standard laboratory techniques.

CLO6: 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 & 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**

II	**Structural Organization of Cell & 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 & 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.	Interactive lectures, Seminars,	**2,3,5,6**
III	**Cell Membrane, Cytoskeleton & Signalling** Plasma Membrane: Fluid mosaic model, lipid rafts, transport mechanisms (passive, active, ABC transporters, ion channels). Endocytosis & 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, Ca^{2+}), MAPK/ERK, PI3K/Akt pathways, signalling in development & differentiation.	Interactive lectures, Seminars, Flipped Classes,	**3,5,6**
IV	**Cell Division Cycle, Death & 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. Oncogenes (Ras, Myc) and tumor suppressors (p53, BRCA1/2). Role of telomerase, metastasis, and tumor microenvironment.	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
(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	**1,2,5,6**	30	01	02	08	11
II	**2,3,5,6**	30	01	02	15	15
III	**3,5,6**	30	-	02	12	14
IV	**4,5,6**	30	-	02	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	2	1	3	1	-	3	1	1	-	1
CLO 2:	3	1	2	2	1	1	-	1	1	1	-	1
CLO 3:	3	2	2	2	1	1	-	1	2	1	-	1
CLO 4:	3	2	3	2	1	2	1	1	2	1	-	1
CLO 5:	2	3	3	3	3	2	2	3	2	2	1	2
CLO 6:	1	2	2	2	1	2	2	2	3	3	3	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

- **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 Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIT04	Bioanalytical Laboratory	0-8-0	**120**	04

Course Learning Outcomes:

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

CLO1: Demonstrate safe microbiology laboratory practices, perform biochemical calculations, and prepare reagents and solutions accurately for experimental work.

CLO2: Perform spectrophotometric analysis and interpret spectral and analytical data for biomolecular characterization.

CLO3: Perform and analyze separation of biomolecules using chromatographic methods (TLC, HPTLC, gel permeation, and affinity chromatography).

CLO4: Separate and analyze proteins and other macromolecules using electrophoresis (native PAGE, SDS-PAGE) and density gradient centrifugation techniques.

CLO5: Evaluate bacterial growth by correlating cell density measurements using spectrophotometric absorbance and standard plate count methods.

Unit/ Sr.No	Course Content	Learning Pedagogies*	CLO(s)
	1. Orientation to the Microbiology laboratory, equipment and its validation 2. General laboratory safety and good laboratory practices. 3. Biochemical calculations and Preparation of reagents 4. Determination of λmax and validation of Beer-Lamberts Law 5. Estimation of DNA by DPA method 6. Estimation of protein by Folins Lowry Method 7. Estimation of proteins by Bradford's Method 8. Separation of amino acids by thin layer chromatography and HPTLC. 9. Titration of aminoacid and determination of pKa of Glycine 10. UV-Visible spectral analysis of Nucleic acids and aromatic amino acids. 11. Separation of proteins by native and SDS PAGE	Interactive lectures, Experiential learning,	**1 To 5**

	12. Separation of proteins by Gel permeation chromatography 13. Separation of glycoproteins by Affinity chromatography 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	Problem Based Learning, Collaborative Learning	

- **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	1	1	1	3	1	3	3	1	1	-	1
CLO 2:	3	2	3	2	3	1	-	3	1	1	-	1
CLO 3:	3	2	2	1	3	1	-	3	1	1	-	2
CLO 4:	3	2	2	1	3	1	-	3	1	1	-	2
CLO 5:	3	3	3	2	3	1	-	3	2	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	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		McGraw Hill book company
3	Biochemical Methods	S. Sadasivam and A. Manickam	2nd	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	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 Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCBIT05	Cell and Molecular Biology Laboratory	0-8-0	120	04

Course Learning Outcomes:

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

CLO1: Isolate and characterize pure microbial cultures from natural samples and analyze microbial growth kinetics, including determination of growth rate constants under different substrates.

CLO2: Isolate, analyse purity and quantify genomic DNA and plasmid DNA from bacteria with high purity.

CLO3: Perform biochemical assays and analyze experimental data for interpretation of cellular and molecular processes.

CLO4: Apply microscopic techniques (bright field, phase contrast, fluorescence) and staining methods to analyze cell structure, cytoskeleton, cell division (mitosis/meiosis), apoptosis, and cell integrity.

CLO5: Conduct literature review–based mini-projects, formulate scientific interpretations, and communicate findings effectively through reports and presentations.

Unit	Course Content	Learning Pedagogies*	CLO(s)
	1. Isolation and characterization of pure culture from natural sample. 2. Growth curve of *E. coli* and determination of specific growth rate constants and Ks on different substrates (glucose, lactose, glycerol) 3. Demonstration of quorum sensing 4. Isolation of genomic DNA from *E. coli* 5. Isolation of plasmid DNA from *E. coli* (alkaline lysis method) 6. Quantification of nucleic acids by UV spectrophotometry and its separation by agarose gel electrophoresis 7. Induction and assay of beta-galactosidase 8. Study of microscopic techniques: bright field, 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 plant cells	Interactive lectures Experiential learning Problem Based Learning Collaborative Learning	**1 To 5**

	12. Demonstration of apoptosis using yeast or onion root tip (chemical induction). 13. Flow cytometry data interpretation (simulated or real dataset). 14. Mini-project: Literature review on a signalling pathway or organelle disorder		

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

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- **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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Master of Science in Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIT01	Bioethics & Biosafety	2-0-0	60	02

Course Learning Outcomes:

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, Seminars, Collaborative Learning, Group Learning, ICT enabled learning	**1**

II	**Genetically modified organism: concerns and challenges** GMOs/LMOs: GOI definition: 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 including drugs/vaccines.	Classroom Lecture (CL); Seminars; Collaborative Learning, ICT - Enabled Learning	**2**
III	**Bioethics: Principles and Practices** 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. Emerging ethical issues: AI and big data ethics in Biology and Health care.	Classroom Lecture, Seminars, Collaborative Learning, Case-based learning.	**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**
			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:	3	1	2	2	3	2	3	1	2	1	-	1
CLO 2:	2	3	2	2	-	3	3	-	3	1	-	2
CLO 3:	1	2	3	2	-	2	3	1	2	1	1	1
CLO 4:	1	3	3	2	-	3	3	-	3	1	1	2
CLO 5:	2	3	3	3	1	3	3	1	3	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	AN INTRODUCTION TO ETHICAL, SAFETY & IPR ISSUES IN BIOTECNOLOGY	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

- **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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Master of Science in Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIT02	Entrepreneurship Fundamentals	2-0-0	60	02

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

Course Learning Outcomes:

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 thinkin identify market potential and customers while developing a compelling value propositio 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 th financial viability of a venture

CLO6: Prepare and deliver an investible pitch deck of their practice venture to attract stakeholder

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.	Interactive Classroom Lecture, Venture Activity, ICT enabled	**1**
II	**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 and assessing initial opportunity.	Interactive Classroom Lecture, Collaborative learning, Experiential Learning	**1,2**

III	**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.	Collaborative Learning, ICT enabled	**1,2,3,4**
IV	**Opportunity Assessment and Sizing** Assess relative market position via competition analysis, sizing the market and assess scope and potential scale of the opportunity	Interactive Classroom Lecture, Venture Activity	**1,3**
V	**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.	Interactive Classroom Lecture, Group discussion, Collaborative learning	**1,5**
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**

- **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	1	2	2	-	2	2	-	1	3	3	3
CLO 2:	1	2	3	2	1	2	1	2	3	2	2	3
CLO 3:	1	2	3	1	-	2	1	1	2	2	1	3
CLO 4:	2	3	2	1	2	1	-	3	1	2	2	3
CLO 5:	1	2	3	2	-	1	2	2	2	2	1	3
CLO 6:	1	1	2	3	-	1	1	-	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	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 Peters, Dean A. Shepherd, Sabyasachi Sinha	11, 2020	Mc GrawHill
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
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 Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIT03	Principles of Ecology	2-0-0	60	02

Course Learning Outcomes:

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, Problem-Based Learning, Seminars (Student-led) Micro-Projects, Collaborative Learning, ICT -Enabled Learning	**1**

II	**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	Classroom Lecture, Problem-Based Learning, Seminars (Student- led), Micro-Projects, Collaborative Learning, ICT -Enabled Learning	**2,3, 5**
III	**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	Classroom Lecture, Problem-Based Learning, Seminars (Student-led) Micro-Projects, Collaborative Learning, Case-based learning	**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	-	01	07	08
II	**2, 3, 5**	20	01	01	07	09
III	**4, 6**	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:	3	1	3	2	2	1	-	2	1	1	-	1
CLO 2:	3	2	2	1	1	1	-	1	2	1	-	1
CLO 3:	3	2	2	1	1	1	-	1	2	1	-	1
CLO 4:	3	2	2	1	2	2	-	2	2	1	-	1
CLO 5:	3	2	2	1	1	2	1	1	2	1	-	2
CLO 6:	2	3	3	3	1	3	2	2	3	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	Ecology	Begon, M. et al	1996	Blackwell Science, Cambridge, USA
2	Fundamentals of Ecology	Odum, E.P., Barrett, G., W.	2005	Thomson Brooks/Cole, Belmor, 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	2nd 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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Master of Science in Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIT04	Pharmaceutical Microbiology	2-0-0	60	02

Course Learning Outcomes:

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: nutritionalrequirements, 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, Seminars Case-Based Learning, ICT-Enabled Learning, Collaborative Learning	**1,2**
II	**Control of Microorganisms and Antimicrobial Strategies:** Sterilisation principles and methods: Physical (Moist heat - autoclaving), dry heat, radiation, filtration. Chemical: (gaseous sterilisation -ethylene oxide). Validation of sterilisation: biological and chemical indicators. Disinfectants: Disinfectant evaluation (phenol coefficient, Kelsey-Sykes test). Antibiotic resistance: development and mechanisms.	Classroom Lecture, Seminars Case-Based Learning,	**2,3**

	New therapeutics: Antimicrobial peptides (history, properties, mode of action, applications), Phage and therapeutic applications, Plant-based antimicrobial agents	ICT-Enabled Learning, Collaborative Learning	
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, cGMP)	Classroom Lecture, Seminars Case-Based Learning, 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 levels (BT)**			**Total Marks**
			Remember (R)	**Understanding (U)**	**Application/ Analyse & above (A)**	
I	**1, 2**	18	01	01	06	08
II	**2, 3**	20	01	01	06	08
III	**3, 4, 5**	22	-	-	09	09
		60	**02**	**02**	**21**	**25**

- **CLOs – PLOs Matrix**

CLOs \ PLOs	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12
CLO 1:	3	1	2	2	1	1	-	1	1	1	-	1
CLO 2:	3	2	3	2	1	2	1	2	2	1	-	2
CLO 3:	3	3	2	2	3	3	3	3	2	1	-	2
CLO 4:	3	2	2	1	2	3	3	2	3	1	-	2
CLO 5:	2	3	3	3	2	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, 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 *Pharmaceutical Microbiology*	Ed. Brendan F. Gilmore and Ste phen P. Denyer	9th ed. 2023	Wiley Blackwell
2	Pelczar, Chan, and Krieg *Microbiology* – For fundamental microbial biology.	NOEL R. KRIEG MICHALE J. PELCZAR JR, E.C.S. CHAN	5th ed 2023	Affiliated East West Press Pvt Ltd
3	The United States Pharmacopoeia (USP) –			
4	Pharmaceutical Microbiology	Error! Hyperlink	18th ed.	Nirali Prakashan
5	Error! Hyperlink reference not valid. -	Error! Hyperlink	2015	Woodhead Publishing series

6	Error! Hyperlink reference not valid. Error! Hyperlink	Error! Hyperlink reference not valid.	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

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 Biotechnology (Semester-I)

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEBIT05	Mathematics Essentials for Biologists	2-0-0	60	02

Course Learning Outcomes:

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, Problem-Based Learning, 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, Problem-Based Learning, Experiential Learning, ICT-Enabled Learning	**3**

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, Problem-Based Learning, Experiential Learning, ICT-Enabled Learning	**4,5,6**

- **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)	
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II	**3**	20	01	01	07	09
III	**4,5,6**	22	01	01	06	08
		60	**02**	**03**	**20**	**25**

- **CLOs – PLOs Matrix**

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

- **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	E. Batschelet	2nd ed.	Springer
	for Life Scientists		2008	
2	Textbooks of Mathematics for classes XI and XII.		3rd 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