Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS401	**Title of the Course**	Biomolecules: Structure & Functions	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**	Biochemistry				
Course Objectives	The course aims to provide students with an understanding of biomolecules, the basic building blocks of living organisms, their structural underpinnings, unique properties, biological roles and functions and interrelations. Emphasis is 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 the chemical structures of carbohydrate, and their structural and metabolic role in cellular system.
CO2	The students will learn about structure and function of membrane and storage lipids, circulating lipids and inflammatory lipid mediators etc.
CO3	The course will aid the students in understanding accessory molecules like vitamins, plant and animal hormones, plant secondary metabolite like terpenes etc.
CO4	The students will be acquainted about amino acids found regularly in proteins and uncommon amino acids. They will learn in detail about primary, secondary, tertiary and quaternary structure of proteins.
CO5	The students will understand the structure and function of nucleosides and nucleotides. They will also learn about the different types of DNA and RNA found in the various cellular systems and their functional relevance.

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; Chemistry of amino sugars, blood sugar compounds, sugar nucleotides	8	CO-1
2	Fatty acids	General formula, nomenclature and chemical properties; Lipid classification: simple, complex; General structure and functions of major lipid subclasses - acyl glycerols, phosphoglycerides, sphingolipids, waxes, terpenes, steroids and prostaglandins & free fatty acids; Circulating lipids - chylomicrons. LDL, HDL and VLDL.	8	CO-2
3	Vitamins	Structure, properties, deficiency, symptoms and functions including biochemical reactions. Hormones: Structure, properties & functions of animal & plant hormones.	8	CO-3
4	Proteins	Chemical structure and general properties of amino acids; Protein classification, size, shape, sequence of proteins; Primary, secondary, tertiary and quaternary structure of proteins.	8	CO-4
5	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; Primary, secondary, and tertiary structures of RNA	8	CO-5

Reference Books:

1. Lehninger, AL "Principles of Biochemistry"
2. Lubert Stryer "Biochemistry"
3. Voet & Voet "Biochemistry"
4. Baltimore "Molecular Cell Biology"

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: 2020-2021							
Course Code	BS402	**Title of the Course**	Bioinformatics, IPR, and Bioethics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**	Biotechnology				
Course Objectives	The course aims to provide students with a foundational understanding of bioinformatics, including biological databases and sequence alignment. It also covers biotechnology-related intellectual property rights, biosafety measures, and ethical considerations in biotechnology practices.						

Course Outcomes	
CO1	Gain a foundational understanding of bioinformatics concepts and applications, including biological databases and sequence alignment techniques.
CO2	Acquire proficiency in sequence alignment methods, both global and local, and database similarity searching using heuristic algorithms, along with an overview of phylogenetic studies.
CO3	Develop expertise in protein structure prediction, gene prediction, promoter scanning, splice site prediction, and applying bioinformatics in drug design.
CO4	Understand IPR, patents, copyrights, trademarks, and their application in software, databases, biodiversity, and trade.
CO5	Gain an understanding of biosafety, GMOs, risk assessment, and bioethics, including ethical conflicts and paradigms in biotechnology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of Bioinformatics	Introduction to Bioinformatics: Concept and Applications. Biological databases: types and categories; Nucleic acid and Protein Sequence Data Banks, Structural databanks; Sequence Alignment: Pair-wise sequence alignment & multiple sequence alignment.	8	CO1
2	Sequence Alignment	Global Alignment: Needleman and Wunsch; Local Alignment: Smith-Waterman algorithm. Database Similarity Searching: Heuristic algorithms for BLAST & FASTA, Multiple sequence alignments-concept, and applications; Center star method; overview of Phylogenetic studies.	8	CO2
3	Protein Structure Prediction	Protein structure prediction: Homology Modeling and applications; Gene prediction studies in eukaryotes and prokaryotes; Promoter scanning; Splice site Prediction; Application of Bioinformatics in Drug design.	8	CO3
4	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 the art procedure; Detailed information on patenting biological products and biodiversity. Trade-related aspects of Intellectual Property Rights and Budapest treaty.	8	CO4
5	Biosafety	Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines - Government of India; Definition of GMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC, etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. Bioethics: Introduction, necessity, and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics.	8	CO5

Reference Books:

D. W. Mount: Bioinformatics-sequence and genome analysis, Cold Spring Harbor Lab Press

Goel, Deepa, and Shomini Parashar. IPR, biosafety, and bioethics. Pearson Education India, 2013.

E-Learning Source:

http://nptel.ac.in/courses/102107028/

	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	1	1	1	2	2	1	1	2	3	2	3	3
CO2	2	2	1	2	3	1	1	2	1	2	2	3
CO3	2	2	2	2	3	1	1	1	1	3	3	3
CO4	1	2	2	2	2	1	3	2	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	BS403	**Title of the Course**	Essentials of Molecular Biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The acid as genetic material, replication, gene organization and its regulation etc. The application of the course lays the foundation to understand the disease objective of the course is learning and understanding the fundamentals of molecular biology like nucleic processes.						

Course Outcomes	
CO1	The students will learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication.
CO2	Understand the detailed mechanism and regulation of Eukaryotic DNA replication, along with Mitochondrial and Chloroplast DNA Replication.
CO3	The students will learn about mechanism and regulation of transcription in prokaryotes along with Reverse transcription.
CO4	Understanding the classes of DNA sequences, Genome-wide and Tandem repeats, Retroelements, Transposable elements, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA and Split genes
CO5	Understanding of the movable genes, transposons and mechanism of transposition

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Nucleic acid as genetic information carriers	Details of Griffith experiment, Avery, McLeod and McCarty experiment, Hershey and Chase experiment; Possible modes of replication: Details of Meselson and Stahl experiment; Prokaryotic DNA replication: Initiation, elongation and termination; Origin of replication; Roles, properties and mechanism of action of DnaA, Helicase, HD protein, Primase, DNA gyrase, Topoisomerase, DNA Polymerase, DNA ligase, Leading and lagging strands; Okazaki fragments; RNA or Rolling circleσprimers; Regulation of replication; Fidelity of replication; X174.ϕreplication in	8	CO-1
2	Eukaryotic DNA replication	Initiation, elongation and termination; Multiple initiation sites; Autonomously replicating sequence; Significance of Origin recognition complex, Minichromosome , Nucleases, DNAε, δ, αmaintenance proteins, DNA dependent DNA polymerases ligase and Telomeres in eukaryotic nuclear DNA replication; Regulation of eukaryotic DNA replication; Mitochondrial and Chloroplastic DNA replication.	8	CO-2
3	Transcription in prokaryotes	Outline of the process - Initiation, elongation and termination; Prokaryotic promoter; DNA dependent RNA polymerase (RNA polymerase): Physical properties, X-Ray subunit; Recognition of promoter;σcrystallographic structure, Subunits, Types of Binding and initiation sites; Melting of DNA; Direction of chain growth; Abortive initiations; Promoter clearance; Rho dependent and Rho independent termination of transcription; Sigma cycle; RNA - dependent DNA polymerase and Reverse transcription.	8	CO-3
4	Classes of DNA sequences	Unique DNA sequences, Repetitive DNA sequences; Zero-time binding DNA; Reasons for generation of reiterative DNA sequences; Highly repetitive and Moderately repetitive DNA sequences; Direct and Inverted repeats; Genome - wide and Tandem repeats; Overview of repetitive DNA sequences: Pseudogenes, LINEs, SINEs, Retroelements, Transposable elements, rRNA, tRNA and Histone genes, Centromeres, Telomeres, Satellite DNA, Minisatellites, Microsatellites; Applications of satellite DNA. Methods of distinguishing or separating double stranded and single stranded DNA; C-value and C-value paradox; Split genes: Exons and Introns	8	CO-4
5	Movable genes Transposons	Simple and Composite transposons, Mechanism of transposition, Example of transposons: Ds/ Ac family of transposon, Ty of yeast, Copia, P and FB element of Drosophila, LINES and SINES.	8	CO-5

Reference Books:

1. Lewin B. (2000). Genes VII. Oxford University press
2. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1987). Molecular biology of the gene.
3. Lehninger: Principles of Biochemistry (2017) by Nelson and Cox Seventh edition, WH Freman and Co.
4. Lodish H, Baltimore D, Berk A, Zipursky SL, Darnell J. (1995). Molecular cell biology.
5. Karp.G (2002) Cell & Molecular Biology, 3rd Edition, John Wiley & Sons; INC
6. Brown, TA Genomes (2020)

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			

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	BS404	**Title of the Course**	Biophysical & Biochemical 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 centers 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	The course will help students to acquaint with basic principles and applications of various sophisticated instruments like phase contrast, fluorescence, electron microscopy, confocal microscopy, fluorescent activated cell sorting, and Freeze drying.
CO2	The students will get theoretical knowledge of Radioisotopes and its uses in the biological system as well as the principle and practical applications of Geiger-Muller counter, Liquid scintillation counter, autoradiography, XRD and Biosensors.
CO3	The students will learn about Instrumentation, types, working and principle of Centrifugation & Electrophoresis.
CO4	Learn various types of chromatography techniques for solving industrial and research problems.
CO5	Students will be able to acquire the knowledge of techniques like UV-VIS spectroscopy, NMR, CD, ORD in biological research

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microscopy	Microscopy: Simple, compound, phase contrast, fluorescence, electron microscopy (TEM, SEM & STM) and confocal microscopy, fluorescent activated cell sorting (FACS), Freeze drying.	8	CO-1
2	Radiotracer technology	Radiotracer technology: Use of radioactive isotopes in biological system, detection and measurement of isotopes, Geiger-Muller counter, Liquid scintillation counter, autoradiography, X-ray Diffraction studies. Biosensors: Basic techniques, enzyme electrode, microbial biosensors.	8	CO-2
3	Centrifugation & Electrophoresis	Centrifugation & Electrophoresis: Centrifugation: types of rotors, techniques and their applications: differential, zonal, 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), Isoelectric focusing, isotachophoresis.	8	CO-3
4	Chromatography	Chromatography: Adsorption, paper, partition, ion-exchange, reverse phase, gel filtration, affinity, gas chromatography, HPLC and FPLC.	8	CO-4
5	Spectroscopy Techniques	Principle, Theory and applications of UV and VIS spectrophotometry, Fluorescence spectroscopy, atomic absorption, nuclear magnetic resonance, mass spectrometry.	8	CO-5

Reference Books:

1. Narayanan, P: Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Keith Wilson & John Walker: Principles and Techniques of Biochemistry and Molecular Biology.
3. Upadhyay, Upadhyay and Nath: Biophysical Chemistry: Principle and Techniques.
4. David Sheehan: Physical Biochemistry Principle and Applications.
5. Sabari Ghosal & A. K. Srivastava: Fundamentals of Bioanalytical techniques and Instrumentation.

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				3		1			3	
CO4	3	1				3		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	MT403	**Title of the Course**	Biostatistics & Biomathematics	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to understand the statistical analysis and differential calculus.						

Course Outcomes	
CO1	The students will learn about handling of data
CO2	Understand the tests of significance
CO3	The students will learn about Correlation analysis
CO4	Understanding the Differential Calculus
CO5	Understanding of the Determinants and its properties, evaluations of 3x3 determinants

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Handling of data	tabulation and diagrammatic representation of data – bar diagram and pie diagram. Measures of central tendency: mean, median and mode. Measures of dispersion: range, quartile deviation, mean deviation and standard deviation. Coefficient of variation	8	CO-1
2	Tests of significance	Null hypothesis and alternative hypothesis, Z-test, Student's distribution, Paired t – test, F-test for equality of population variances. Contingency table, Chi-square test for goodness of fit and independence of attributes	8	CO-2
3	Correlation analysis	Positive and negative correlation, Karl person's coefficient of correlation, Spearsman's rank coefficient of correlation. Regression analysis: regression lines X on Y and Yon X	8	CO-3
4	Differential Calculus	Derivative and its physical significance, basic rules for differentiation. Integral Calculus: basic rules for integration, method of substitution and method of by parts. Definite integral & simple examples based on its properties. Applications in Biology and Chemistry.	8	CO-4
5	Determinants and its properties, evaluations of 3x3 determinants	Matrices: Definition and types of matrices, transpose of a matrix, addition, subtraction and multiplication of matrices, matrix inversion, solution of simultaneous equations by matrix method. 8Interpolation: Newton's forward and backward formula, Lagranges formula	8	CO-5

Reference Books:

1. D. Freedman, R.Pisani, R.Purves, J.M.Lachin, "Biostatistical method: the assessment of relative risks"
2. P.S.S. Sunder Rao and J.Richard, "An introduction to Bilstatistics", Prentice Hall of India, N.Delhi
3. Pillai & Bagavathi, "Statistics-theory and practice", S. Chand.
4. H.K. Dass, "Engineering Mathematics", S.Chand.
5. H.C. Saxena, "Text book of Numerical Analysis", S.Chand

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				3		1				3
CO4	3	1				3		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	BS405	**Title of the Course**	Biochemistry/Bioinformatics lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	I	0	0	12	6
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding and basic knowledge of bimolecular testing and bioinformatics.						

Course Outcomes	
CO1	To know method for qualitative testing of carbohydrates (Molisch test, Benedict test, Fehling test, Bradford and Iodine tests) and fructose estimation
CO2	To know method for qualitative and quantitative testing of proteins & Amino Acids and finding out isoelectric point of protein
CO3	To know method for separation of amino acids and sugars by TLC and paper chromatography
CO4	Estimate cholesterol and DNA in a given sample
CO5	To learn how to use and develop bioinformatics application software

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Qualitative tests of carbohydrates: Carbohydrate: Molish's Test, Fehling's Test; Benedict's Test; Barfoed's Test; Phenyl Hydrazine Test; Seliwanoff's Test; mucic acid Test, bial's test; Iodine Test, Nelson-Somogyi Method.	6	CO-1
Exp-02	Qualitative tests of proteins: Proteins & Amino Acids: Millon's test, Biuret test; Ninhydrin Test; Xanthoproteic Test; Hopkin's Cole Test.	6	CO-2
Exp-03	Estimation of fructose by resorcinol method	6	CO-1
Exp-04	Estimation of protein by Biuret method	6	CO-2
Exp-05	Estimation of protein by Folin's-Lowry's method	6	CO-2
Exp-06	Estimation of cholesterol in egg	6	CO-4
Exp-07	Estimation of DNA by DPA method	6	CO-4
Exp-08	Chromatography: Separation of amino acids, and sugars by TLC & paper chromatography	6	CO-3
Exp-09	To find out isoelectric point of protein	6	CO-2
Exp-10	Usage & Development of Bioinformatics Application Software	6	CO-5

Reference Books:

1. Keith Wilson, John Walker, John M. Walker "Principles and Techniques of Practical Biochemistry"
2. Chirikjian "Biotechnology Theory & Techniques".
3. Joseph Sambrook, David W. Russell, Joe Sambrook "Molecular Cloning: A Laboratory Manual"
4. William M, O'Leary Robert, Dony Wu "Practical Handbook of Microbiology".
5. Sadasivam "Biochemical Methods"
6. Plumer "Practicals"

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	2		3	2
CO2	3	3	1			3		3	2		3	2
CO3	3	3	1			3		3	2		3	2
CO4	3	3	1			3		3	2		3	2
CO5	3	3	1	2		3		3	2		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	BS411	**Title of the Course**	Gene Expression & Regulation	**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 the course is to introduce to the students the basic knowledge about how genes are transcribed and how translation takes place in prokaryotes and eukaryotes and how these processes are regulated, so that students can apply this knowledge in enhancing their analytical and problem solving skills..						

Course Outcomes	
CO1	To understand the gene expression and regulation in Eukaryotes
CO2	To gain better knowledge about Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA.
CO3	Learn about the Translation in prokaryotes and eukaryotes and Properties of Genetic code.
CO4	To study the Post - translational processing: Basics of Protein folding.
CO5	To study about the Regulation of gene expression and concept of operon.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Transcription in eukaryotes	Transcription in eukaryotes: Synthesis of pre-mRNA: Outline of process - Initiation, elongation and termination, RNA Pol II promoter, Enhancer elements, Subunit structure of RNA Pol II, Roles of RNA polymerase II, Transcription factors, Nucleosome modifiers, Mediator complexes, Chromatin remodellers, Elongation factors in transcription; Cleavage and polyadenylation; Synthesis of pre-rRNA and pre-tRNA: Outline of process, RNA Pol I and III promoters sequences, RNA Pol I and III; DNA-binding motifs: Helix-turn-Helix, Zinc Finger, LeucineZipper, Homeodomain.	8	CO-1
2	Post - transcriptional / Cotranscriptional processing	Post - transcriptional / Cotranscriptional processing (Maturation of precursors of rRNA, mRNA, tRNA): End modifications (Addition of 5` cap and 3‟ Poly A tail in mRNA), RNA splicing - Self splicing and Spliceosome mediated splicing, Cutting events or action of ribonucleases, Covalent modifications, RNA editing, Alternative splicing.	8	CO-2
3	Translation in prokaryotes and eukaryotes	Outline of the process - Initiation, elongation and termination; Adapter role of tRNA, Evidences for a triplet code; Properties of Genetic code; Ubiquitous code and deviations; Synonymous codons; Codon family and Codon pairs; Nonsense and Sense codons; Degeneracy: Significance of Isoacceptor tRNAs and Wobble hypothesis; Codon bias; Amino acyl tRNA synthetase: Classification, Specificity, Reaction catalyzed; A, P and E sites of ribosome; Start and stop codons, Ribosome binding site; Formation of initiation complex; Transpeptidation and Translocation; Ribosome cycle; Roles of Initiation factors, Elongation factors, Release factors, Aminoacyl tRNA synthetase, tRNA, rRNA, GTP, Peptidyl transferase site and Factor binding site of ribosomes in translation.	8	CO-3
4	Post - translational processing	Post - translational processing, Basics of Protein folding, Intein splicing, Chemical modification, Proteolytic cleavage, Zymogen activation; Polycistronic and monocistronic.	8	CO-4
5	Regulation of gene expression	Regulation of gene expression; Concept of operon: Lac, Trp and Ara operons, Significance of repressor, Attenuation; Inhibitors of transcription and translation.	8	CO-5

Reference Books:

1. Lehninger, AL “Principles of Biochemistry”
2. Lubert Stryer “Biochemistry”
3. Voet & Voet “Biochemistry”
4. Baltimore “Molecular Cell Biology”
5. Brown, TA “Genomes”
6. Watson, JD “Molecular Biology of the cell”

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	BS412	**Title of the Course**	Enzymology & Enzyme kinetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	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				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: 2020-21							
Course Code	BS413	**Title of the Course**	Metabolism & Bioenergetics	**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 enable the students to provide basic knowledge about 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 extends comprehensive knowledge about biochemical pathways involved in intermediary metabolism of carbohydrate, protein, lipid and nucleic acid.						

Course Outcomes	
CO1	The student will be able to learn Carbohydrate catabolism and its association with cellular energy production. They will learn different metabolic pathways and cycles for the degradation of carbohydrates.
CO2	The student will be acquainted with carbohydrate anabolism in plants and animal cells. They will be able to understand different metabolic pathways for the biosynthesis of carbohydrates like glucose and glycogen.
CO3	The student will get familiar to the biosynthesis of membrane glyco- and phospholipids like glycerolipids and sphingolipids; and storage lipids like triglycerides etc. They will also learn the biosynthesis of plasmalogens and cholesterol.
CO4	The student will also learn about the breakdown or degradation of fatty acids via various mechanisms like alpha, beta and omega oxidation and its connection with cellular energy generation. He will also be familiar with ketone bodies and acidosis/ketosis. They will also learn about the degradation of cholesterol and importance of bile salts and pigments.
CO5	The student will learn and understand about the biosynthesis and degradation of amino acids; and inborn errors (genetic diseases) of metabolism. He will also learn about the de novo biosynthesis of purines and pyrimidine nucleotides and salvage pathways; and degradation of nucleotides.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Carbohydrate catabolism	Glycolytic pathway and non-glycolytic pathways, Hexose monophosphate pathway, Tricarboxylic acid cycle. Anaplerotic sequences in metabolism, glycogenolysis, Krebs- Kornberg pathway, Glyoxylate pathway. Glucose catabolism in cancerous tissue, Energy production by aerobic and anaerobic respiration: Electron transport chain, oxidative phosphorylation	8	CO-1
2	Biosynthesis of carbohydrates	Gluconeogenesis, glycogen synthesis, reductive pentose phosphate pathway, carbon dioxide assimilation in C3 and C4 plants.	8	CO-2
3	Lipid biosynthesis	Synthesis of saturated and unsaturated fatty acids, biosynthesis of triacylglycerols glycerophospholipids and membrane phospholipids, plasmologens, sphingolipids, cholesterol.	8	CO-3
4	Lipid metabolism	Degradation of fatty acids: α, β, ω oxidation; Ketone bodies, acidosis, ketosis, Cholesterol degradation.	8	CO-4
5	Nucleic acid metabolism	Biosynthesis of purines and pyrimidines, degradation of nucleosides, nucleotides and nucleic acids, Salvage pathways. Biosynthesis and biodegradation of amino acids. Inborn errors of metabolism.	8	CO-5

Reference Books:

1- Lehninger AL "Principles of Biochemistry"

2- Lubert Stryer "Biochemistry"

3- Voet & Voet "Biochemistry"

4- Shuler "Bioprocess Engineering"

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	BS414	**Title of the Course**	Microbiology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objectives of this course are to introduce the students to the field of microbiology with emphasis on microbial growth, reproduction, microbial diversity, morphology and nutrition; basic techniques implied in microbiology including concept of aseptic work, isolation, identification, and cultivation of microbes from different habitats/sources.						

Course Outcomes	
CO1	Students would be able to identify or classify the microbial diversity i.e. bacteria, fungi, virus etc. on the basis of their characteristics, Learn microbiological techniques, and apply to study microbial phylogeny
CO2	Students would learn the nutritional types of microorganisms, measure and control microbial growth, isolate, maintain and preserve microorganisms for various applications
CO3	Students would know the defining characteristics of the major groups of microorganisms and means of adaptation for various diverse groups of microorganisms
CO4	Students would understand the interactions between microbes, hosts and environment.
CO5	Students would gain insights on mechanism of action of antibiotics, classify the medically important microorganisms i.e. non-pathogenic and pathogenic microbes, and understand their mode of survival and antibiotics resistance mechanisms.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Concepts in classification of microorganisms	Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification: morphology, cytology, genetic relatedness, host specialization, serology; Concept of Classification of Bacteria according to Bergey"s manual.	8	CO-1
2	Microbial culture techniques and growth	Isolation, maintenance, sterilization and culture techniques; Microbial growth and nutrition; Factors effecting growth; Definition of growth; Mathematical expression of growth; Measurement of growth and growth yields; Synchronous and non - synchronous growth; Continuous culture.	8	CO-2
3	Ultrastructure of Microbes and adaptation	Ultrastructure of Eubacteria (*E. coli*), Archaea (Methanococcus), Unicellular Eukaryotes (Yeast) and Structure and genetic system of viruses - Bacterial viruses in general; Plant (TMV, CaMV) and Animal viruses (HIV). Physiological adoption and lifestyle of Prokaryotes and the Extremophiles.	8	CO-3
4	Microbial interactions	Microbial interactions - Symbiosis, Synergism, Commensalism, Ammensalism, Predation and Parasitism; Ecological impacts of microbes: Microbes and Nutrient cycles; concept of quorum sensing.	8	CO-4
5	Medically important micro-organisms and antibiotics	Classification of medically important micro-organisms: Non-pathogenic and Pathogenic Microbes, Production of antibiotics, mode of action of antibiotics; different mechanism of antibiotic resistance. Prebiotics and Probiotics.	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- G Reed; Prescott and Dunn's; Industrial Microbiology; 4th Edition; CBS Publishers; 1987.

4- M.T. Madigan and J.M. Martinko; Biology of Microorganisms; 11th Edition; Pearson Prentice Hall; USA; 2006.

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	1	2	2		
CO2	3	1				3	1	1	3		3	
CO3	3	1					3	1	3			
CO4	3	1					3	1	3			
CO5	3	1			2	3	1	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: 2020-21							
Course Code	BS415	**Title of the Course**	Molecular Genetics	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The aim of the course is to provide students with an understanding of both classical and modern concepts in genetics with special emphasis on the areas of chromosome structure and function, molecular and developmental genetics, DNA damage and repair and chromosomal aberrations. The course will also provide in-depth knowledge of cancer etiology, Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics.						

Course Outcomes	
CO1	Students would understand the Genome organization and DNA packaging including Chromosome structure and function in both prokaryotes and eukaryotes.
CO2	Students would be able to understand the Genetic Control of Development in *C. elegans, Drosophila, Neurospora crassa, Arabidopsis thaliana.*
CO3	Students would understanding the principles of Mendelian genetics, extensions and applications.
CO4	To understand the Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanism, and the role of various oncogenes in cancer etiology
CO5	Able to understand The Human Genome project and genetic diversity including Legal and Ethical Issues in Genetics

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genome organization and DNA packaging	Genome organization and DNA packaging; Nuclear decondensation (in both prokaryotes and eukaryotes); Chromosome structure and function; Numerical and structural changes in chromosomes; Cytogenetics: chromosome aberration.	8	CO-1
2	Genetic Control of Development	Genetic Control of Development in *C. elegans*, Drosophila, *Neurospora crassa, Arabidopsis thaliana*.	8	CO-2
3	Principles of Mendelian inheritance	Principles of Mendelian inheritance, Linkage and genetic mapping; Extrachromosomal inheritance, Sex-linked inheritance and genetic disorders, Somatic cell genetics, Population genetics.	8	CO-3
4	Mutation and cancer	Physical and Chemical Mutagens, Drug metabolism and detoxification; DNA damage: Types of mutations, DNA repair mechanisms: Y-family DNA Polymerases; Micronuclei; FISH; COMET Assay. Etiology of cancer: Oncogenes; protooncogenes; Viral and cellular oncogenes; tumour suppressor genes from humans; Structure; function and mechanism of action of pRb and p53 tumour suppressor proteins.	8	CO-4
5	Applied Genetics	The Human Genome Project; gene therapy, integration of DNA into mammalian genome, Expression of foreign genes in transgenic animals, Genetic Testing-DNA Fingerprinting; Genetic Diversity - Conservation Genetics; Legal and Ethical Issues in Genetics; Genetic Counseling	8	CO-5

Reference Books:

1. Gardener “Principles of Genetics”
2. Tom Strachan, T. Strachan, Andrew Read, Andrew P. Read “Human Molecular Genetics”
3. William S. Klug Michael R. Cummings “Concepts of Genetics (7th Edition)”
4. Ricki Lewis “Human Genetics: Concepts and Applications”
5. Anthony Atala, Robert P. Lanza “Methods of Tissue Engineering”
6. Leland Hartwell Leroy Hood Michael L. Goldberg Ann E. Reynolds Lee M. Silver Ruth C. Veres Ricki Lewis “Genetics: From Genes to Genomes”
7. Debra Davis “Animal Biotechnology: Science-Based Concerns”
8. Nigel Jenkins “Animal Cell Biotechnology: Methods and Protocols”
9. Carl Pinkert “Transgenic Animal Technology: A Laboratory Handbook”

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				2		1	3			
CO3	3	1				2		1	3			
CO4	3	1				1		1	3		1	
CO5	3	1			2	1	1	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: 2020-21							
Course Code	BS416	**Title of the Course**	Environmental biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course content aims to make the students identify and explain the environmental factors responsible for the pollution. It also helps in understanding how biotechnology can provide solutions for environmental problems and understand legal aspects related with environmental issues and environmental protection. This course enables the students to select the appropriate method for the treatment of wastewater and solid waste management as well as can apply Suitable bioremediation methods for the treatment.						

Course Outcomes	
CO1	Comprehend environmental issues and role of biotechnology in the cleanup of contaminated environments.
CO2	Comprehend fundamentals of biodegradation, biotransformation and bioremediation of organic contaminants and toxic metals.
CO3	Apply biotechnological processes in wastewater and solid waste management.
CO4	Demonstrate innovative biotechnological interventions to combat environmental challenges
CO5	Biodeterioration concept of different organic and in-organics materials and their control.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microbiology of air and aquatic environments	Microbiology of air and aquatic environments - Bacteriological indicators of pollution, Bacteriological examination of water, nuisance bacteria in water systems. Chemical and microbiological characteristics, Biological Oxygen Demand (BOD), Microorganisms and pollution problems and interaction with human bodies.	8	CO-1
2	Environmental pollution	Definition, source and types of pollution (air, water and soil). Xenobiotic toxicity/genotoxicity, Mode of action of pesticides, fungicides and insecticides; Mutation detection by Ames, microsomal assay. Bioaccumulation and bioremediation, Biosensors, DNA probes and their environmental applications, Toxicogenomics.	8	CO-2
3	Recycling of organic waste	Recycling of organic waste: Major sources of recyclable materials including agricultural waste. Key technology in recycling of crop residues, human and animal wastes. Composting and vermicomposting; Production and application. Role of microbes in composting and biogas production. Municipal solid waste treatment and management.	8	CO-3
4	Microbes of toxic environments	Microbes of toxic environments: Microbial biotransformation/ degradation of organic pollutants in soil. Microbial degradation and persistence of xenobiotics, pesticides, herbicides, heavy metals and radio isotopic materials. Pesticides toxicity to microbes and plants. Acid mine drainage, coal desulphurization.	8	CO-4
5	Biodeterioration-concept	Biodeterioration-concept, biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic, paints, lubricants, cosmetics, control of biodeterioration.	8	CO-5

Reference Books:

1- Environmental biotechnology (Industrial pollution Management).Jogdand S.N., Himalaya pub. house.

2- Waste water treatment – Rao M.N. and A.K.Datta

3- Industrial pollution Control, Vol. 1, E. Joe, Middle Brooks.

4- The treatment of industrial wastes, 2nd Ed. Edmund D. Besselievere and Max Schwartz.

5- Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment

6- Longman Scientific Technical. Grant WD, Long PL. (1981) Environmental Microbiology.

7- Blackie Glasgow and London. Paul EA, Clark FF Soil Microbiology and Biochemistry, Academic Press, San Diego.

8- Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane: Nitrogen oxides and Halomethanes. ASM, Washington DC.

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	3	1	3			
CO2	3	1				2	3	1	3	1	2	
CO3	3	1				2	3	1	1		2	
CO4	3	1				2	3	1	2		1	
CO5	3	1				2	3	1	2		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: 2020-21							
Course Code	BS417	**Title of the Course**	Pharmaceutical biology	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course enables the students to learn the various aspects of pharmaceutical sciences. In this course, students get exposed to the insights into various therapeutic strategies against infectious and non-infectious diseases i.e. via monoclonal antibodies (mABs), peptide based therapeutics, liposome/emulsion-based drug delivery systems, PEG-conjugates-based drug delivery and various factors affecting the drug delivery, its release, and absorption.						

Course Outcomes	
CO1	Understand the principle of monoclonal antibodies generation, their mode of action, and their application in targeting various diseases.
CO2	Formulate therapeutic proteins and peptides, their encapsulation with other macromolecules and implications in drug delivery.
CO3	Prepare lipid-based drug delivery systems as well as PEG-conjugates for fast drug delivery and release inside the body.
CO4	Develop the strategies of pulmonary drug delivery.
CO5	Apply the knowledge of polymers for production of biopharmaceuticals with controlled drug delivery.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Monoclonal antibodies	Applications, generation, recombinant antibodies, production methods, Pharmaceutical, regulatory and commercial aspects.	8	CO-1
2	Formulation of proteins and peptides	Making small protein particles, precipitation of proteins, quality control issues, multi-phase drug delivery system; Preparation of collagen, gelatin particles, albumin microparticles.	8	CO-2
3	Proteins and phospholipids	Structural properties of phospholipids, injectable lipid emulsions, liposomes, cochleal phospholipids structures; Polymeric systems for oral protein and peptide delivery.	8	CO-3
4	Pulmonary drug delivery systems for biomacromolecules	Lipid based pulmonary delivery; Solid colloidal particles; Polycyanoacrylates; Poly (ether-anhydrides); Diketopiperazine derivatives; Polyethylene glycol conjugates; Factors affecting pulmonary dosing	8	CO-4
5	Polymers used for controlled drug delivery	Hydrophobic polymers poly(esters), poly(cyanoacrylate), poly (ortho esters), poly (phosphazenes), Hydrophobic polymers poly (alkyl methacrylates), poly (methacrylates), poly (acrylates)], alginates, chitosan, polyethylene glycol. Gene therapy: the current viral and nonviral vectors	8	CO-5

Reference Books:

1- Groves MJ „Pharmaceutical Biotechnology", Taylor and Francis Group.

2- Crommelin DJA, Robert D, Sindelar „Pharmaceutical Biotechnology".

3- Kayser O, Muller R „Pharmaceutical Biotechnology".

4- Banga AK „Therapeutic peptides and proteins

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		2	3		3	
CO2	3	1		1		3		2			3	
CO3	3	1		1		3		2	3		3	
CO4	3	1		1		3		2			3	
CO5	3	1		1		3		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	BS418	**Title of the Course**	Microbiology / Enzymology Lab	**L**	**T**	**P**	**C**
Year	I	**Semester**	II	0	0	12	6
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to enable the students to learn the various techniques to handle microbiological samples. There has been an exclusive demand for microbial metabolites and pharmaceutical products which can be used to improve human health and wellbeing. These techniques equip the students to work in research related to microbiological testing						

Course Outcomes	
CO1	The student will learn methods of sterilization and preparation of various culture media, microbial enumeration and purification techniques.
CO2	The student will be able to learn Identification of isolated bacteria, sensitivity testing for antibiotics/antifungal agents and growth curve of microorganisms.
CO3	The student will be able to perform protein separation by PAGE.
CO4	The student will be able to perform enzyme isolation and activity determination.
CO5	The student will be able to understand the effect of various factors on enzyme activity.

Exp. No.	**Title of the Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Methods of sterilization and preparation of various culture media.	6	CO-1
Exp-02	Enumeration of microorganisms from water/soil samples, colony purification	6	CO-1
Exp-03	Purification techniques: Serial dilution, pour plate and streak plate method	6	CO-1
Exp-04	Identification of isolated bacteria: Gram staining other staining methods, metabolic characterization	6	CO-2
Exp-05	Sensitivity of various organisms towards Antibiotic/Antifungal agents.	6	CO-2
Exp-06	Growth curve of microorganisms.	6	CO-2
Exp-07	Protein separation by Poly Acrylamide Gel Electrophoresis	6	CO-3
Exp-08	Isolation of enzyme and determination of enzyme activity	6	CO-4
Exp-09	Study of the effect of pH on the enzyme activity.	6	CO-5
Exp-10	Study of the effect of varying substrate concentration on the enzyme activity and determination of Km.	6	CO-5
Exp-11	Study of the effect of temperature on the enzyme activity.	6	CO-5
Exp-12	Study of the effect of inhibitors on the enzyme activity.	6	CO-5

Reference Books:

1- Keith Wilson John Walker John M. Walker “Principles and Techniques of Practical Biochemistry

2- Chirikjian “Biotechnology Theory & Techniques”

3- Joseph Sambrook, David W. Russell, Joe Sambrook “Molecular Cloning: A Laboratory Manual”

4- William M, O'Leary Robert, Dony Wu “Practical Handbook of Microbiology”.

5- Brown, TA “Gene cloning: An introduction”

6- Tortora “Microbiology”

7- Cappucino “Microbiology Manual”

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	3	1		3	1	3	2		3	2
CO2	3	3	3	1		3	2	3	2		3	2
CO3	3	3	3			3		3	2		3	2
CO4	3	3	3			3		3	2		3	2
CO5	3	3	3		2	3		3	2		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	BS419	**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	1		3	3
CO2	3	2	2	1				1				3
CO3	3	2	2	1				1				3
CO4	3	2				2		2				3
CO5	3			1				3				3

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

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