Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	**B080701T/ BS440**	**Title of the Course**	Microbial taxonomy and General Microbiology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**4**	**2**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course aims to provide a basic understanding of key microbiology concepts such as microbial classification, taxonomy, physiology, and growth kinetics. It trains students in techniques like isolation, culturing, and identification, while highlighting microbiology's role in health, diagnostics, sterilization, and daily life.						

Course Outcomes	
CO1	Students will be able to classify microorganisms based on morphological, physiological, and molecular characteristics.
CO2	Students will be able to evaluate and justify the selection of appropriate techniques for the control and culturing of microbes.
CO3	Students will be able to analyze the ecological and economic significance of Algae, Protozoa, and Fungi in industries, agriculture, and environmental sustainability.
CO4	Students will be able to design and optimize culture strategies by formulating media, isolating pure cultures, and tailoring nutrient requirements for microbial growth and preservation.
CO5	Students will be able to analyze microbial growth kinetics under different culture conditions, evaluate factors influencing microbial growth.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**History of microbiology**	History and development of Microbiology - Theory of abiogenesis & biogenesis, Koch's postulates, River's postulate. Recent criteria used in microbial taxonomy including numerical taxonomy and methods based on genetic relatedness, rRNA based phylogenetic relationship.	8	CO-1
2	**Classification of bacteria**	Main outline of bacterial classification. General characteristics and importance of Viruses, Chlamydia, Rickettsia, Mycoplasma, Bacteria and Actinomycetes.	6	CO-1
3	**Control of microbes**	Physical and chemical methods for microbial control: Sterilization, disinfection, and antimicrobial agents, Mechanisms and significance of multidrug resistance in microbes, Strategies to combat antimicrobial resistance in clinical and environmental settings	6	CO-2
4	**Microbial culture techniques**	Principles of microbial culture techniques and selective factors used in microbial growth, Enrichment culture techniques for isolating specific microbial groups, Single-cell isolation methods and their applications in microbiology	8	CO-2
5	**Diversity of microbes**	Distinguished characteristics, general account on morphology, classification and economic importance of Algae, Protozoa and Fungi. Fungi as Plant Pathogens.	8	CO-3
6	**Bacterial nutrition**	Major nutritional types of bacteria and their metabolic adaptations; Microbial requirements for macronutrients (C, N, S, P) and microelements; Role of growth factors in microbial development and survival	8	CO-4
7	**Preservation of microbes**	Preparation and applications of different types of culture media; Pure culture techniques and characterization of microbial cultures; Principles and methods for the preservation of bacteria, yeasts, and molds	8	CO-4
8	**Growth kinetics**	Growth and control of microbes – Growth phases – kinetics, asynchronous, synchronous, batch and continuous culture. Factors affecting growth; Measurement of growth.	8	CO-5

Reference Books:

1. Pelczar MJ Jr.; Chan ECS and Kreig NR.; Microbiology; 5th Edition; Tata McGraw Hill; 1993.
2. Maloy SR; Cronan JE Jr.; and Freifelder D; Microbial Genetics; Jones Bartlett Publishers; Sudbury; Massachusetts; 2006.
3. Crueger and A Crueger; (English Ed.; TDW Brock); Biotechnology: A textbook of Industrial Microbiology; Sinaeur Associates; 1990.
4. G Reed; Prescott and Dunn‟s; Industrial Microbiology; 4th Edition; CBS Publishers;

e-Learning Source:

https://microbiologyonline.org/index.php

https://swayam.gov.in/nd1_noc24_bt11/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	3		2	1	2	
CO2	3	1				3	1		3	3	2	
CO3	3	1				3	3		3	1		
CO4	3	1				3	3		3	3	3	
CO5	3	1				3	1		2	2	3	

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080702T/ BS447**	**Title of the Course**	Microbial Cytology and Genetics	**L**	**T**	**P**	**C**
Year	1	**Semester**	I	**4**	**2**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course aims to give students a proper understanding of prokaryotic and eukaryotic cell organization, to develop in students the understanding about mechanism and regulation of eukaryotic cell cycle and signal transduction and to explain students about various methods of gene transfer in bacteria.						

Course Outcomes	
CO1	The students will be able to evaluate the significance of bacterial ultrastructure (e.g., cell wall, endospores, flagella, pili, capsules) in survival, pathogenicity, and antibiotic resistance.
CO2	The students will be able to develop hypotheses and experimental approaches to study membrane function, transport, cytoskeletal elements, protein targeting and translocation mechanisms in eukaryotic cells (ER, Golgi, lysosomes, mitochondria, chloroplasts, peroxisomes).
CO3	The students will be able to predict the consequences of dysregulation in cell cycle control and its implications various disorders.
CO4	The students will be able to critically evaluate research findings on quorum sensing, biofilms, and signal transduction to address unresolved questions in cell biology and microbiology.
CO5	The students will be able to evaluate methods of gene transfer in bacteria and different types of transposons present in prokaryotes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Prokaryotic Cell Organization	Bacterial cell wall, Biosynthesis of peptidoglycan, basis of antibiotics, Mode of action of antibiotics, development of resistance, cytoplasmic membrane, ultrastructure of bacterial cell, Endospore, flagella, cell membrane, pili, capsule.	**8**	**CO1**
2	Ultrastructure and transport in Eukaryotic Cell	Structure and functions of cell membrane, Transport across cell membrane: Diffusion, Facilitated diffusion, Active transport. Structure and functions of cell organelles (Cell wall, nucleus, mitochondria, chloroplast, endoplasmic reticulum, microsomes, Golgi apparatus, lysosomes & peroxisomes), Cytoskeleton (structural proteins- microtubules, actins, etc.),	**8**	**CO2**
3	Protein trafficking in cells	Concept of protein targeting signal sequences: protein translocation in ER and vesicular transport to Golgi, lysosomes and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes.	**8**	**CO2**
4	Cell division and cell cycle	Eukaryotic Cell division cycle: Mitosis, Meiosis, Check points, role of cyclins and cyclin dependent kinases in its regulation. Cell proliferation and cell death, apoptosis.	**8**	**CO3**
5	Cell communication and signalling-I	Introduction to microbial interactions and signalling, Quorum Sensing: Mechanisms of quorum sensing, Autoinducers: Quorum sensing regulation in pathogenic bacteria (e.g., *Pseudomonas aeruginosa*, *Vibrio cholerae*), quorum quenching. Microbial Biofilms and Communication, Formation and structure of biofilms, Cell-to-cell communication in biofilm, Biofilm resistance mechanisms and their medical significance.	**6**	**CO4**
6	Cell communication and signalling-II	Basics of signal transduction in eukaryotes: Role of calcium, cAMP, G-proteins, inositol phosphates, phospholipases and protein kinases in signal transduction,	**8**	**CO4**
7	Microbial Genetics-I	Gene transfer mechanisms in bacteria: Transduction: Generalized, restricted; Transformation: Discovery, competence development, molecular mechanism of DNA uptake; Conjugation: mechanism; mapping	**8**	**CO5**
8	Microbial Genetics-II	Genetic organization in prokaryotes and eukaryotes (euchromatin, heterochromatin, Nucleosome model),Transposons in prokaryotes: Simple, composite, and complex transposons, Mechanism of transposition; Retrotransposons.	**6**	**CO5**

Reference Books:

Alberts Bruce (1985) Molecular Biology of Cell. Garland Pub

Lodish H, Berk A, Zipursky SL et al. (2000) Molecular Cell Biology, 4th edn. New York: WH Freeman.

De Robertis E. D. P. and De Robertis E. M. F. (1987), Cellular and Molecular Biology Lea and Febiger, Philadelphia.

Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) General Microbiology, 4th edition, Mac Millan Press, London.

Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. Prescott's principles of microbiology, New York : McGraw-Hill, 2012.

Schlegel Hans G. (1995) General Microbiology, Edition 7, CUP, Cambridge.

e-Learning Source:

https://www.youtube.com/watch?v=exJiN3OemKU

https://onlinecourses.swayam2.ac.in/cec22_bt05/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1			1		1	3	1		
CO2	3	1				1		1	3	1		
CO3	3	1	1			1		1	3	1		
CO4	3	1	1			1		1	3	1		
CO5	3	1				3		1	3	1		

1. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:2025-26							
Course Code	**B080703T/ BS448**	**Title of the Course**	Soil and Agricultural Microbiology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This paper of microbiology and biochemistry of soil is designed with the objective to provide general introduction of soil and in-depth information on soil microbial diversity and the role of microorganisms in biogeochemical cycling of elements like C, N, P and trace elements and soil fertility.						

Course Outcomes	
CO1	Students will be able **to determine** the physical, chemical and biological properties of soil and their effects.
CO2	Students will be able **to critically evaluate** the role of microorganisms in plant growth particularly in rhizosphere and phyllosphere.
CO3	Students will be able **to evaluate the role of microorganisms in** C and N cycle specifically degradation of native and organic matter and biological nitrogen fixation.
CO4	Students will be able **to evaluate the role of microorganisms in** the transformation of elements as Phosphorus, Iron and Manganese
CO5	Students will be able **to** formulate the production process, application methods and reflect on the quality control of microbial biofertilizers and biopesticides.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Soil Microbiology	Structural and textural classes; Soi profile, Physico-chemical and biological properties of soil, microorganisms and soil fertility. Methods used in soil chemistry and microbiological studies.	8	CO-1
2	Rhizosphere and Phyllosphere	Rhizosphere and Phyllosphere microorganisms, Rhizosphere effect, root exudates, soil enzymes, influence of rhizosphere on crop productivity.	7	CO-2
3	Plant growth Promotion	Plant growth promoting bacteria and fungi, biological control within microbial communities of rhizosphere, role o/f antibiotics and siderophore in biocontrol of plant pathogens, Induced resistance: Phytoalexins	8	CO-2
4	Carbon cycle:	Carbon cycle: aerobic and anaerobic decomposition of native and added organic matter, lignolytic and cellulolytic microorganisms.	8	CO-3
5	Nitrogen cycle:	Nitrogen cycle: symbiotic and asymbiotic nitrogen fixation, Ammonification, nitrification, denitrification	7	CO-3
6	Microbial transformation	Microbial transformation of Phosphorus, sulphur and micronutrients– Phosphorus cycle, mineralization of inorganic phosphates. Microbial transformation of Iron and Manganese.Microbial transformation of sulphur- Sulphur cycle, sulphur oxidizing and reducing microorganisms (*Thiobacillus* and *Desulfovibrio*).	8	CO-4
7	Biofertilizers and Biopesticides I	Definition and status of biofertilizer, types of biofertilizers. Nitrogenous and phosphatic biofertilizers - *Rhizobium*, *Azotobacter*, *Azospirillum*, *Frankia*, Vesicular Arbuscular Mycorrhiza and PSB/PSF. Biopesticides as *Trichoderma*.	**8**	CO-5
8	Biofertilizers and Biopesticides II	Technologies for the production of biofertilizers. Methods of inoculation on seed and in soil. BIS and quality control of biofertilizers.	6	CO-5

Reference Books:

1. Agricultural Microbiology – Rangaswami.
2. Soil Microbiology – Alxander Martin.
3. Soil and soil microorganisms – Subbarao

e-Learning Source:

1. https://wachemo-elearning.net/courses/agricultural-microbiology/#tab-course-section__overview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	1	3		1	
CO2	3	1					2	1	3		1	
CO3	3	1					1		3		1	
CO4	3	1					1		3		1	
CO5	3	1			1	2	2	1	2		3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-2026							
Course Code	**B080704T/ BS449**	**Title of the Course**	Biomolecules and microbial metabolism	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**4**	**2**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to enable the students to with an understanding of biomolecules, the basic building blocks of living organisms and provide basic knowledge about microbial metabolism. It also gives understanding of how enzymes and metabolites in microbial living system works.						

Course Outcomes	
CO1	The students will be able to compare the biological significance of different polysaccharides. The students will be able to differentiate between simple and complex carbohydrates and lipids based on their structure and function and assess their roles in various physiological processes.
CO2	The students will be able to examine the significance of protein structure in enzymatic and regulatory functions and critically evaluate the importance of DNA and RNA structures in genetic regulation.
CO3	The students will be able to analyze enzyme kinetics, inhibition, and regulation, and evaluate the mechanisms of enzyme action, including isozymes, ribozymes, and allosteric regulation.
CO4	The students will be able to describe the major metabolic pathways (carbohydrate, lipid, amino acid, and nucleotide metabolism) in microorganisms, including energy production (glycolysis, TCA cycle, oxidative phosphorylation) and biosynthesis.
CO5	The students will be able to explain nitrogen and sulfur metabolism in bacteria, including nitrogen fixation, denitrification, and assimilation of various nitrogen sources, along with sulfate reduction and H_2S formation.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Carbohydrates**	Classification, characteristics and functions of simple carbohydrates; Structure and properties of mono, oligo and polysaccharides; Complex carbohydrates: Types, structure and general function.	8	CO-1
2	**Lipids**	Fat: Introduction, numbering and nomenclature; Lipids: Classification; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids.	6	CO-1
3	**Proteins**	Chemical structure and general properties of amino acids; Ramachandran Plot; Protein structure; Primary, secondary, tertiary and quaternary structure of proteins.	8	CO-2
4	**Nucleic acids**	Structure of purines, pyrimidines, nucleosides and nucleotides; Physical & biochemical properties of DNA; Types of DNA: A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA: tRNA, rRNA, mRNA and hnRNA	6	CO-2
5	**Enzymes**	Introduction, classification, enzyme kinetic parameters, catalytic efficiency, activity units, turnover number. Enzyme kinetics: Michaelis Menten equation and Lineweaver-Burk plot. Isozymes, ribozymes and abzyme, Enzyme inhibition, models and type of inhibition, and allosteric regulation.	8	CO-3
6	**Microbial metabolism of carbohydrate**	Brief account of photosynthesis - oxygenic-anoxygenic photosynthesis; fixation of CO_2- Calvin cycle - C3-C4 pathway. Aerobic and anaerobic metabolism in bacteria. Respiratory metabolism – Embden-Mayer Hoff pathway, hexose monophosphate shunt and Entner Doudroff pathway, TCA cycle. Electron transport chain and oxidative phosphorylation	8	CO-4
7	**Metabolism of lipids, amino acids and nucleotides**	Oxidation of fatty acid (beta-oxidation) and biosynthesis of fatty acid. Metabolism of amino acids and nucleotides.	8	CO-4
8	**Nitrogen metabolism**	Nitrogen fixation: nitrogenase enzymes, structure and properties. Denitrification, nitrate and nitrite reduction, deamination and transamination. Utilization of various nitrogen sources (ammonia, urea, nitrate, amino acids) by bacteria. Sulphate and sulphur reduction and H_2S formation.	8	CO-5

Reference Books:

1. Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th ed.). W. H. Freeman.
2. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). Brock Biology of Microorganisms (16th ed.). Pearson.
3. Voet, D., Voet, J. G., & Pratt, C. W. (2016). Fundamentals of Biochemistry: Life at the Molecular Level (5th ed.). Wiley.
4. Shuler, M. L., Kargi, F., & DeLisa, M. P. (2017). Bioprocess Engineering: Basic Concepts (3rd ed.). Prentice Hall.

e-Learning Source:

2. https://www.khanacademy.org/science/biology/metabolism
3. https://www.coursera.org/learn/biochemistry-metabolism

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO												
CO1	3	1				3	2	1	3	1	3	
CO2	3	1				3	2	1	3	1	3	
CO3	3	1				3	2	1	3	1	3	
CO4	3	1				3	3	1	3	1	3	
CO5	3	1			2	3	2	1	3	1	3	2

1. Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080705P/ BS468**	**Title of the Course**	**General Microbiology and Biochemistry Lab.**	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**0**	**0**	**8**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course is designed to enable students to understand and acquire the basic knowledge of General Microbial techniques and biochemical tests						

Course Outcomes	
CO1	Demonstrate an understanding of microbiology lab safety, discipline, handling of microscopes, glassware cleaning, and sterilization techniques
CO2	Perform microbial culture techniques, including pure culture isolation and enumeration of bacteria, fungi, and actinomycetes from environmental samples.
CO3	Apply staining and identification methods for bacteria and fungi using morphological and biochemical techniques based on Bergey's.
CO4	Quantify biomolecules like carbohydrates, proteins, DNA, RNA, and chlorophyll through biochemical estimation techniques.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Exp-01**	**Lab Safety, handling instruments and microscopic calibration** – Introduction to microbiology laboratory practices, safety protocols, and proper handling of equipment, icroscipic calibration and easureent	6	CO-1
	Exp-02	**Glassware Cleaning and Sterilization** – Preparation of cleaning solutions, sterilization methods, and aseptic handling techniques.	6	CO-1
2	**Exp-03**	**Pure Culture Techniques** – Isolation of microbes using serial dilution, pour plate, spread plate, and streak plate methods.	6	CO-2
3	**Exp-04**	**Microbial Enumeration** – Quantification of bacteria, fungi, and actinomycetes from soil samples.	6	CO-2
4	**Exp-05**	**Bacterial and fungal Staining Techniques** – Microscopic examination of bacterial morphology using Gram's, and spore staining; Identification of fungi using lactophenol cotton blue staining.	6	CO-3
5	**Exp-06**	**Microbial Identification** – Morphological and biochemical characterization of bacteria using Bergey's Manual of Determinative Bacteriology.	6	CO-3
6	**Exp-07**	**Isolation of *Rhizobium*** – Extraction and identification of *Rhizobium* from root nodules.	6	CO-3
7	**Exp-08**	**Biochemical Estimations** – Quantitative analysis of carbohydrates and proteins.	6	CO-4
8	**Exp-09**	**Biochemical Estimations** – Quantitative analysis of DNA and RNA.	6	CO-4
	Exp-10	**Biochemical Estimations** – Quantitative analysis of chlorophyll.	6	CO-4

Reference Books:

1. Cappuccino, J.G. & Welsh, C.T. – Microbiology: A Laboratory Manual (11th Edition, Pearson)
2. Dubey, R.C. & Maheshwari, D.K. – Practical Microbiology (S. Chand & Co.)
3. Aneja, K.R. – Experiments in Microbiology, Plant Pathology and Biotechnology (New Age International)
4. Bergey's Manual of Determinative Bacteriology – A comprehensive guide for bacterial identification
5. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L., & Painter, P.R. – The Microbial World (5th Edition, Prentice-Hall)

e-Learning Source:

Microbe Online – https://microbeonline.com/
WHO Laboratory Biosafety Manual – https://www.who.int/publications/i/item/9789240011311
MIT OpenCourseWare (Microbiology Courses) – https://ocw.mit.edu/courses/biology/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1					3	3	2		3	2
CO2	3	1					3	3	2		3	2
CO3	3	1					3	3	2		3	2
CO4	3	1					3	3	2	3	3	2
CO5	3	1		2			3	3	2	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080801T/BS450**	**Title of the Course**	Molecular Biology	**L**	**T**	**P**	**C**
Year	1	**Semester**	II	**4**	**2**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To develop in students basic understanding about the molecular biology of the microbes and detailed knowledge of molecular mechanism of gene expression and its regulation.						

Course Outcomes	
CO1	The students will be able to explain the detailed mechanism of DNA replication and regulation in prokaryotes and eukaryotes.
CO2	The students will be able to discuss the characteristics of promoter and mechanism of transcription in prokaryotes and eukaryotes.
CO3	The students will be able to explain the detailed mechanism of translation and its regulation in prokaryotes and eukaryotes.
CO4	The students will be able to describe in detail the types of post-transcriptional and post translation modifications in eukaryotes.
CO5	The students will be able to explain the regulation of gene expression in different organisms and methods of DNA repair.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Nucleic acid as information carriers	Nucleic acid as information carriers and Replication: Griffith, Avery, McLeod and McCarty, Hershey and Chase experiment; Possible modes of replication: Meselson and Stahl experiment	**4**	**CO1**
2	DNA replication	DNA replication: Origin of replication; Mechanism of DNA replication (initiation, elongation and termination); Roles of DNA polymerases and other proteins involved in replication; Replication in eukaryotes. Fidelity and regulation of replication. or Rolling circle replication in X174.	**9**	**CO1**
3	Transcription	Transcription: Mechanism of transcription in prokaryotes and eukaryotes (initiation, elongation and termination); RNA polymerases: structure, subunits and function. Promoter; Transcription factors; Enhancer and other regulatory elements of eukaryotes. Reverse transcription.	**8**	**CO2**
4	Translation	Translation in prokaryotes and eukaryotes: Adapter role of tRNA, Evidence for a triplet code; Properties of Genetic code; Wobble hypothesis; A, P and E sites of ribosome; Ribosome binding site; Formation of initiation complex; Ribosome cycle; Initiation, elongation and termination of translation in prokaryotes and eukaryotes. Roles of Initiation factors, Elongation factors, Release factors, Aminoacyl tRNA synthetase	**9**	**CO3**
5	Post-transcriptional modifications	Post - transcriptional / Co-transcriptional processing of rRNA, mRNA, tRNA: Addition of 5` cap and 3' Poly A tail in mRNA, RNA splicing - Self splicing and Spliceosome mediated splicing, Alternative splicing; Cutting events or action of ribonucleases, Covalent modifications, RNA editing.	**9**	**CO4**
6	Post-translational modifications	Post-translational processing: Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Protein degradation Ubiquitin-Proteasome Pathway; Polycistronic and monocistronic. Inhibitors of transcription and translation.	**8**	**CO4**
7	Regulation of gene expression	Concept of operon: Lac and Trp operons, Eukaryotic gene expression, Significance of repressor, Attenuation; histone modifications, Mutation: Spontaneous, induced; Chemical and physical mutagens; Nonsense mutation; Missense mutation; Frame shift mutation; Suppressor mutation.	**9**	**CO5**
8	DNA repair mechanisms	Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, Recombination repair, Translesion DNA synthesis.	**4**	**CO5**

Reference Books:

Lewin B. (2000). Genes VII. Oxford University press

Lodish H, Baltimore D, Berk A, Zipursky SL, Darnell J. (1995). Molecular cell biology.

Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987). Molecular biology of the gene.

Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freman and Co.

Voet, Donald, and Judith G. Voet. *Biochemistry*. New York: J. Wiley & Sons, 1995. Print

e-Learning Source:

https://www.youtube.com/watch?v=TNKWgcFPHqw

https://onlinecourses.nptel.ac.in/noc25_bt35/preview

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				1		1	3	1		
CO2	3	1				1		1	3	1		
CO3	3	1				1		1	3	1		
CO4	3	1	2			1		1	3	1		
CO5	3	1	2			2		1	3	1		

Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080802T/ BS457**	**Title of the Course**	Bioinformatics & Bioanalytical Techniques	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	4	2	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course provides essential knowledge in bioinformatics and bioanalytical techniques, including sequence analysis, protein modeling, and core laboratory methods like electrophoresis, chromatography, and spectroscopy and experimental techniques in biological research						

Course Outcomes	
CO1	Students will learn to analyze biological databases, manage sequence and structure data, understand virus taxonomy resources, perform sequence alignments, use BLAST/FASTA tools, and evaluate alignment significance.
CO2	Students will gain skills in analyzing the protein model, understand molecular phylogenetics, apply appropriate tools, and effectively construct and interpret phylogenetic trees.
CO3	Students will also be justifying their opinion about different forms of microscopy and will access the effectiveness of different forms of centrifuges and electrophoresis
CO4	Students will distinguish between various types of chromatography and spectroscopic techniques for solving industrial and research problems.
CO5	Students will be able to evaluate the radioisotopes in the biological system as well as the principle and practical applications of Geiger Muller counter, Liquid scintillation counter, autoradiography

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Biological Databases	Nucleotide and protein sequence databases, RCSB-PDB, AlphaFold database, NCBI-bibliography databases, PubChem database, Biological file formats, overview of International Committee on Taxonomy of Viruses (ICTV) and Animal Virus Information System (AVIS).	8	CO-1
2	Sequence Alignment	Overview of pairwise and multiple sequence alignment, dynamic programming, scoring matrices, homology searching using BLAST and FASTA algorithm, statistical significance of BLAST and FASTA results.	8	CO-1
3	Protein Structure Prediction	Secondary structure prediction of proteins using Chou-Fasman and GOR methods, tertiary structure prediction of proteins using knowledge-based and Ab initio-based methods, Common online tools for model evaluation and validation.	8	CO-2
4	Molecular Phylogenetics	Overview of molecular evolution and molecular phylogenetics, major assumptions and key terminologies, procedures, methods, and programs for phylogenetic tree construction, evaluation techniques for phylogenetic trees, and common tools and resources for constructing and analyzing phylogenetic trees.	8	CO-2
5	Microscopy and flow cytometry	Microscopy: Simple, compound, phase contrast, fluorescence, confocal microscopy, electron microscopy (TEM & SEM), Flow cytometry, fluorescent activated cell sorting (FACS), Freeze drying.	8	CO-3
6	Centrifugation and Electrophoresis	Types of rotors, techniques and their applications: density gradient and ultra-centrifugation. Electrophoresis: Principle, techniques and applications: capillary electrophoresis, paper and gel electrophoresis (SDS & NATIVE-PAGE, Agarose, Pulse Field gel electrophoresis, 2D-PAGE)	8	CO-3
7	Chromatography and Spectroscopy Techniques	Paper Chromatography, ion-exchange Chromatography, affinity Chromatography, gas chromatography, HPLC, Principle, Theory and applications of UV and VIS spectrophotometry, Fluorescence spectroscopy, atomic absorption, nuclear magnetic resonance, mass spectrometry.	6	CO-4
8	Radiotracer technology	Use of radioactive isotopes in biological system, detection and measurement of isotopes, Geiger-Muller counter, Liquid scintillation counter, autoradiography.	8	CO-5

Reference Books:

Mount, David W., and David W. Mount. Bioinformatics: sequence and genome analysis. Vol. 564. Cold Spring Harbor, NY: Cold spring harbor laboratory press, 2001.

Xiong, Jin. *Essential bioinformatics*. Cambridge University Press, 2006.

Narayanan, P: Essentials of Biophysics, New Age Int. Pub. New Delhi.

Keith Wilson & John Walker: Principles and Techniques of Biochemistry and Molecular Biology.

e-Learning Source:

1.. https://nptel.ac.in/courses/102103044
2. https://nptel.ac.in/courses/102106553

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				1		1	3	1		1
CO2	3	1				1		1	3	1		1
CO3	3	1				3		1	3	1		1
CO4	3	1				2		1	3	1		2
CO5	3	1			1	2	2	1	3	1		2

1.Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26						
Course Code	**B080803T/ BS458**	**Title of the Course**	Industrial Microbiology and IPR	**L**	**T**	**P**
Year	I	**Semester**	II	3	1	0
Pre-Requisite	UG in Biological Science	**Co-requisite**				
Course Objectives	On completion of this course, students will be able to develop an understanding of Industrial microbiology & fermentation contains improved biochemical or physiological fermentation are mainly carried out by fungi and bacteria on large scale to produce commercial products. The main objective of industrial fermentation is to produce highest quality and quantity of particles produce by combining.					

Course Outcomes	
CO1	Students will be able **to explain** the basics of fermentation technology and analyze the growth of microbes.
CO2	Students will be able **to** illustrate the design of a fermenter, media and the process of fermentation
CO3	Students will be able **to** design how to optimize fermentation process and DSP.
CO4	Students will be able **to** develop a process in which microbes can be used for production of important industrial products.
CO5	Students will be able **to** analyze intellectual property rights and evaluate patents.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Industrial Microbiology	Basic principles of fermentation technology, Isolation, screening and maintenance of industrially important strains, Types of fermentations, Growth Kinetics of microbes during fermentation (Batch and continuous).	8	CO-1
2	Fermentation media	Fermentation media-Types of fermentation media, sources of carbon, nitrogen, trace elements, growth factors, precursors, buffers, antifoam agents. Sterilization of media, air and fermenter.	**8**	CO-1
3	General design of fermenter	General design of fermenter, concept and importance of gas exchange and mass transfer and scale-up in microbial fermentation. Processes of fermentation. Basic concept of cell and enzyme immobilization and reactors used for immobilized enzymes	8	CO-2
4	Growth and product formation	Growth and product formation: Definition of primary and secondary metabolites, and their control, screening of new metabolites and isolation approaches of unidentified microbial products. Overproduction of industrially important metabolites by strain improvement; Product recovery and techniques involved in downstream processing	8	CO-3
5	Microbial production of industrially important products I	A brief idea about the products obtained from microbes, commercial production of citric acid and glutamic acid, antibiotics (as penicillin), solvents (ethanol) and vitamins (B12).	8	CO-4
6	Microbial production of industrially important products II	Commercial production of enzymes (Amylase, Protease). Production of single cell protein-Microorganisms and substrates used, techniques of production, merits and demerits of single cell protein.	6	CO-4
7	Intellectual property rights	Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design, copyright and trademark. Issues related to IPR protection of software and database;	6	CO-5
8	Patent and patent application	Requirement of a patentable novelty; Obtaining patent; Invention step and prior art and state of art procedure; Some important case studies. IPR protection of life forms. Patenting biological products and biodiversity. Trade related aspects of Intellectual Property Rights and Budapest treaty.	**8**	CO-5

Reference Books:

1. Principles of fermentation technology by P. Stanbury & Allan Whitekar, Pergamon
2. Press Industrial microbiology by Cruger and Cruger W. Sinauer Associates; Madison,
3. Industrial Microbiology by L.E Casida , John Wiley and sons INC.
4. Prescott and Dunn,s Industral microbiology, 4th edition (1982) by Gerald Reed.

e-Learning Source:

1. https://onlinecourses.nptel.ac.in/noc19_bt20/preview
2. https://onlinecourses.swayam2.ac.in/cec22_bt18/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				1		1	3			
CO2	3	1				1		1			3	
CO3	3	1				1			1		3	
CO4	3	1				2			1		3	
CO5	3	1		2	3	2		2				3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080804T/ BS459**	**Title of the Course**	Microbial Ecology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**4**	**2**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course explores microbial diversity, interactions, and ecological roles, emphasizing biogeochemical cycles, sustainability, and adaptation. It highlights microbial applications in bioremediation, agriculture, industry, and connects microbial ecology with climate change and synthetic ecology, preparing students for research and industry careers.						

Course Outcomes	
CO1	Students will be able to explain microbial interactions, diversity, and ecological roles.
CO2	Students will be able to analyze oxygenic and anoxygenic microbes and bioluminescence
CO3	Students will be able to evaluate microbial contributions to biogeochemical cycles and environmental sustainability.
CO4	Students will be able to apply microbial ecology concepts in bioremediation, agriculture, and industry.
CO5	Students will be able to investigate microbial responses to climate change and design microbial solutions for sustainability.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Microbial ecology**	Introduction to microbial ecology: Definition, scope, and significance; Concepts of habitat, ecological niches, and microbial ecosystems; Biotic community structure	8	CO-1
2	**Microbial interactions**	Microbial interactions: Symbiosis, synergism, commensalism, amensalism, predation, and parasitism; Mycorrhizal associations – structure, characteristics, and their significance in agriculture and forestry; Algal associations with microorganisms and plants, their ecological and functional roles	6	CO-1
3	**Photosynthetic microbes**	Anoxygenic photosynthetic microbes: Characteristics and ecological significance of purple and green sulfur bacteria; Oxygenic photosynthetic microbes: General features of Cyanobacteria and Prochlorales; Role of blue-green algae (BGA) in agriculture and soil fertility enhancement.	6	CO-2
4	**Archaebacteria**	Methanogenic Archaea: General characteristics and ecological significance; Bioluminescent and nitrogen-fixing bacteria: Energy-intensive metabolic processes and their applications; Magnetotactic bacteria: Characteristics, mechanisms, and environmental adaptations.	8	CO-2
5	**Microbial Adaptation**	Microbial interactions in ecological succession and environmental adaptation; Role of microorganisms in oil prospecting; Extremophiles – adaptations and significance of acidophilic, alkalophilic, psychrophilic, thermophilic, and halophilic microbes.	8	CO-3
6	**Microbial cycles**	Microbial involvement in carbon, nitrogen, sulfur, and phosphorus cycles; Role of microbes in decomposition and nutrient recycling; Energy flow dynamics in microbial food chains and food webs.	8	CO-4
7	**Microbial degradation**	Microbial degradation of pollutants, including xenobiotics, petroleum, plastics, and pesticides; Role of microbes in wastewater treatment processes such as activated sludge and biofilms; Microbial ecology of caves and subsurface environments.	8	CO-4
8	**Microbes and climate change**	Microbial contributions to carbon sequestration and climate regulation; Impact of climate change on microbial communities	8	CO-5

Reference Books:

1. Atlas, R. M., & Bartha, R. – Microbial Ecology: Fundamentals and Applications (4th Edition, Benjamin Cummings)
2. Madigan, M. T., Bender, K. S., et al. – Brock Biology of Microorganisms (15th Edition, Pearson)
3. Lynch, J. M., & Hobbie, J. E. – Microorganisms in Action: Concepts and Applications in Microbial Ecology
4. Tiedje, J. M. – Microbial Ecology (Springer-Verlag)

e-Learning Source:

The International Society for Microbial Ecology (ISME) – https://www.isme-microbes.org/

https://nptel.ac.in/courses/105107173

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	3		3	1	1	
CO2	3	1				3	3		3	1	1	
CO3	3	1				3	3		3	1	1	
CO4	3	1				3	3		3	1	3	
CO5	3	1				3	1		3	1	3	

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Effective from Session: 2025-26							
Course Code	**B080805T/ BS488**	**Title of the Course**	Mycology and Plant Microbe Interactions	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	4	2	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to develop an understanding of the fungi, lichen and interaction of microbes to plant and to understand different plant diseases caused by fungi						

Course Outcomes	
CO1	The student will be able to distinguish fungi.
CO2	The student will be able to classify the main groups of fungi.
CO3	The student will be able to evaluate the economic importance of fungi and lichens and their role in ecosystems.
CO4	The student will be able to evaluate the complex plant-microbe interaction in Rhizosphere and phyllosphere.
CO5	The student will be able to distinguish some common Plant Diseases, including their epidemiology and symptoms.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fungi	Contribution of Indian scientist in Mycology; General characters of fungi with special reference to thallus organization and reproduction in fungi. Nutritional types of fungi: biotrophs, hemibiotrophs, symbionts and necrotrophs and life cycle in fungi. Genetic variation in fungi- heterocaryosis and parasexual cycle and their significance. Sex hormones in fungi.	8	CO-1
2	General classification of fungi I	Study of the following main groups of fungi: Myxomycota with special reference to *Stemonitis*; *Plasmodiophormycetes* with special refrence to *Plasmodiophora*; Oomycetes with special reference to Pythium.; *Zygomycotina* with special reference to *Zygorhynchus*;	6	CO-2
3	General classification of fungi II	Study of the following main groups of fungi: Ascomycotina with special reference to Yeasts, *Protomyces, Aspergillus, Taphrina*; Basidiomycotina with special reference to *Puccinia, Agaricus*; Deuteromycotina with special reference to *Alternaria.*	8	CO-2
4	Economic importance of fungi	Lichens: types, biology and physiology of lichen thallus, economic importance of lichens; Mycorhiza. Beneficial uses of fungi in industry, as food: edible mushrooms. Fungi as animal parasites, mycoses of vertebrates types and symptoms. Insect fungus association. Role of saprotrophs in ecosystems.	8	CO-3
5	Plant Microbe interaction	Interaction of microbes in Rhizosphere and phyllosphere. Plant growth promotion and its mechanisms, Biofertilizers and biopesticides. Plant pathogens: Koch's postulates. Classification of plant diseases. Dissemination of phytopathogens. Causal agents of plant diseases. General symptoms of plant diseases. Factors influencing infection, colonization and development of symptoms.	8	CO-4
6	Pathogenesis	Specialization of parasitism, pathogenesis: role of enzymes and toxins in pathogenesis. Genetics of host- pathogen interaction. Defense mechanism in host: effect of infection on host physiology. Control of plant pathogens (plant quarantine; Cultural, Physical, chemical & biological methods of control). Pesticides and their classification. Problems of pesticide hazards and environmental pollution. Integrated Pest Management.	8	CO-4
7	Plant Diseases I	Epidemiology, symptoms, etiology, perennation and control of following diseases: Damping off of seedling and fruit rot- Pythium; Stem gall of coriander-*Protomyces macrospores*; Peach leaf curl-*Taphrina deformans*;	7	CO-5
8	Plant Diseases II	Rust of wheat- Puccinia recondite; Covered smut of barley-*Ustilago hordei*; Leaf spot and shot holes- Alternaria spp. Citrus canker; Tobacco mosaic disease; Root knot of vegetables-Meloidogyne; Abiotic/Non pathogenic diseases – Black tip of mango; Mycotoxins and storage diseases.	**7**	CO-5

Reference Books:

1- Aneja, K.R. & Mehrotra, R.S. (2011). Fungal Diversity & Biotechnology. New Age International Publishers, New Delhi.

2- Alexopoulos, C. J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. 4th edition John Wiley & Sons, USA.

3- Mehrotra, R.S. and Aneja, K.R. (2010). Introduction to Mycology. Wiley Eastern Ltd. New Delhi.

e-Learning Source:

1.https://onlinecourses.nptel.ac.in/noc25_bt33/preview
2.https://onlinecourses.nptel.ac.in/noc23_hs05/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO / **CO**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1							3	1		
CO2	3	1							3	1		
CO3	3	1				1		1	3	1	3	
CO4	3	1			1	1	2	1	3	1		
CO5	3	1			1		1	1	3	1		

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

2-

Integral University, Lucknow

Effective from Session: 2025-26							
Course Code	**B080806P/ BS489**	**Title of the Course**	Bioinformatics and Fermentation Lab.	**L**	**T**	**P**	**C**
Year	**I**	**Semester**	I	**0**	**0**	**8**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To equip students with practical skills and foundational knowledge in bioinformatics tools and techniques, along with basic experimental approaches in fermentation, enabling them to apply theoretical concepts to real-world biological data analysis and microbial process handling.						

Course Outcomes	
CO1	Students will gain the ability to retrieve, analyze, and interpret biological data from major nucleotide, protein, structural, and demonstrate understanding of common biological file formats and virus classification systems and to perform pairwise and multiple sequence alignments, utilize BLAST and FASTA algorithms and to construct phylogenetic tree.
CO2	Learners will acquire proficiency in predicting the secondary and tertiary structure of protein and to evaluate and validate predicted protein structures using standard models.
CO3	Apply and evaluate techniques for isolation, screening, and maintenance of industrially important microbial strains
CO4	Understand and analyze fermenter design, operation and growth kinetics

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Exp-01**	To explore major biological databases for nucleotide, protein, structural, bibliographic, and chemical data, understand biological file formats, and familiarize with virus classification systems and related resources.	6	CO-1
2	**Exp-02**	To understand molecular evolution through the construction, analysis, and evaluation of phylogenetic trees using aligned sequence data and appropriate bioinformatics tools and methods.	6	CO-1
3	**Exp-03**	To predict the secondary and tertiary structures of proteins using computational approaches such as Chou-Fasman, GOR method, knowledge-based, and Ab initio modeling tools.	6	CO-2
4	**Exp-04**	To evaluate and validate predicted protein structures using standard model assessment tools such as Ramachandran plot, PROCHECK, and MolProbity.	6	CO-2
5	**Exp-05**	To perform and analyze pairwise and multiple sequence alignments using BLAST and FASTA algorithms, apply scoring matrices, and interpret the statistical significance of sequence alignment results for homology search.	6	CO-1
6	**Exp-06**	To explore major biological databases for nucleotide, protein, structural, bibliographic, and chemical data, understand biological file formats, and familiarize with virus classification systems and related resources.	6	CO-2
7	**Exp-07**	Isolation and screening of industrially important microbial strains	6	CO-3
8	**Exp-08**	Growth kinetics of microorganisms during batch fermentation	6	CO-3
9	**Exp-09**	Studying effect of carbon/nitrogen sources on any one or few parameter(s) of fermentative process.	6	CO-4
10	**Exp-10**	Study of general design of a fermenter	6	CO-4

Reference Books:

1.Mount, D. W. (2004). Bioinformatics: Sequence and Genome Analysis (2nd ed.). Cold Spring Harbor Laboratory Press.
2. Karp, G. (2013). Cell and Molecular Biology: Concepts and Experiments (7th ed.). Wiley.
3. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). Principles of Fermentation Technology (3rd ed.). Elsevier.
4. Crueger, W., & Crueger, A. (2000). Biotechnology: A Textbook of Industrial Microbiology (2nd ed.). Panima Publishing.
5. Cappuccino, J. C., & Sherman, N. (1992). Microbiology: A Laboratory Manual. Addison Wesley Pub. Co.

e-Learning Source:

1.	https://archive.nptel.ac.in/courses/102/105/102105058/
2.	https://onlinecourses.nptel.ac.in/noc24_bt03/preview

Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1			3	3	3	3	2	1	3	2
CO2	3	1			3	3	3	3	2	2	3	2
CO3	3	1					3	3	2	2	3	2
CO4	3	1					3	3	2	3	3	2

1.Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HOD**

Integral University, Lucknow
Department of Biosciences

Evaluation Scheme of Under Graduate Program as per NEP-2020 Guidelines (Microbiology)

w.e.f. Session 2025-26

CERTIFICATE IN MICROBIOLOGY

Year: First / Semester: First (Odd Semester)

S. N.	Course Code	Course Title	Theory / Practical	Course Type	Periods/ Per week			Continuous Assessment			End Semester Examination (ESE)	Subject Total	Total Credit Points	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture (L)	Tutorial (T)	Practical (P)	Class Test (CT)	Teacher Assessment (TA)	Total				mplo abili y	Entre ene ursh p	Skill Develo pment	Gend e r Equa i ty	nviron m ent & ustain abi lity	Huma n Value	Profe ssion al Ethics	
1	B080701T/ BS440	Microbial Taxonomy and General Microbiology	Theory	Core Major (Compulsory)	3	1	0	15	10	25	75	100	04			✓					
2	B080702T/ BS447	Microbial Cytology and Genetics	Theory		3	1	0	15	10	25	75	100	04	✓	✓	✓		✓			
3	B080703T/ BS448	Soil and Agricultural Microbiology	Theory		3	1	0	15	10	25	75	100	04	✓		✓					
4	B080704T/ BS449	Biomolecules and microbial metabolism	Theory		3	1	0	15	10	25	75	100	04	✓	✓	✓					
5	**B080705P/ BS468**	General Microbiology and Biochemistry Lab.	Practical		0	0	4	15	10	25	75	100	02	✓	✓	✓		✓			
TOTAL					**12**	**4**	**4**	**75**	**50**	**125**	**375**	**500**	**18**								

Integral University, Lucknow
Department of Biosciences

Evaluation Scheme of Under Graduate & Post Graduate Program as per NEP-2020 Guidelines
w.e.f. Session 2025-26

CERTIFICATE IN MICROBIOLOGY

Year: First / Semester: Second (Even Semester)

S. N.	Course Code	Course Title	Theory / Practical	Course Type	Periods/ Per week			Continuous Assessment			End Semester Examination (ESE)	Subject Total	Total Credit Points	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture (L)	Tutorial (T)	Practical (P)	Class Test (CT)	Teacher Assessment (TA)	Total				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
1	**B080801T/ BS450**	Molecular Biology	Theory	Core Major (Compulsory)	3	1	0	15	10	25	75	100	04	✓		✓					
2	**B080802T/ BS457**	Bioinformatics & Bioanalytical Techniques	Theory		3	1	0	15	10	25	75	100	04	✓				✓			
3	**B080803T/ BS458**	Industrial Microbiology and IPR	Theory		3	1	0	15	10	25	75	100	04	✓		✓					
4	**B080805T/ BS488 or B080804 T/ BS459**	1. Microbial Ecology 2. Mycology and Plant Plant-Microbe Interaction	Electives		3	1	0	15	10	25	75	100	04	✓	✓	✓		✓			
5	**B08080 6P/ BS489**	Bioinformatics and Fermentation Lab. (Pract 2+2)	Practical		0	0	4	15	10	25	75	100	02	✓	✓	✓		✓		✓	
6	**B100806P/BS490**	Educational/ Industrial tour	Tour		0	0	8	0	0	0	100	100	04	✓	✓	✓		✓	✓	✓	
TOTAL					**12**	**4**	**12**	**75**	**50**	**125**	**475**	**600**	**22**								

Integral University, Lucknow
Department of Biosciences
Evaluation Scheme of Undergraduate & Post Graduate Program as per NEP-2020 Guidelines
w.e.f. Session 2025-26

DIPLOMA IN MICROBIOLOGY

Year: Second / Semester: Third (Odd Semester)

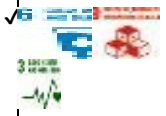
S. N.	Course Code	Course Title	Theory / Practical	Course Type	Periods/ Per week			Continuous Assessment			End Semester Examination (ESE)	Subject Total	Total Credit Points	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture (L)	Tutorial (T)	Practical (P)	Class Test CT)	Teacher Assessment (TA)	Total				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainabilt y	Human Value	Professional Ethics	
1	**B080901T/ BS540**	Recombinant DNA Technology	Theory	Core Major (Compulsory)	3	1	0	15	10	25	75	100	04	✓		✓					
2	**B080902T/ BS547**	Medical Microbiology	Theory		3	1	0	15	10	25	75	100	04	✓	✓	✓					
3	**B080903T/ BS548**	Fundamentals of infection and Immunity	Theory		3	1	0	15	10	25	75	100	04	✓	✓	✓					
4	**B080904P/ BS549**	rDNA Technology/Immunology Lab	Practical		0	0	4	15	10	25	75	100	02	✓		✓		✓		✓	
5	**B110905R/BS520**	Research Project/ Internship-III **(4-Credit)**	Internship		0	0	12	15	10	25	75	100	06	✓	✓	✓		✓	✓	✓	
TOTAL					**9**	**3**	**16**	**75**	**50**	**175**	**375**	**500**	**20**								

* The Evaluation Scheme for the Project Work

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Research Project/ Internship-III	**B110905R/BS520**	200	100	100	400

Integral University, Lucknow
Department of Biosciences
Evaluation Scheme of Under Graduate & Post Graduate Program as per NEP-2020 Guidelines
w.e.f. Session 2025-26

DIPLOMA IN MICROBIOLOGY **Year: Second / Semester: Fourth (Even Semester)**

S. N.	Course Code	Course Title	Theory / Practical	Course Type	Periods/ Per week			Continuous Assessment			End Semester Examination (ESE)	Subject Total	Total Credit Points	Attributes							United Nations Sustainable Development Goals (SDGs)
					Lecture (L)	Tutorial (T)	Practical (P)	Class est (CT)	Teacher Assessment (TA)	Total				Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
1	**B081001T/ BS550**	Food and Dairy Microbiology	Theory	Core Major (Compulsory)	3	1	0	15	10	25	75	100	04	✓	✓	✓		✓		✓	
2	**B081002T/ BS554**	Virology and Biosafety (Th-4)	Theory		3	1	0	15	10	25	75	100	04	✓	✓	✓					
3	**B081005P/ BS557**	Food and Environmental Lab	Practical		0	0	4	15	10	25	75	100	02	✓	✓	✓		✓		✓	
	B081003T/ BS555 **B081004T/ BS556**	1. Environmental Microbiology 2. Pharmaceutical and Applied microbiology	Electives		3	1	0	15	10	25	75	100	04	✓	✓	✓					
4	**B111005R/BS 530**	Research Project-IV **(4-Credit)**	Research Project		0	0	4	15	10	25	75	100	02	✓	✓	✓					
TOTAL					**9**	**3**	**8**	**75**	**50**	**125**	**375**	**500**	**16**								

* The Evaluation Scheme for the Project Work

	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Research Project-IV	**B111005R/BS530**	200	100	100	400

Cumulative minimum credits (Required for the award of certificates/ diploma/degree)			Subject I	Subject II	Subject III	Vocational	Co-curricular**	Audit Course*	Industrial training Survey/ Research project	Minimum Credits (Year)
			Major	Major	Minor Elective	Minor	Minor	Compulsory	Major	
			4/5/6 Credits	4/5/6 Credits	4/5/6 Credits	3 Credits	2 Credits	Non-credits	4/6 Credits	
	Y.	Sem.	Own Faculty	Other Faculty	Other Faculty	Vocational/ Skill development course	Co-curricular (Qualifying)	Audit Course (Q & NC)	Inter/Intra Faculty related to main subject	
1-Year PG Degree										
(120 + 40 = 160 1-Year M.Sc. Microbiology	1	I	Microbial taxonomy and General Microbiology (Th-4) **B080701T/ BS440**							**40** (First Year)
			Microbial cytology and Genetics (Th-4) **B080702T/ BS447**							
			Soil and Agricultural Microbiology (Th-4) **B080703T/ BS448**							
			Biomolecules and microbial metabolism (Th-4) **B080704T/ BS449**							
			General Microbiology and Biochemistry Lab. (Pract 2+2) **B080705P/ BS468**							
		II	Molecular Biology (Th-4) **B080801T/ BS450**					Educational/ Industrial tour **B100806P/BS490**		
			Bioinformatics & Bioanalytical techniques (Th-4) **B080802T/ BS457**							
			Industrial Microbiology and IPR (Th-4) **B080803T/ BS458**							
			Microbial Ecology (El Th-4) **B080804T/ BS459** Mycology and Plant microbe interaction (El Th-4) **B080805T/ BS488**							
			Bioinformatics and Fermentation Lab. (Pract 2+2) **B080806P/ BS489**							
2-Year PG Degree										
(160 + 40 = 200 2-Year M.Sc. Microbiology	2	III	Recombinant DNA Technology (Th-4) **B080901T/ BS540**						Research Project/ Internship-III **(4-Credit) B110905R/BS520**	**40** (Second Year)
			Medical Microbiology (Th-4) **B080902T/ BS547**							
			Fundamentals of infection and Immunity (Th-4) **B080903T/ BS548**							
			rDNA Technology/Immunology Lab (Pract 2+2) **B080904P/ BS549**							
		IV	Food and Dairy Microbiology (Th-4) **B081001T/ BS550**						Research Project-IV **(4-Credit) B111005R/BS530**	
			Virology and Biosafety (Th-4) **B081002T/ BS554**							
			Environmental Microbiology(El Th-4) **B081003T/ BS555** Pharmaceutical and Applied microbiology (El Th-4) **B081004T/ BS556**							
			Food and Environmental Lab (Pract 2+2) **B081005P/ BS557**							

- ✓ T-4 = Theory with 4 credits; P-2 = Practical with 2 credits; R = Research Project with 4 credits; Q: Qualifying; NC = Non-Credit.
- ✓ Co-curricular courses offered by UP higher education.
- ✓ Vocational courses offered by respective Department/University
- ✓ *Audit Courses: The respective Department/University offers Rashtra Gaurav and X+AI (Advanced Application of Artificial Intelligence in Chemical Sciences) as compulsory **Non-Credit** courses. All students will have to pass these courses for obtaining a Certificate, Diploma, Undergraduate Degree, or Undergraduate Honors Degree with Research only once.
- ✓ **Regional Language is a co-curricular course offered by the respective Department or University in the third semester, such as Hindi, Urdu, Awadhi, Sanskrit, etc.
- ✓ 01, 02, and 03 combinations are elective papers, out of which students must choose any one with a minimum of ten students' strengths.
- ✓ For entry into the 4-Year UG Degree with Hons and Research program, students must secure ≥75% marks in the 3-Year UG Degree program.
- ✓ Students with a 3-Year Single Subject with Hons UG Degree below 75% marks in the 3-Year UG Degree program go for a two-year PG program.