Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B110501T / BS344	**Title of the Course**	Bioenergetics and Metabolism	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The course has been designed to: ● Understand the concepts of metabolism, characteristics of anabolic and catabolic pathways. ● Gain a detailed knowledge of various metabolic pathways and their regulations ● Gain knowledge about the diseases/in-born error caused by defects in metabolism						

Course Outcomes	
CO1	The students will understand the concept of thermodynamics and laws associated with it
CO2	The students will understand the metabolism of carbohydrate and electron transport chain along with the diseases associated with metabolic irregularities
CO3	The students will understand the metabolism of lipids and its type, its regulation, abnormal lipid metabolism and diseases associated
CO4	The students will understand the metabolism of protein and nucleic acids. The concept of deamination and transamination. *De-novo* and salvage pathways of nucleotide synthesis and disorders associated
CO5	The students will understand the concept of photosynthesis and nitrogen metabolisms in plants.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Principle of Bioenergetics	Bioenergetics and thermodynamics, Laws of Thermodynamics, Gibbs free energy, enthalpy, Entropy and their relationships, ATP as universal currency in biological system, Coenzymes and proteins as universal electron carriers	**6**	**CO1**
2	Carbohydrate Metabolism	Glycolysis, TCA cycle, Pentose phosphate pathway, Gluconeogenesis and Glycogen metabolism, Diseases associated with metabolic irregularities	**8**	**CO2**
3	Oxidative phosphorylation	The electron transport chain - its organization and function, Peter Mitchell's chemiosmotic hypothesis and Proton motive force, FoF1ATP synthase, structure and mechanism of ATP synthesis.	**6**	**CO2**
4	Lipid Metabolism	Oxidation of fatty acids, β oxidation, ω oxidation and α oxidation, Ketone-body metabolism, Cholesterol biosynthesis, Regulation of fatty acid metabolism, Diseases associated with abnormal lipid metabolism	**8**	**CO3**
5	Protein Metabolism	Urea Cycle, Transport of ammonia, Deamination and transamination reactions, Inborn errors of protein metabolism, Glucogenic and ketogenic amino acids, Overview of amino acid synthesis	**8**	**CO4**
6	Nucleic Acid Metabolism	*De novo* synthesis of purine and pyrimidine nucleotides, Salvage pathways, Degradation of purine and pyrimidine nucleotides, Disorders of purine and pyrimidine metabolism	**8**	**CO4**
7	Photosynthesis	Light harvesting and photosynthetic electron transport, Water splitting, formation of H+ gradient and photophosphorylation, Calvin cycle, and its regulation, Photo respiration, C4 and CAM pathways in plants	**8**	**CO5**
8	Nitrogen metabolism	Nitrogen cycle, biological nitrogen fixation by free living and in symbiotic association Structure and function of the enzyme nitrogenase, Nitrate assimilation: Nitrate and Nitrite reductase	**8**	**CO5**

Reference Books:

1. Lehninger,Albert, Cox,Michael M. Nelson, David.(2017) Lehninger Principles of biochemistry/NewYork:W.H.Freeman.
2. Voet,D.,&Voet, J.G.(2011). Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubert stryer Freeman International Edition.
4. Biochemistry – Keshav Trehan Wiley Eastern Publications
5. Fundamentals of Bochemistry-J.L.Jain S.Chand and Company
6. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
8. Biochemistry and Molecular Biology: Oxford University Press
9. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition
10. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons,

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4

CO1	3	1					2	3			3
CO2	3	1					2	3			3
CO3	3	1					2	3			3
CO4	3	1					2	3			3
CO5	3	1					2	3			3

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100503 T / BS319	**Title of the Course**	Genetic Engineering	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 in Biology	**Co-requisite**					
Course Objectives	The course has been designed to make students aware of DNA manipulative enzymes and Gene cloning vectors, Screening and selection of recombinants, Techniques used as Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing and Application of r-DNA techniques						

Course Outcomes	
CO1	Get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors, In vitro construction of recombinant DNA molecules
CO2	Gain knowledge about isolation of genomic and plasmid DNA, creation of rDNA and methods of Transformation
CO3	Learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA
CO4	Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.
CO5	Gain knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	DNA manipulative enzymes	Restriction enzymes, DNA ligases, Polymerases, Kinases, Alkaline phosphatases, Reverse Transcriptase	8	CO-1
2	Vectors	Gene cloning vectors: Plasmids, Bacteriophage and Chimeric plasmids. *In vitro* construction of recombinant DNA molecules (pBR332, pUC19)	8	CO-1
3	Isolation of DNA	Isolation of genomic and plasmid DNA	8	CO-2
4	rDNA	Creation of r-DNA, Transformation of r-DNA by different methods.	8	CO-2
5	Screening and selection of recombinant host cells	Immunological screening, colony hybridization and blue-white screening.	6	CO-3
6	Gene Libraries	Preparation and comparison of Genomic DNA and cDNA library, Expression of cloned DNA in *E. coli*.	8	CO-3
7	Techniques	Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Sanger's method, Blotting techniques: Southern, Western and Northern blot.	8	CO-4
8	Applications	Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.	8	CO-5

Reference Books:

1. Glick, B.R & Pasternak J.J (1994) Molecular Biotechnology, Princi[ples and Applications of Recombinant DNA, American Society for Microbiology, Washington D.C
2. Christopler H. (1995) Gene cloning and Manipulating, Cambridge University Press
3. Nicholl, D.S.T (1994) An Introduction of Genetic Engineering, Cambridge University Press.
4. Old. R.W. and Primrose, S.B. (186) Principles of Gene manipulation, An introduction to genetic engineering (3rd Edition) Black well Scientific Publications
5. Watson J.D. Hopkins, N.H Roberts, J.W.Steitz J.A and Weiner A.M (1988). Molecular biology of society for Microbiology
6. Lewin b. (1994) Genes VI, New York, Oxford University Press

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					2	3	3	3	
CO2	3	1					2	3	3	3	
CO3	3	1					2	3	3	3	
CO4	3	1		2	2		3	3	3	3	
CO5	3	1		1	1	1	3	3	3	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: 2024-25							
Course Code	B110503T/ BS345	**Title of the Course**	Plant Biochemistry	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	• The course has been designed to: • Understand the plant cell, photosynthesis, transporters and important primary metabolites. • Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses • Explain about plant secondary metabolites and their functional importance.						

Course Outcomes	
CO1	The students will understand the concept of plant cell structure and membrane transport across plant membrane.
CO2	The students will understand the biotic and abiotic stresses and plants response under these conditions.
CO3	The students will understand various types of plant hormones and their mode of action.
CO4	The students will understand the structure and importance of secondary metabolites.
CO5	The students will understand the concept of photosynthesis and nitrogen metabolisms in plants.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Plant cell structure	Plant cell- structure and molecular components: Cytoskeleton, Chemical and physical composition of cell wall. Structure of cellulose, hemicellulose and pectin. Plant cell division.	8	CO1
2	Plant cell membrane transport	Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of transporters in plant cell and organelle membranes; Ion channels- properties and significance; Aquaporins.	8	CO1
3	Biotic stress	Plant responses to biotic stresses: Introduction; plant pathogens and diseases; plant defense systems-hypersensitive response; systemic acquired resistance.	6	CO2
4	Abiotic stress	Plant responses to abiotic stress- Salt stress, drought and heavy metal stress responses.	8	CO2
5	Plant hormones	Plant growth regulators: Role of auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid and salicylic acid.	8	CO3
6	Secondary metabolites	Plant Secondary Metabolites: An overview of primary metabolism contribution to secondary metabolites biosynthesis. Classification of plant secondary metabolites. Alkaloids, Phenolics and Terpenoids: General characteristics and classification with examples. Applications of secondary metabolites in plant defense. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments.	8	CO4
7	Nitrogen metabolism	Nitrogen assimilation: Nitrate and nitrite reduction. Fixation of molecular nitrogen	6	CO5
8	Photosynthesis	Carbon assimilation: An overview of photosynthesis; electron transport in higher plants and its relation with the carbon fixation pathways. C3, C4 plants and crassulacean acid metabolism (CAM); photorespiration; Phytochromes.	8	CO5

Reference Books:

1. Lehninger,Albert, Cox,Michael M. Nelson, David.(2017) Lehninger Principles of biochemistry/NewYork:W.H.Freeman.
2. Voet,D.,&Voet, J.G.(2011). Biochemistry.NewYork:J.Wiley&Sons
3. Biochemistry – Lubert stryer Freeman International Edition.
4. Biochemistry – Keshav Trehan Wiley Eastern Publications
5. Fundamentals of Bochemistry-J.L.Jain S.Chand and Company
6. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
7. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott:
8. Biochemistry and Molecular Biology: Oxford University Press
9. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition
10. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons,

e-Learning Source:

PO-PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**		**PSO4**

CO										PSO 3	
CO1	3	1				2		3			
CO2	3	1				2		3			
CO3	3	1				2		3			
CO4	3	1				2		3			
CO5	3	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: 2024-25							
Course Code	B110504T / BS346	**Title of the Course**	Industrial and environmental biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to get proper knowledge about Structural and Functional dynamics of microbes for fermentation; understand upstream processing and downstream processing for industrial production using fermenters, understanding of environmental biotechnology, bioremediation, waste management, bioleaching, biofuel						

Course Outcomes	
CO1	Get proper knowledge about Structural and Functional dynamics of microbes for fermentation.
CO2	Know about environmental pollutant and their impact
CO3	Learn about the basics of the general design of fermenter; Processing; and products obtained by industrial microbiological fermentation
CO4	Gain knowledge about bioremediation, Solid waste treatment and wastewater Treatment
CO5	Have knowledge about production of biofuel and GMOs.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Structural and Functional dynamics of microbes**	Structural and Functional dynamics of microbes; Microbial diversity; screening for new metabolites: primary and secondary products; strain improvement through selection, mutations and recombination	**7**	**CO1**
2	**Environment and pollution**	Characteristics of environment; Water, soil and air as a component of environment, Pollutants: Nature, origin, source, monitoring and their impacts; Air, Water and Noise pollution; conventional fuels and their environmental impact; bioreporters, biosensors and their applications	**8**	**CO2**
3	**Bioprocess technology**	Design and working of a typical fermenter; basic principle components of fermentation technology. Types of fermentation – Batch, Fedbatch and Continuous culture.	**8**	**CO3**
4	**Production of alcohols, antibiotic and enzymes**	Production of alcohols (Ethanol) and organic acids (citric and acetic); production of biologically active compounds: antibiotics (penicillin) and enzymes (amylase, protease); production of microbial food and single cell proteins; bioreactor for immobilized cells/enzyme system.	**8**	**CO3**
5	**Bioremediation**	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents; degradation of lignin and cellulose using microbes, degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products; phytoremediation	**9**	**CO4**
6	**Waste Treatment**	SWM: Integrated Waste management, solid waste processing (Mechanical, thermal and biological), WWM: Primary, secondary and tertiary treatment	**7**	**CO4**
7	**Biofuel**	Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	**7**	**CO5**
8	**Use of genetically modified organisms**	Environmental significance of genetically modified microbes, plants and animals; Bioleaching, Biodegradable plastics, Biopesticides, Biofertilizer	**6**	**CO5**

Reference Books:

1. Ritmann R and McCarty P L (2000). Environmental Biotechnology: Principle & Applications. 2nd Ed., McGraw Hill Science.
2. Benny Joseph (2005) Environmental Studies, Tata McGraw Hill.
3. Bailey J E and Ollis D F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
4. Chapman JL . Ecology: Principal & Application. Cambridge Univ. Press.
5. Stanbury P F and Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press
6. Crueger W and Crueger A (2002) Cruegers Biotechnology: A Textbook of Industrial Microbiology. Third Edition, Panima Publishing Corp., New Delhi.
7. Odum E and Barret G. (2004) Fundamentals of Ecology. Nataraj Publication.

e-Learning Source:

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

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B110502P / BS347	**Title of the Course**	Metabolism Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The course is designed to train the students in fundamentals of enzymology and metabolism.						

Course Outcomes	
CO1	The students will be able to isolate enzyme determine enzympe kinetics
CO2	The students will be able to perform biochemical tests related to starch hydrolysis, gelatin Liquefaction
CO3	The students will be able to perform amylase assay
CO4	The students will be able to perform cholesterol estimation
CO5	The students will be able to understand rhizobium from root nodules of legumes

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	Isolation of enzyme and determination of enzyme activity	3	CO-1
2	Exp-02	Study of the effect of varying substrate concentration on the enzyme activity and determination of Km and Vmax.	3	CO-1
3	Exp-03	Biochemical tests–starch hydrolysis, gelatin Liquefaction	3	CO-2
4	Exp-04	Assay of salivary amylase	3	CO-3
5	Exp-05	Cholesterol estimation	6	CO-4
6	Exp-06	Study of Rhizobium from root nodules of legumes	6	CO-5

Reference Books:

1. Wilson, K and Walker, J (eds 2000 Principles and Techniques of Practical Biochemistry, 5th edn Cambridge University Press
2. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
3. Trevor Palmer and Philip Bonner 2008 Enzymes Biochemistry, Biotechnology, Clinical Chemistry, 2nd edn EWP

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1						3		3	
CO2	3	1		3		3	1	3	2	3	
CO3	3	1		3		3	1	1		3	
CO4	3	1		3		3	1				3
CO5	3	1		3	3	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: 2024-25							
Course Code	B100504P / BS320	**Title of the Course**	Genetic Engineering Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basics of genetic engineering and PCR.						

Course Outcomes	
CO1	The students will be able to isolate genomic DNA from bacteria, plant, and animal tissues.
CO2	The students will be able to isolate plasmid DNA (*E. coli*).
CO3	The students will be able to perform restriction digestion of DNA.
CO4	The students will be able to perform Agarose Gel Electrophoresis.
CO5	The students will be able to explain Polymerase Chain Reaction.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	Isolation of genomic DNA from bacteria (E. coli)	6	CO-1
2	Exp-02	Isolation of genomic DNA from plant and animal tissue	6	CO-1
3	Exp-03	Isolation of plasmid DNA (E. coli)	6	CO-1
4	Exp-04	Restriction digestion of DNA	6	CO-2
5	Exp-05	Agarose Gel Electrophoresis	6	CO-3
6	Exp-06	Demonstration of PCR	6	CO-4

Reference Books:

1. Gene Cloning and DNA Analysis: An Introduction, 6th Edition by T. A. Brown
2. Sambrook J, Russell D (2001) Molecular Cloning: A Laboratory Manual, 3rd Ed. Cold Spring Harbor, NY: 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	PSO1	PSO2	PSO3	PSO4
CO1	3	1						3		3	
CO2	3	1		3		3	1	3	2	3	
CO3	3	1		3		3	1	1		3	
CO4	3	1		3		3	1				3
CO5	3	1		3	3	3	1				3

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100507R / BS392	**Title of the Course**	Industrial visit and survey report	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**4**	**4**
Pre-Requisite	**10+2**	**Co-requisite**					
Course Objectives	The main objective of this course is to provide the students an exposure to various research activities and acquaint the student with state of the art technique/instruments used in various reputed research institutions and industries.						

Course Outcomes	
CO1	To develop understanding of state of the art techniques/instruments used in various reputed research institutions.
CO2	To develop understanding of state of the art techniques/instruments used in various reputed research institutions. and industries
CO3	To prepare the tour report.

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

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B110603 T/BS353	**Title of the Course**	Biostatistics, Bioinformatics and computer application in Biochemistry	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basic principles, working and application of Biostatistics, Bioinformatics and computer application						

Course Outcomes	
CO1	Understand the principles of biological data collection, statistical analysis and presentation. Collect, analyze and interpret biological data using appropriate statistical tools. Learn and appreciate various factors that influence type of sample collected and sample size.
CO2	Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving DNA, RNA, or protein sequence data. Explain common methods and applications for analysis of gene or protein expression.
CO3	Improvise their computational, mathematical and computer skills, which would increase their eligibility to pursue research based higher education.
CO4	Acquire proficiency in sequence alignment methods, both global and local, and database similarity searching using heuristic algorithms, along with an overview of phylogenetic studies.
CO5	Use data visualization software to effectively communicate results.

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.	**4**	**CO1**
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, Correlation analysis	**8**	**CO1**
3	Molecular Techniques	DNA sequencing, Polymerase Chain Reaction (PCR), Primer designing, DNA fingerprinting, site directed mutagenesis, RFLP, RAPD, Southern, Northern and Western Blotting	**4**	**CO2**
4	Basics of Computer and Bioinformatics	Operating systems, Hardware, Software, DOS, Data Access Using Data Control, Internet, LAN, WAN, Web servers. MS word office, excel ,powerpoint, Definition and need of Bioinformatics, Brief history of biological databases International nucleotide databases (e.g., Gen Bank, European Molecular Biology Laboratory (EMBL) Bio information and DNA Data Bank of Japan (DDBJ) Center), International Nucleotide Sequence Database Collaboration (INSDC).	**8**	**CO3**
5	Protein Databases	Classification of protein databases (e.g., primary, secondary, and composite databases), Brief overview of ExPASy (Expert Protein Analysis System) bioinformatics resource portal, Protein 3D structural databases (e.g., RCSB-PDB (Research Collaboratory for Structural Bioinformatics Protein Data Bank), and MMDB (Molecular Modeling Database) of NCBI)	**8**	**CO2**
6	Database Similarity Searches	BLAST, FASTA, PSI-BLAST, algorithms, Multiple sequence alignments - CLUSTAL, PRAS. Primer Designing, Homology Modeling, Phylogenetic analysis Drug Designing, Determination of Secondary & Tertiary of proteins	**8**	**CO4**
7	Biological File Formats and Literatures Databases	Brief overview of biological sequence and 3D structure file formats (e.g., GenBank/GenPept, EMBL, FASTA, PIR, and PDB), NCBI's literature databases (e.g., PubMed, PubMed Central, PubChem Project and OMIM database	**8**	**CO5**
8	Database Similarity Searching and Phylogenetics	Requirements of database searching, BLAST (Basic Local Alignment Search Tool) algorithm, Statistical significance and variants of BLAST FASTA algorithm and its statistical significance, Comparison of BLAST and FASTA, Brief Overview of phyogenetic analysis	**8**	**CO4**
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:

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

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

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

Effective from Session: 2024-25							
Course Code	B110601T / BS355	**Title of the Course**	Food and Nutritional Biochemistry	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 in Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the basic concepts of nutritional biochemistry which comprises nutritional values of foods, dietary requirements of carbohydrates, lipids, proteins and the factors responsible for malnutrition and measures to overcome malnutrition in infants and adults.						

Course Outcomes	
CO1	Concept of nutrition, energy measurements, BMR, SDA, RNI and RDA
CO2	Classification, Functions, Bioavailability and deficiency of Minerals and vitamins
CO3	Distribution, composition and functions of fluid in human body
CO4	Classification, composition, food sources, functions of carbohydrates, proteins, fats and oils
CO5	Introduction to various clinical diagnostic tests

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Food and Nutrition	Food as a source of nutrients, Functions of food- Physiological, psychological and social, definition of nutrition, nutrients, adequate, optimum and good nutrition, malnutrition.	6	CO-1
2	Energy Metabolism	Unit of energy measurements of food stuffs by Bomb colorimeter, calorific value and RQ of food stuffs. Basic metabolic rate (BMR), its measurements and influencing factors, SDA of food. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.	8	CO-1
3	Minerals & Vitamins	Minerals Classification: Macronutrients and Micronutrients, Functions, sources, Bioavailability, and deficiency of minerals. Classification, Bioavailability, sources, functions and deficiency: Fat soluble vitamins- A, D, E and K, Water soluble vitamins- thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B12 and vitamin C	8	CO-2
4	Water metabolism	Distribution & composition of fluid in human body, ECF, ICF, Functions of water, fluid balance disorder of water metabolism, Homeostasis.	8	CO-3
5	Carbohydrates	Classification, composition, food sources, functions, storage in body.	8	CO-4
6	Fat and Oils	Classification, composition, saturated and unsaturated fatty acids, food sources, functions of fats.	8	CO-4
7	Proteins	Composition, , essential and non-essential amino acids, food sources, functions, protein deficiency.	8	CO-4
8	Biochemical test	Introduction to liver function test, Liver function test LFT profile, Glucose tolerance test, renal function test, Evaluation of filtration barrier, Total Protein Albumin/Globulin Ratio (A-G Ratio).	8	CO-5

Reference Books:

1. Tom Brody: Nutritional Biochemistry (Second Edition), Academic Press.
2. David A. Bender: Nutritional Biochemistry of the Vitamins, Second Edition, University College London, Cambridge University Press.
3. Harper's Illustrated Biochemistry, 29th edition, Mc Graw Hill Education, Lange
4. Denise R. Ferrier, Richard A. Harvey, Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. Wolters Kluwer/Lipincott, Williams and Wilkins
5. Rekhi T and Yadav H (2014). Fundamentals of Food and Nutrition. Elite Publishing House Pvt Ltd., Delhi.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	3			
CO2								3			
CO3	3	1					1	3			
CO4	3	1					1	3		1	
CO5	3	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: 2024-25							
Course Code	B100607T/BS313	**Title of the Course**	**BIONANOTECHNOLOGY**	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	3	1	0	4
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the Basics of nanotechnology and an overview of nanoscale materials, Nanomaterials: Biosensors: Biophotonics and Bioimaging and Principles of Toxicology;						

Course Outcomes	
CO1	Understand the basics of nanotechnology and overview of nanoscale materials.
CO2	Understand the basics of Nanomaterials.
CO3	Understand the basics of Biosensors.
CO4	Understand the basics of Biophotonics and Bioimaging.
CO5	Understand the Principles of toxicology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Introduction**	Introduction to nanotechnology and overview of nanoscale materials, the effect of length scale on properties,	6	CO.1
2	**Bionanotechnology**	Introduction to bionanotechnology, challenges and opportunities associated with biology on the Nanoscale, bionanotechnology systems, biological and medical applications of Bionanomaterials.	8	CO.1
3	**Nanomaterials**	Introduction to nanomaterials. DNA-based nanostructures. General surface and colloid chemistry, principles, experimental techniques, surface potential, DLVO theory; Characteristics of nanoparticles, chemical speciation of dissolved species, Environmental behavior of nanoparticles.	8	CO.2
4	**Characteristics of nanoparticles**	Characteristics of nanoparticles, chemical speciation of dissolved species, Environmental behavior of nanoparticles.	8	CO.2
5	**Biosensors**	Introduction to biosensors, the biological component, the sensor surface, Immobilization of the sensor molecule, Transduction of the sensor signal: Optical, Electrochemical and Mechanical sensors, Sensor stabilization	8	CO.3
6	**Biophotonics**	Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Introduction to biophysics,	6	CO.4
7	**Bioimaging**	Basic physical concepts in imaging, Major techniques using ionizing and non-ionizing radiation: fluorescence and multi-photon microscopy, spectroscopy, OCT, MRI, X-ray CT, PET and SPECT imaging.	8	CO.4
8	**Nanotoxicology**	Principles of toxicology; toxicology models, experimental toxicology studies; activation and detoxification mechanisms, importance of biological membrane in toxicology; Toxicology and bioaccumulation of particles. Biological activity of nanomaterials.	8	CO.5

Reference Books:

· Engines of Creation, K E Drexler, Oxford Paperbacks, New York
· .Engines of Creation, K E Drexler, Oxford Paperbacks, New York
· Nanosystems: Molecular Machinery, Manufacturing and Computation, K E Drexler, Wiley, ISBN 0471575186
· Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform the World, Prometheus ISBN 1573929921
· Nanobiotechnology-Concepts, Applications and Perspectives edited by CM Niemeyer and CA Mirkin, Wiley-VCH ISBN 527-30658-7
· NanoBiotechnology Protocols in Methods in Molecular Biology Series Edited by SJ Rosenthal and DW Wright, Humana Press, ISBN: 1-58829-276-2
· Understanding Nanotechnology Scientific American, ISBN: 0446679569 Prey (a novel) by Michael Crichton, ISBN:

006621412

e-Learning Source:
www.nanotechweb.org; www.nano.gov; www.nanotec.org.uk

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

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

1-

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B110602P/BS356	Title of the Course	Food and Nutritional Biochemistry Lab	L	T	P	C
Year	III	Semester	V	0	0	4	2
Pre-Requisite	10+2	Co-requisite					
Course Objectives	The course is designed to train the students in techniques of Food and Nutritional Biochemistry.						

Course Outcomes	
CO1	The students will be able to quantify total protein content of different food products.
CO2	The students will be able to quantify carbohydrate content of different food items.
CO3	The students will be able to estimate phenolic content.
CO4	The students will be able to estimate carotenes.
CO5	The students will be able to plan meals for individuals according to their requirement.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Exp-01	Estimation of total protein content of different food products by Lowry's method.	3	CO-1
2	Exp-02	Estimation of carbohydrate content of different edible items by Anthrone's method.	3	CO-1
3	Exp-03	Estimation of phenolic content.	3	CO-2
4	Exp-04	Estimation of carotenes	3	CO-3
5	Exp-05	Estimation of reducing sugar by dinitrosalicylic acid method.	6	CO-4
6	Exp-06	Meal planning for persons of different age groups to meet their nutritional requirements (Kids, Adolescents, Adults etc.)	6	CO-5
Reference Books:				
1. W.F. Harrigan, Laboratory methods in Microbiology, Publisher – Elsevier				
2. Lynne Mc Landsborough, Food Microbiology Laboratory, CRC Press				
e-Learning Source:				

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

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

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

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Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B110604P/BS354	**Title of the Course**	Bioinformatics, Biostatistics and Computer application Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**0**	**0**	**4**	**2**
Pre-Requisite	10+2	**Co-requisite**					
Course Objectives	The course is designed to train the students in bioinformatics and Biostatistical tools.						

Course Outcomes	
CO1	To understand the working of computer, MS-Word, MS-excel, MS-PowerPoint.
CO2	To understand data analyzing software and sequence databases.
CO3	Develop understanding of Bioinformatics as tools for Sequence Alignment.
CO4	To study gene/protein homologs, Protein Structure Visualization, as well as for Gene Finding
CO5	To learn the biostatistical methods and designing of diagram chart and plots.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	An introduction to Computers, MS-Word, MS Excel, MS Power Point.	2	CO1
2	Exp-02	Learning to analyze data using SPSS or R software	4	CO2
3	Exp-03	Introduction to types of sequence databases (Nucleotides & Protein)	2	CO2
4	Exp-04	Pair wise Sequence Alignment (NW and SW approach), FASTA & BLAST search	4	CO3
5	Exp-05	Multiple Sequence Alignment (ClustalX&Treeview)	2	CO3
6	Exp-06	Use of gene prediction methods (GRAIL, Genscan, Glimmer).	4	CO4
7	Exp-07	Use of different protein structure prediction databases (PDB, SCOP, CATH etc.).	4	CO4
8	Exp-08	Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student test, ANOVA	4	CO5
9	Exp-09	Designing of bar diagram, pi chart, histogram, scatter plots, in EXCEL for presentation of data.	4	CO5

Reference Books:

Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.

Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. Baxevanis, A. D., & Ouellette, B. F. (2001).

Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience

Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.

Rastogi VB.(2015). Biostatistics (3rd Edition). MedTec

e-Learning Source:

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

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

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

Effective from Session: 2024-25							
Course Code	B100604P / BS310	**Title of the Course**	Food microbiology and Biotechnology Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of food microbiology and biotechnology.						

Course Outcomes	
CO1	The students will be able to isolate and characterize yeast.
CO2	The students will be able to isolate and identify important microorganisms of food microbiology.
CO3	The students will be able to assess the quality of raw milk and preparation of sauerkraut.
CO4	The students will be able todetermine total proteins by Bradford method.
CO5	The students will be able to analyse moisture, ash, protein, fat, fiber and carbohydrate in food sample.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Exp-01	Isolation and characterization of Yeast used in Bakery/distillery/winery	6	CO-1
2	Exp-02	Isolation & identification of important microorganism of food microbiology	6	CO-1
3	Exp-03	Methylene Blue Dye Reduction Test for Assessing the quality of raw milk.	6	CO-1
4	Exp-04	Preparation of sauerkraut.	6	CO-2
5	Exp-05	Quantitative determination of Total proteins by Bradford method	6	CO-3
6	Exp-06	Proximate analysis of food sample: moisture, ash, protein, fat, fiber and carbohydrate	6	CO-4

Reference Books:

1. Aneja, K.R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R.C. and Maheshwari. D.K. 2012. Practical Microbiology, S.Chand & Company, Pvt. Ltd., New Delhi.

e-Learning Source:

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

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

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

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	B100605T/BS394	Title of the Course	Applied Biotechnology	L	T	P	C
Year	III	Semester	V	3	1	0	4
Pre-Requisite	10+2 Biology	Co-requisite					
Course Objectives	The objective of this course is to make students familiar with Genomics and proteomics, principle, methodology and application of Drug discovery, Bioprospecting and conservation: importance of biodiversity, General theory of free radical and antioxidants, Significance of IPR; Requirement of a patentable novelty, Biosafety and GMOs.						

Course Outcomes	
CO1	Get proper knowledge about Genomics, Proteomics and gene expression.
CO2	Gain knowledge about Drug Discovery and Designing: Drug and target identification, target validation.
CO3	Learn about Bioprospecting and conservation: importance of biodiversity.
CO4	Learn about the basics of Free Radical Biology: General theory of free radical and antioxidants.
CO5	Have knowledge of Significance of IPR and Biosafety.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Genomics and Genome annotation	Introduction to genomics, Genome annotation, Alignment, Whole genome sequencing methods, Human genome project and its application	8	CO1
2	Proteomics and its analysis	Introduction to Proteomics, Proteomics classification, Protein expression and its analysis, Bioinformatics in proteomics	8	CO1
3	Drug Discovery and designing	Drug and target identification, Drug and target validation, Molecular docking studies and its Insilco tools e.g. Autodock, GOLD.	8	CO2
4	Bioprospecting and conservation	Importance of biodiversity. biodiversity informatics, databases in biological materials. International efforts and issues of sustainability.	8	CO3
5	Free Radical Biology	General theory of free radicals and antioxidants. Free radical mediated damage to lipids, proteins and DNA; Natural antioxidants and their applications.	6	CO3
6	IPR and Patenting	Significance of IPR; Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms; International convention in IPR; Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity.	8	CO4
7	Biosafety	Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines Government of India; Roles of Institutional Biosafety Committee, RCGM, GEAC etc.	8	CO5
8	GMOs	Definition of GMOs; GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication	6	CO5

Reference Books:

3. 1.Genome, T.A. Brown, John Willey & Sons Inc.
4. 2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Publishing
5. 3. Molecular Cell Biology, H. Lodish, A.Berk, S. Zipursky, P Matsundaira, D. Baltimore and J.E. Barnell, W.H. Freeman and Company.
6. 4. Molecular Biology of the Gene, J.D. Watson, A.M. Weiner and N.H. Hopkins, Addison- Wesley Publishing.
7. 5. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley and Sons Inc.

6. Biotechnology- B.D. Singh

e-Learning Source:

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					3	3	1	1	3
CO2	3	1					3	3	1	1	3
CO3	3	1			1	3	3	3	1	1	3
CO4	3	1					3	3	1	1	3
CO5	3	1			3	2	3	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: 2024-25							
Course Code	B100606T/ BS395	**Title of the Course**	Genomics, Proteomics & Metabolomics	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of Genome sequencing, Genome databases, Genome analysis, Proteomics and Metabolomics.						

Course Outcomes	
CO1	The students will be able to explain Genome sequencing techniques and Sequencing technology.
CO2	The students will be able to discuss about major Genome databases, Genome analysis, Comparative genomics, Functional genomics techniques.
CO3	The students will be able to describe about basic Proteomics technologies.
CO4	The students will be able to describe the basics technologies used in Metabolomics.
CO5	The students will be able to discuss applications of Genomics and Proteomics in various fields of life.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genome sequencing	Sequencing technology: Sanger sequencing, Maxam-Gilbert sequencing. Pros and cons of these sequencing technologies. Whole shotgun genome sequencing	**6**	**CO1**
2	Next generation Sequencing	Sequencing technology: Pyrosequencing, Illumina/Solexa, SOLiD System, Ion Torrent. Introduction to third generation sequencing technologies.	**8**	**CO1**
3	Genome databases and Structural genomics	Major Genome databases, Genome analysis and their applications-Structural genomics: Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of Genomes; sequence assembly and annotation.	**8**	**CO2**
4	Functional genomics	Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics. Comparative genomics.	**8**	**CO2**
5	Proteomics	Introduction to basic proteomics technology: 1D-SDS-PAGE, 2D-SDS PAGE. Detection and quantitation of proteins in gels. Pros and cons of various staining methods. Yeast-two-hybrid system, cDNA microarrays.	**8**	**CO3**
6	Mass spectrometry	Basics of mass spectrometry. MALDI-TOF and ESI, and their application in proteomics, Tandem MS/MS spectrometry, Peptide sequencing by tandem mass spectrometry.	**8**	**CO3**
7	Metabolomics	Technologies in metabolomics, Role of Spectroscopy, Electrophoretic and Chromatographic techniques in metabolic profiling. Nutrigenomics.	**8**	**CO4**
8	Applications	Applications of genomics and proteomics in agriculture, human health, and industry.	**6**	**CO5**

Reference Books:

1. Griffiths JF, “An Introduction to Generic Analysis”.
2. Gene Cloning and DNA Analysis: An Introduction, 6th Edition by T. A. Brown
3. Genomics and Proteomics: Functional and Computational Aspects by Suhai and Sándors,
4. Genomics and Proteomics: Principles, Technologies, and Applications by Devarajan Thangadurai and Jeyabalan Sangeetha
5. The Handbook of Metabolomics and Metabolomics by John C. Lindon, Jeremy K. Nicholson and Elaine Holmes

e-Learning Source:

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

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100608R/ BS396	**Title of the Course**	Research Project (minor) and seminar	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**0**	**0**	**6**	**6**
Pre-Requisite		**Co-requisite**					
Course Objectives	The main objective of this course is to acquaint the student with various techniques used in contemporary research in microbiology/biotechnology that will be useful in successful completion of their project work in the fourth semester.						

Course Outcomes	
CO1	To develop synopsis of a defined research problem.
CO2	To conduct the bench work.
CO3	To prepare the research report and its oral demonstrations.

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

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

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