Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS441	**Title of the Course**	General Microbiology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course aims to provide students with an understanding of general microbiology, contribution of microbiology to human life for various daily needs. The knowledge is used in health care for prevention of diseases, diagnosis, sterilization methods and drug production. Further, the knowledge is also extended into food production, production of alcohol, in agriculture, leather industry, etc						

Course Outcomes	
CO1	Know about the history and development of Microbiology, taxonomy, genetic relationship
CO2	Know about control and culturing of the microbes
CO3	Know about the distinguished characteristics, morphology and importance of microbes
CO4	Learn the preparation and use of culture media, Pure culture and cultural characteristics & preservation methods of microbes
CO5	Know about the growth phases – kinetics, asynchronous, synchronous, batch and continuous culture

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. Main outline of bacterial classification. General characteristics and importance of Viruses, Chlamydia, Rickettsia, Mycoplasma, Bacteria and Actinomycetes.	8	CO-1
2	Culture and control of microorganisms	Physical and chemical methods of control of microorganisms. Multidrug resistance in Microbes: importance & mechanisms. Microbial Culture techniques – principles and selective factors employed, enrichment systems –single cell isolation methods.	8	CO-2
3	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
4	Bacterial Nutrition	Study of microbes - Preparation and use of culture media. Pure culture and cultural characteristics. Principles and methods of preservation of bacteria, yeasts and molds Bacterial Nutrition: Major nutritional types of bacteria, Microbial requirements of C, N, S, P, and microelements, growth factors, etc.	8	CO-4
5	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. Gerherdt P, Murray RG, Wood WH. Kreig, NR (1994) Methods for General and Molecular Bacteriology, ASM, Washington DC
2. Madigan MT, Martinko JM, Parker J. (1997) Biology of Microorganisms, Prentice Hall International Inc
3. Pelczar Jr. MJ, Chan ECS, Krieg NR (1993). Microbiology – Mc Graw Hill. Inc, New York
4. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1992). General Microbiology, Mac Millan Education Ltd. London

e-Learning Source:

	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				2	2	1	3			
CO2	3	1					2	1	3			
CO3	3	1				2		1	3			
CO4	3	1				2		1	3		3	
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: 2020-21							
Course Code	BS442	**Title of the Course**	Biophysical methods	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objectives of this course are to provide the students with the understanding of various analytical techniques used in biotechnology-based research and industry. The course will acquaint the students with the various instruments, their configuration and principle of working, operating procedures, data generation and its analysis.						

Course Outcomes	
CO1	To understand and learn various microscopy techniques used in biotechnology field.
CO2	To understand and learn isolation of cellular fractions-separation, purification of proteins and amino acids, assay techniques for enzymes.
CO3	Demonstrate principle and working of centrifugation and chromatography techniques.
CO4	To learn the principles and applications of molecular techniques in microbiology.
CO5	To learn principles and applications of various biophysical techniques used in the determination of biopolymer structures.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microscopy	Principles and application of light phase contrast, fluorescence microscopy, scanning and transmission electron microscopy.	8	CO-1
2	Isolation of cellular fractions	Separation, purification of proteins and amino acids, assay techniques for enzymes. Methods for lysis of plant, animal and microbial cell. Ultrafiltration, freeze drying and fractional precipitation. Use of detergents in isolation of membrane proteins.	8	CO-2
3	Centrifugation	Ultracentrifugation - velocity and buoyant density determination. Density gradient centrifugation, molecular weight determination. Chromatography: Basic principles and applications of ion-exchange, types of ion- exchange resins, gel filtration, partition, affinity, HPLC and reverse phase chromatography, gas chromatography, TLC, Paper chromatography. Chromatofocussing.	8	CO-3
4	Principles and applications of molecular techniques in microbiology	Electrophoresis: Agarose Gel electrophoresis, PAGE, Isoelectric focusing, capillary electrophoresis. Pulse field gel electrophoresis. RFLP, RAPD, ARDRA, RISA, Western, Northern and Southern blotting, FISH, Fluorescent activated cell sorting (FACS).	8	CO-4
5	Determination of biopolymer structure	Principles and applications: X-ray diffraction, fluorescence , UV, visible, CD/ORD, ESR, NMR and Mass spectroscopy, Atomic Absorption Spectrophotometer, Plasma emission spectroscopy.	8	CO-5

Reference Books:

1. Protein Purification by Robert Scopes, Springer Verlag Publication
2. 1982 Tools in Biochemistry David Cooper
3. Methods of Protein and Nucleic acid Research, Osterman Vol I – III
4. Centrifugation D. Rickwood
5. Practical Biochemistry, V th edition, Keth, Wilson and Walker

e-Learning Source:

	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	
CO2	3	1		3		3		3			3	
CO3	3	1		3		3		3			3	
CO4	3	1		3		3		3			3	
CO5	3	1		3		3	1	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: 2020-21							
Course Code	BS443	**Title of the Course**	Biomolecules	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To understand the basics of the understanding of biomolecules, the basic building blocks of living organisms, focusing on their structural underpinnings, unique properties, biological roles and functions and inter relations. Emphasis will be on the association between structure and function of various biomolecules at a chemical level with a biological perspective.						

Course Outcomes	
CO1	The students will learn about carbohydrate types structure and functions.
CO2	The students will learn about lipids: Definition and classification of lipids.
CO3	The students will learn about proteins and amino acids structure, classification and functions.
CO4	The students will learn about Nucleic acids (DNA and RNA), their composition, structure and functions
CO5	The students will learn about water- and fat-soluble vitamins functions

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Carbohydrates	Definition, classification, structure and functions of carbohydrates; Stereoisomerism, aldoses and ketoses; Important classes of monosaccharides, disaccharides, Structural and storage polysaccharides and mucopolysaccharides.	8	CO-1
2	Lipids	Lipids: Definition and classification of lipids. Nature of fatty acids. Role of triglycerides in energy storage and phospholipids in membrane formation, sterols, pigments.	8	CO-2
3	Proteins	Proteins: Nature of naturally occurring amino acids, Structure and functions of proteins (primary, secondary, tertiary and quaternary structure), Forces responsible for maintenance of protein structure	8	CO-3
4	Nucleic acids	. Nucleic acids: Composition of nucleic acids (ribo and deoxyribonucleic acids); Nucleosides, nucleotides and polynucleotides. Structure and function of DNA and RNA. Types of DNA: A, B and Z DNA, their structure and significance; Physical & biochemical properties of RNA: tRNA, rRNA, mRNA and hnRNA; Primary, secondary, and tertiary structures of RNA	8	CO-4
5	Vitamins:	Vitamins: Fat soluble and water soluble vitamins; elementary ideas about the physiological functions and deficiency diseases; Role of water soluble vitamins as co-enzyme precursor	8	CO-5

Reference Books:

1. Eckstein F, Lilley DM (1996). Catalytic RNA. Springer Verlag.
2. Freidberg EC, Walker GC, Siede W. (1995). DNA Repair and Mutagenesis, ASM Press.
3. Freifelder D. (1991). Molecular Biology. Narosa Publishing House
4. Gardener EJ, Simmons MJ, Snustad DP. (1991). Principles of Genetics, John Wiley & Sons.

e-Learning Source:

	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		3		
CO2	3	1						1		3		
CO3	3	1						1		3		
CO4	3	1						1		3		
CO5	3	1						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: 2020-21							
Course Code	BS444	**Title of the Course**	Microbial Cytology and Genetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	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 explain prokaryotic cell organization, bacterial cell wall synthesis and details about antibiotics mechanism and development of antibiotic resistance.
CO2	The students will be able to describe eukaryotic cell organization, membrane function and transport, cytoskeletal elements and genetic organization.
CO3	The students will be able to discuss cell division in eukaryotes, cell cycle checkpoints and its regulation and various pathways of cell proliferation and apoptosis.
CO4	The students will be able to explain basics and mechanism of signal transduction, Quorum sensing and Biofilms.
CO5	The students will be able to explain 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, prokaryotic genome.	8	CO-1
2	Eukaryotic Cell Organization and protein targeting	Membrane biology: Structure, function, membrane protein transport in eukaryotes. Structure and functions of cell organelles, Cytoskeleton (structural proteins- microfilaments, actins, etc.), genetic organization (euchromatin, heterochromatin, Nucleosome model), concept of protein targeting.	8	CO-2
3	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	CO-3
4	Cell Communication	Basics of signal transduction: Role of calcium, cAMP, G-proteins, inositol phosphates, phospholipases and protein kinases in signal transduction, Quorum sensing, Biofilms and their application.	8	CO-4
5	Microbial Genetics	Gene transfer mechanisms in bacteria: Transduction: Generalized, restricted; Transformation: Discovery, competence development, molecular mechanism of DNA uptake; Conjugation: mechanism; mapping; Transposons in prokaryotes: Simple, composite, and complex transposons, Mechanism of transposition; Retrotransposons.	8	CO-5

Reference Books:

1. Alberts Bruce (1985) Molecular Biology of Cell. Garland Pub
2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry Edition , John Wiley and Sons, New Delhi.
3. De Robertis E. D. P. and De Robertis E. M. F. (1987), Cellular and Molecular Biology Lea and Febiger, Philadelphia.
4. Schlegel Hans G. (1995) General Microbiology, Edition 7, CUP, Cambridge.
5. Stanier R. Y., Adelberg E. A., Ingraham J. L., (1976) General Microbiology, 4th edition, Mac Millan Press, London.
6. Lodish H, Berk A, Zipursky SL et al. (2000) Molecular Cell Biology, 4th edn. New York: WH Freeman.
7. Joanne M. Willey, Linda M. Sherwood, Christopher J. Woolverton. Prescott's principles of microbiology, New York : McGraw-Hill, 2012.

e-Learning Source:

	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				2	1	1		3		
CO2	3	1				2	1	1		3		
CO3	3	1				2		1		3		
CO4	3	1				2		1		3		
CO5	3	1				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:							
Course Code	BS445	**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	Comprehend the physical, chemical and biological properties of soil and their importance.
CO2	Have in depth knowledge of the role of microorganisms in plant growth particularly in rhizosphere and phyllosphere.
CO3	Develop an understanding of the microbiology and physiology of C and N cycle specifically degradation of native and organic matter and biological nitrogen fixation.
CO4	Have knowledge of microbial transformation of elements as Phosphorus, Iron and Manganese
CO5	Get insight of the types, production process, application methods and quality control of microbial biofertilizers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Soil Microbiology	Structural and textural classes; Physico-chemical and biological properties of soil, soil enzymes, 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, influence of rhizosphere on crop productivity, plant growth promotingbacteria, biological control within microbial communities of rhizosphere, role of antibiotics and siderophore in biocontrol of plant pathogens, Induced resistance: Phytoalexins	8	CO-2
3	Biogeochemical cycles	Carbon cycle: aerobic and anaerobic decomposition of native and added organic matter, lignolytic and cellulolytic microorganisms. Nitrogen cycle: symbiotic and asymbiotic nitrogen fixation, Ammonification, nitrification, denitrification	8	CO-3
4	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
5	Biofertilizers	Definition and status of biofertilizer, types of biofertilizers. Nitrogenous and phosphatic biofertilizers - Rhizobium, Azotobacter, Azospirillum, Frankia, Vesicular Arbuscular Mycorrhiza and PSB/PSF Technologies for the production of biofertilizers. Methods of inoculation on seed and in soil. Quality control of biofertilizers.	8	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					2	1	3		1	
CO2	3	1				2	2	1	3		1	
CO3	3	1					2	1	3	2		
CO4	3	1					2	1	3	2		
CO5	3	1			1	2	2	1	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: 2020-21							
Course Code	BS446	**Title of the Course**	General Microbiology lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	0	0	6	3
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course has been designed to provide the students a practical hand on various biochemical assays that are being used on regular basis in the biochemistry labs i.e. tests for carbohydrates, proteins, amino acids, cholesterol, DNA and RNA. In addition, student will also perform microbiology experiments i.e. detection of gram positive and negative bacteria, preparation on culture media sterilization and growth pattern in bacteria etc.						

Course Outcomes	
CO1	Know the principles and instruments used in microbiology and various techniques.
CO2	Students will learn pure culture techniques and know how to enumerate microbes from soil samples.
CO3	Know how to perform Gram staining, spore staining for bacteria, and fungal staining followed by microscopic examination and biochemical identification of bacteria.
CO4	Students will know how to determine bacterial motility and isolate Rhizobium from nodules.
CO5	Students will also be able to perform biochemical estimations of macromolecules in a given sample.

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	General instructions, Microbiology laboratory and its discipline.	6	CO-1
Exp-02	Handling of microscopes, Calibration and measurement of microscopic objects.	6	CO-1
Exp-03	Cleaning of glassware and sterilization. Preparation and use of glassware cleaning solutions, sterilization.	6	CO-1
Exp-04	Pure culture techniques: serial dilution, pour plate, spread plate, streak plate methods	6	CO-2
Exp-05	Enumeration of bacteria, fungi and actinomycetes from soil samples.	6	CO-2
Exp-06	Culture and microscopic examination of bacteria by staining methods - Gram's, capsule and spore staining.	6	CO-3
Exp-07	Culture and microscopic examination of fungi by Lacto-phenol cotton blue staining.	6	CO-3
Exp-08	Identification techniques: morphological and biochemical identification of bacteria using Bergey's Manual of Determinative Biology	6	CO-3
Exp-09	Motility of bacteria.	6	CO-4
Exp-10	Isolation of Rhizobium from nodules	6	CO-4
Exp-11	Estimation of carbohydrates, protein, DNA, RNA, and chlorophyll	6	CO-5

Reference Books:

1. Cappuccino, J. C. and Sherman, N. (1992). Microbiology: A laboratory manual, Addison Wesley Pub. Co
2. Benson HJ (1994). Microbiological Applications, WmC Brown Publishers, Oxford.
3. Collins C.H, Lyne P.M, (1985). Microbiological methods. Butterworths, London.
4. Rhodes P.M, Stanbury P.F. Applied Microbial Physiology - A practical approach. IRL Press, Oxford University Press, Oxford.
5. Wilson K, Walker J. (1995) Practical Biochemistry Principles and Techniques, Cambridge University Press
6. K.R. Aneja Bergey's Manual of Determinative Bacteriology

e-Learning Source:

	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	3	1			3		3	1		3	2
CO2	3	3	1			3	1	3	3		3	2
CO3	3	3	1			3		3	3		3	2
CO4	3	3	1			3		3	3		3	2
CO5	3	3	1			3		3		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: 2020-21							
Course Code	BS451	**Title of the Course**	Microbial Metabolism	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG with Biological Science	**Co-requisite**					
Course Objectives	On completion of this course, students will be able to develop an understanding of catabolism, anabolism, regulation of metabolism and pathway analysis. It also gives understanding of how enzymes and metabolites in living system work to produce energy and synthesizing different biomolecules. The course also imparts comprehensive knowledge about biochemical pathways involved in intermediary metabolism of carbohydrate, protein, lipid and nucleic acid.						

Course Outcomes	
CO1	Understand the concept of enzymes and enzyme kinetics
CO2	Comprehend the carbohydrate metabolism, significance of glycolysis and ETC
CO3	Acquire knowledge about the metabolism of lipids, amino acids and nucleic acids.
CO4	Understand the basics of microbial degradation of Xenobiotics and Fermentation: Special pathways for primary attack on organic compounds by microorganisms
CO5	Have knowledge about the Nitrogen metabolism and Biological nitrogen fixation

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Enzymes	Classification, properties and factors influencing enzyme activity, co-enzymes, prosthetic group and co-factors, Lock & key hypothesis, induced fit hypothesis, Enzyme kinetics: Michelis Menten equation, Lineweaver-Burk plot, Enzyme inhibition, Allosteric enzymes	8	CO-1
2	Aerobic and anaerobic metabolism in bacteria	Aerobic and anaerobic metabolism in bacteria - role of ATP, reducing powers and Biochemistry of catabolic reactions in aerobic heterotrophs: Glycolysis, hexose monophosphate shunt and Entner doudoroff pathways, TCA cycle, Role of glyoxylate cycle in acetic acid oxidation. Electron transport chain and oxidative phosphorylation, Gluconeogenesis	8	CO-2
3	Metabolism of lipids, amino acids and Nucleic acids	Oxidation of fatty acid (beta-oxidation) and its biosynthesis. Metabolism of amino acids. Biosynthesis and degradation of nucleotides	8	CO-3
4	Microbial degradation of Xenobiotics and Fermentation	Special pathways for primary attack on organic compounds by microorganisms, Catabolic reactions of anaerobic chemohetrotrophs, Anaerobic respiration and fermentation. Autotrophic nutrition of microorganisms. Bacterial photosynthesis	8	CO-4
5	Nitrogen metabolism	Biological nitrogen fixation: nitrogenase enzymes, structure and properties, nif' gene: regulation and functions. Physiology and biochemistry of nitrogen fixation, denitrification, nitrate and nitrite reduction, sulphate and sulphur reduction, H_2S formation, deamination and transamination. Utilization of various nitrogen sources (ammonia, urea, nitrate, amino acids) by bacteria.	8	CO-5

Reference Books:

1. Brock ―Biology of Microorganisms
2. Brown, T.A. ―Gene cloning: An introduction
3. Freifelder, DM ―Molecular Biology
4. Lehninger ―Biochemistry
5. Levine- Genes

e-Learning Source:

	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		3		
CO2	3	1						1	3	3		
CO3	3	1						1		3		
CO4	3	1					1	1	3	3		
CO5	3	1					2	1	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: 2020-21							
Course Code	MT412	**Title of the Course**	Bioinformatics and Biostatistics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To understand the basics of the computer bioinformatics and statistical analysis						

Course Outcomes	
CO1	To understand the Basics of computers.
CO2	To understand the biological data formats
CO3	To understand the mechanisms of sequence analysis.
CO4	To understand the biostatistics
CO5	To understand the correlation analysis

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of computers	Block diagram of computer, input and output devices, storage devices, operating systems – DOS, Windows, Linux. Basics of networking and their types, topologies, INTERNET: TCP/IP, World Wide Web, e-mail etc.	8	CO-1
2	Biological data file formats	*.FASTA, *.PIR, *.GDE, *.PDB, Alignment files (*.ALN) etc. Search engines: ENTREZ, DBGET, SRS etc. Primary nucleotide sequence atabases: Genbank, EMBL, DDBJ; Primary Protein sequence databases: SwissProt, Protein information resources, TREMBL. Etc. Secondary databases: PROSITE, PRINTS, BLOCKS, PFAM.; Microbiology DATABASES: ICTV, Animal Virus Information System (AVIS).	8	CO-2
3	Sequence analysis – Pair wise Sequence Alignment	Needleman wunsch, Smith Watermann algorithms, Sequence similarity search programs – BLAST and FASTA. Substitution matrices: PAM, BLOSSUM. Multiple sequence alignments: Center Star method, Clustal, PRAS. Phylogenetic analysis: Character based (Parsimony) and distance-based methods (UPGMA, neighbor joining), Protein structure prediction: Homology modeling, Primer Designing, Multi dimentional protein identification technology – identification using database.	8	CO-3
4	Biostatistics	Measures of central tendency – mean (arithmetic, harmonic & geometric) median and mode; Measures of dispersion- range, quartile deviation, mean deviation and standard deviation. Coefficient of variation.	8	CO-4
5	Correlation analysis	Positive and negative correlation, Karl Pearson‘s coefficient of correlation, Spearman‘s rank correlation. Regression analysis: regression line Y on X and X on Y, angle between two regression lines. Test of significance: null and alternative hypothesis, level of significance, Z-test, Student_t‘-test, Chi-square test for goodness of fit and independence of attributes.	8	CO-5

Reference Books:

1. Developing Bioinformatics Computer Skills: Cynthia Gibas & Per Jambeck – 2001
2. Shroff Bioinformatics Basics: Applications in Biological Science and Medicine – 2002
3. HH Rashidi & LK Buehler, CRC Press, London Bioinformatics: Sequence, structure and databanks – 2000
4. Des Higgins & Willie Taylor – Bioinformatics: A practical guide to the analysis of genes and proteins – 2001
5. AD Baxevanis & BFF Ouellette – Wiley Interscience – New York
6. Biostatistics (1996) Arora PN & Malhon PK – Imalaya Publishing House, Mumbai. Primer of Biostatistics – Stanton A & Clantz – The McGraw Hill Inc., New York

e-Learning Source:

	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				2		1		3	2	
CO2	3	1				2		1		3	2	
CO3	3	1				2		1		3	2	
CO4	3	1				2		1				3
CO5	3	1				3		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: 2020-21							
Course Code	BS452	**Title of the Course**	Molecular Biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To develop in students the 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	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. σ or Rolling circle replication in ϕX174.	8	CO-1
2	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	CO-2
3	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	8	CO-3
4	Post – transcriptional and post-translational 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. Post-translational processing: Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Protein degradation Ubiquitin-Proteosome Pathway; Polycistronic and monocistronic. Inhibitors of transcription and translation.	8	CO-4
5	Regulation of gene expression	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, DNA repair mechanisms: Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, Recombination repair, Translesion DNA synthesis.	8	CO-5

Reference Books:

1. Lewin B. (2000). Genes VII. Oxford University press.
2. Lodish H, Baltimore D, Berk A, Zipursky SL, Darnell J. (1995). Molecular cell biology.
3. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987). Molecular biology of the gene.
4. Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freman and Co.
5. Voet, Donald, and Judith G. Voet. *Biochemistry*. New York: J. Wiley & Sons, 1995. Print

e-Learning Source:

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

	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				1		1		3		
CO5	3	1				1		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:							
Course Code	BS453	**Title of the Course**	Industrial Microbiology & Fermentation Technology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
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	Know the basics of fermentation technology.
CO2	Have insight to the general design of fermenter, media and the process of fermentation
CO3	Understand the relation between growth and product formation, optimization of fermentation process and DSP.
CO4	Have knowledge of how microbes are used for production of important industrial products.
CO5	Have basic knowledge of intellectual property rights specially 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). Fermentation media-Types of fermentation media, sources of carbon, nitrogen, trace elements, growth factors, precursors, buffers, antifoam agents, sterilization of media	8	CO-1
2	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
3	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
4	Microbial production of industrially important products	A brief idea about the products obtained from microbes, commercial production of citric acid and glutamic acid, antibiotics (as penicillin), solvents (ethanol), vitamins (B12), enzymes (Protease). Production of single cell protein- Microorganisms and substrates used, techniques of production, merits and demerits of single cell protein.	8	CO-4
5	Intellectual property rights	Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design copyright and trademark. Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms. Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on 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	1	3			
CO2	3	1				1		1			3	
CO3	3	1				1		1	1		3	
CO4	3	1				2		1	1		3	
CO5	3	1		3	3	2	1	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:							
Course Code	BS454	**Title of the Course**	Microbial Diversity	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	On completion of this course, students will be able to develop an understanding of microbial diversity						

Course Outcomes	
CO1	Microbial ecology – concepts of Niche, habitat, ecosystem etc.
CO2	Microbial interactions: symbiosis, synergism, fungal and algal association with plants.
CO3	General characteristic of purple and green sulphur bacteria, Cyanobacteria and Prochlorales, BGA in agriculture.
CO4	Methanogenic Archeobacteria—General characteristics. Bioluminescent and nitrogenfixing bacteria. Magnetotactic bacteria
CO5	Microorganisms in prospecting of oils Extremophiles- Acidophilic, alkalophilic, psychrophilic, thermophilic and halophilic microorganisms

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microbial ecology	Concept of habitat and ecological niches, Ecosystem, Energy flow, food chain, food web, biotic community concept, Microbial succession, adaptation and natural selection of microbial population.	8	CO-1
2	Microbial interactions	Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism, Mycorrhizal associations-structure, characteristics and their role in Agriculture and Forestry, Algal association with other microorganisms and plants	8	CO-2
3	Photosynthetic microbes	Anoxygenic photosynthetic microbes General characteristic of purple and green sulphur bacteria. Oxygenic photosynthetic microbes- General characteristics of Cyanobacteria and Prochlorales; Role of blue green algae (BGA) in agriculture	8	CO-3
4	Archeobacteria	Methanogenic Archeobacteria—General characteristics. Bioluminescent and nitrogenfixing bacteria- A high energy spending bacteria. Magnetotactic bacteria Microorganisms in prospecting of oils Extremophiles- Acidophilic, alkalophilic, psychrophilic, thermophilic and halophilic microorganisms.	8	CO-4
5	Microbes of toxic environments and Biodeterioration	Acid mine drainage, coal desulphurisation, waste containing cyanides, xenobiotics, pesticides and chemicals, heavy metals, hydrocarbons & radio isotopic materials Concept of autotrophy – an example of extreme synthesis Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic,	8	CO-5

Reference Books:

1. Extremophiles-(2000) By B.N.Johari Springer Verlag,New York.
2. Microbial diversity (1999) by D.Colwd Academic press. and Wilkins, Baltimore Academic press
3. Bergy‘s Manual of Systematic Bacteriology (1984).Vols.I and III .Williams and Wilkins, Baltimore Academic press

e-Learning Source:

	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	2	3			
CO2	3	1					3	2	3			
CO3	3	1					3	2	3			
CO4	3	1					3	2	3			
CO5	3	1					3	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: 2020-2021							
Course Code	BS455	**Title of the Course**	Mycology and Plant Microbe Interactions	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	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	Students will gain insight into the general characters of fungi, their nutritional types and genetic variation.
CO2	Students will acquire knowledge of the general classification and main groups of fungi.
CO3	Comprehend the economic importance of fungi, the biology and importance of lichens and the role of saprotrophs in ecosystems.
CO4	Students will develop basic understanding of the complex plant microbe interaction in Rhizosphere and phyllosphere and know the microorganisms acting as biofertilizers and biopesticides or causing diseases and understand the factors influencing plant diseases.
CO5	Students will have knowledge of some common Plant Diseases: including their epidemiology and symptoms.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fungi	Historical account; 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	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; 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
3	Economic importance of fungi	Lichens: types, biology and physiology of lichen thallus, economic importance of lichens; Mycorhiza. Beneficial uses of fungi, industrial production of enzymes and penicillin. Edible Mushrooms. Fungi as animal parasites, mycoses of vertebrates types and symptoms. Insect fungus association. Role of saprotrophs in ecosystems.	8	CO-3
4	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. 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).	8	CO-4
5	Plant Diseases	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; 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.	8	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.

4- Moore –Landcker, E. (1996). Fundamentals of the Fungi. Prentice Hall.

5- Agriose, G.N. (2005). Plant Pathology, 5th edition Academic Press, Inc., Ainsworth, G.C. and Sussman, A.A. (Eds).

6- Deacon J.W. (1997). Modern Mycology (Basic Microbiology) 3rd Ed. Wiley Blackwell.

e-Learning Source:

	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	3			
CO2	3	1					3	1	3			
CO3	3	1				2	3	1	3			
CO4	3	1			1	1	3	1	3			
CO5	3	1			1	1	3	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: 2020-21							
Course Code	BS412	**Title of the Course**	Enzymology & Enzyme Kinetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course has been designed to teach the student majoring in science all the major aspects of the study of enzymes. The course focuses on the theories of enzyme kinetics, the mechanisms of enzyme catalysis, and immobilization of enzyme.						

Course Outcomes	
CO1	The students will understand the general properties of enzymes and their classification & nomenclature.
CO2	The students will understand the theories of enzyme kinetics.
CO3	The students will understand the mechanisms of enzyme catalysis and enzyme inhibition & activation.
CO4	The students will understand the Multisubstrate enzyme kinetics.
CO5	The students will understand the enzyme Immobilization and its clinical & industrial use.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Classification and nomenclature of enzymes	General properties of enzymes. Mechanism of enzyme action: Chymotrypsin, ribonuclease, activation of transition metal cation, activation by alkaline earth metal cation, nicotinamide nucleotide, flavin nucleotide and adenosine phosphate.	8	CO-1
2	Enzyme kinetics	Michaelis-Menten initial rate equation based on equilibrium assumption, Briggs Haldane steady state approach, integrated form of the Michaelis equation, methods for the determination of Km and Vmax normalized initial rate equation and normalized curves, Haldane relationship.	8	CO-2
3	Effect of factors and inhibitors on enzyme kinetics	Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions. Enzyme inhibition and activation: Types of reversible inhibitors, qualitative analysis of data, derivation of equations for different types of inhibitions, determination of inhibitor constant, determination of activator constant.	8	CO-3
4	Multisubstrate enzyme kinetics	Multisubstrate enzyme kinetics: random bi-bi, and ping pong reactions. Intracellular localization of enzymes, purification of enzymes and tests for homogeneity.	8	CO-4
5	Applied Enzymology	Immobilization; kinetics of immobilized systems. Isozymes. Allosteric enzymes. Industrial and clinical scope of enzymes.	8	CO-5

Reference Books:

1. Enzymes Biochemistry, Biotechnology, Clinical Chemistry Authors: T Palmer, P L Bonner; Woodhead Publishing
2. Biochemistry – Lubert Stryer Freeman International Edition.
3. Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freman and Co.
4. Enzyme Structure and Mechanism; Publisher W H Freeman & Co, New York; Alan Fersht
5. Enzymes: Authors: Malcolm Dixon, Edwin C. Webb; Academic Press

e-Learning Source:

	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				2		1		3		
CO2	3	1				2		1		3		
CO3	3	1				2		1		3		
CO4	3	1				2		1		3		
CO5	3	1				2		1		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: 2020-21							
Course Code	BS456	**Title of the Course**	Applied Microbiology and Bioinformatics Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	12	6
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To understand about the various chemical and physical factors involved in bacterial growth along with Enumeration of phyllosphere/rhizosphere microbial flora,detection of extracellular microbial enzymes and antibiotic sensitivity and/or toxicity testing using bacterial system. Basics of computers – basic commands – file creation, copying, moving & deleting in DOS & Windows. will also be performed along with the understanding of various biological databases. The provides knowledge and practicing of sequence analysis, multiple sequence analysis and gene prediction						

Course Outcomes	
CO1	Measurement of bacterial growth/growth curve, Effect of physical and chemical factors on the growth of bacteria: temperature, pH, and salts and Enumeration of phyllosphere/rhizosphere microbial flora and Enumeration/Isolation of PSB/PSF
CO2	Detection of extracellular microbial enzyme: Beta lactamases, Testing for antibiotic sensitivity and/or toxicity using bacterial system, Determination of MIC values (tube dilution and spot plate method), Screening for antibiotic producing microbes and Microbiological examination of milk and milk products
CO3	Microbiological quality testing of milk (MBRT test) and Microbial examination of industrial waste water/sewage.
CO4	Understanding basics of computers – basic commands – file creation, copying, moving & deleting in DOS & Windows. Internet - Using browsers – search engines and understanding use of various biological databases-GENBANK, EMBL, Swissprot – Protein Data Bank
CO5	Performing different types of sequence analysis queries in BLAST and FASTA. (Homology search), Multiple sequence alignments (Clustal) and Phylogenetic Analysis. (Phylip or Clustal) and Gene Prediction

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Measurement of bacterial growth/growth curve, Effect of physical and chemical factors on the growth of bacteria: temperature, pH, and salts	6	CO-1
Exp-02	Enumeration of phyllosphere/rhizosphere microbial flora. Enumeration/Isolation of PSB/PSF	6	CO-1
Exp-03	Detection of extracellular microbial enzyme: Beta lactamases, Testing for antibiotic sensitivity and/or toxicity using bacterial system, Determination of MIC values (tube dilution and spot plate method)	6	CO-1
Exp-04	Screening for antibiotic producing microbes	6	CO-2
Exp-05	Microbiological examination of milk and milk products, Microbiological quality testing of milk (MBRT test).	6	CO-3
Exp-06	Microbial examination of industrial waste water/sewage.	6	CO-4
Exp-07	Basics of computers – basic commands – file creation, copying, moving & deleting in DOS & Windows. Internet - Using browsers – search engines	6	CO-3
Exp-08	Using biological databases – GENBANK, EMBL, Swissprot – Protein Data Bank.	6	CO-4
Exp-09	Different types of sequence analysis queries in BLAST and FASTA. (Homology search).	6	CO-4
Exp-10	Multiple sequence alignments (Clustal) and Phylogenetic Analysis. (Phylip or Clustal)	6	CO-5
Exp-11	Gene Prediction.	6	CO-5

Reference Books:

1. Gerhardt P. Murray RG, Wood WA, and Kreig NR (ed.) (1994) Methods for General and Molecular Bacteriology - American Society for Microbiology, Washington D.C.
2. Patrick R. Murray. (editor chief) (1999) Manual of clinical microbiology, 7 Th edition, ASM Press, Washington D.C. • Prakash M., Arora, C.K. (1998) Pathological techniques - Anmol Publications Pvt. Ltd. N.D.
3. Sambrook J, Fritsch EF, Maniatis T. (1989). Molecular coloning. Cold Spring Harbor Laboratory Press.

e-Learning Source:

	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	3	1			3	3	3	3		3	2
CO2	3	3	1			3	3	3	3		3	2
CO3	3	3	1			2	1	3	3		3	2
CO4	3	3	1			3		3	2	3	3	2
CO5	3	3	1			2	2	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: 2020-21							
Course Code	BS 419	**Title of the Course**	Educational Tour	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	0	0
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The main objective of this course is to provide the students an exposure to various research activities in the country and acquaint the student with state-of-the-art technique/instruments used in various research institutions and industries of national repute. The student needs to submit a report after completion of the tour.						

Course Outcomes	
CO1	Develop understanding of state-of-the-art techniques/instruments used in various reputed research institutions. and industries
CO2	Take part in Group discussion and learn Teamwork.
CO3	Enhance communication and social skills by communication with peers.
CO4	Student shall be able to plan and improve the Technical Report writing skills
CO5	Have created Interest to pursue lifelong learning.

	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			2		3	2	3	3	3
CO2	3	2	2	1				1		3		3
CO3	3	2	2	1				1		3		3
CO4	3					2		2	2	3		3
CO5	3	2						3	2	3		3

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

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