Integral University, Lucknow

Effective from Session: 2015-16							
Course Code	CH215	**Title of the Course**	Fundamental of Physical Chemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Chemistry	**Co-requisite**	Elementary Mathematics				
Course Objectives	The purpose of this undergraduate course is to impart basic and key knowledge of physical chemistry. By using the principle of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completing the course, the student will be able explore the subject into their respective dimensions.						

Course Outcomes	
CO1	Students are able to understand the order and molecularity of reaction, concept of activation energy method of integration, half-life method and isolation and their applications.
CO2	Students would restate the definition of system, surrounding, closed and open system, extensive and intensive properties and understand the first law of thermodynamics by taking isothermal & adiabatic processes.
CO3	Students evaluate fundamentals of electrochemistry and understand the concept of pH, solubility and its application.
CO4	Students would get inside the sound knowledge of gas and their properties and examine the relationships between gas temperature, pressure, amount, and volume.
CO5	Students will be able to understand the key concepts for lowering of vapor pressure, elevation in boiling point and depression in freezing point. They are able to distinguish between osmosis and reverse osmosis and their applications.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Chemical Kinetics	Rate of a reaction, factors influencing the rate of a reaction, concentration, solvent, temperature, pressure, light, catalyst concentration dependence of rates, mathematical characteristics of simple chemical reactions- First & second order, half life. Determination of order of reaction (integration, method), Arrhenius equation, concept of activation energy.	8	CO1
2	Thermodynamics	Definition and explanation of terms- System, boundary, surrounding. Homogeneous system, isolated system, Closed system, Open system. Intensive and extensive properties. First law of Thermodynamics: statement and equation- Cp, Cv relationship- Calculation of W, q, dU and dH for the expansion of ideal gases under reversible- isothermal and adiabatic conditions.	8	CO2
3	Electrochemistry	Galvanic Cells, Electrode potential, Standard electrode potential, Nernst equation, Electrochemical series and its applications: measurement of pH,Solubility and solubility product and its applications	8	CO3
4	Gaseous state	Ideal and real gases, Causes of deviation from ideal behaviour, van der Waals gas equation and their limitations. Kinetics gas equation, deduction of gas laws from kinetic gas equation, kinds of velocities: Root mean square, average and most probable velocities. Calculation of molecular velocities.	8	CO4
5	Colligative Properties	Lowering of vapour pressure, Raoult's law, Determination of molecular mass of solute from lowering of vapour pressure, Elevation of boiling point, relation between elevation of boiling point and lowering of vapor pressure, Depression of freezing point and relation between Depression of freezing point and lowering of vapor pressure. Determination of molecular mass of solute from depression of freezing point , Osmosis and osmotic pressure, vant't Hoff equation.	8	CO5

Reference Books:

1. Principles of Physical Chemistry by Puri Sharma and Pathan by Vishal Publishing House.
2. Essentials of Physical Chemistry, Bahl & Tuli, S. Chand & Co. Ltd.
3. Simplified course in Physical Chemistry, Madan & Tuli, S. Chand & Co. Ltd.
4. Atkin's Physical Chemistry, Atkin, Oxford Press.

e-Learning Source:

1. https://nptel.ac.in/courses/104106089
2. https://onlinecourses.swayam2.ac.in/nce19_sc15/preview
3. https://www.bonsecourscollege.edu.in/box-chemistry.php

	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	3	2	2	2	1
CO2	3	1				1	3	3	2	1	2	1
CO3	3	1				2	2	3	2	1	3	2
CO4	3	1				1	2	3	1	1	1	1
CO5	3	1				3	2	3	2	2	2	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	BS202	**Title of the Course**	Biophysical Chemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basic principles, working and application of commonly used biophysical techniques viz spectroscopy, chromatography, Centrifugation, Electrophoresis and the Importance of radioactivity in biological studies including GM counters and Scintillation counting.						

Course Outcomes	
CO1	Understand the basics of biophysics, chemical bonds and concept of thermodynamics.
CO2	Understand the basics and types of spectroscopy.
CO3	Know basic principle, methodology and application of various chromatographic techniques
CO4	Study centrifugation and electrophoresis - principles and applications
CO5	Understand the importance of radioactivity in biological studies, GM counters and Scintillation counting.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of Biophysics	Chemical bonding–Ionic bond, covalent bond, hydrogen bond and peptide bond, Vander-Waals forces, Principles of thermodynamics	8	CO1
2	Analytical techniques	Colorimetry, UV-visible spectrophotometry, NMR, IR, Fluorescence and atomic absorption spectroscopy, Mass spectroscopy.	8	CO2
3	Chromatography	Chromatography: Paper, thin-layer, Column, Ion-Exchange, HPLC, GLC and molecular sieving	8	CO3
4	Centrifugation & Electrophoresis	Centrifugation principles, Theory, Types, instrumentation and applications. Electrophoresis: Principles, working and applications of PAGE and Agarose gel electrophoresis	8	CO4
5	Radioactivity	Radioactivity: Types, their importance in biological studies, measure of radioactivity, GM counters, Scintillation counting and Autoradiography	8	CO5

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	PSO1	PSO2	PSO3	PSO4
CO1	**3**	**1**					**2**	**3**			**1**
CO2	**3**	**1**					**2**	**3**			**1**
CO3	**3**	**1**					**2**	**3**			**1**
CO4	**3**	**1**					**2**	**3**			**1**
CO5	**3**	**1**					**2**	**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: 2019-20							
Course Code	BS241	**Title of the Course**	Fundamentals of Genetics	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basic concepts in genetics, To understand disorder related with genetics.						

Course Outcomes	
CO1	The student will learn Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.
CO2	The student will learn Model organism for genetic analysis, Drosophila development, maternal effect genes, morphogens
CO3	The student will learn Structural Organization: centromere, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype, nucleosome model, Special types of chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations.
CO4	The student will learn Mendels laws of heredity, Test cross, Incomplete dominance and simple problems, Interaction of Genes Complementary genes , Epistasis: Plumage colour in poultry, Multiple allelism: Blood groups in human beings, Concepts of allosomes and autosomes,
CO5	The student will learn Spontaneous and induced mutations, Physical and chemical mutagens, Mutation at the molecular level, Mutations in plants, animals, and microbes for economic benefit of man. Human Genetics.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genetics of bacteria and virus	Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.	8	CO1
2	The genetic control of development and sex determination	Model organism for genetic analysis, Drosophila development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.	8	CO2
3	Chromosomes	Structural Organization: centromere, telomere, chromonema, euchromatin and heterochromatin, chemical composition and karyotype, nucleosome model, Special types of chromosomes: Salivary gland and Lampbrush chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations.	8	CO3
4	Mendelism	Mendels laws of heredity, Test cross, Incomplete dominance and simple problems, Interaction of Genes: Supplementary factors, Comb pattern in fowls, Complementary genes: Flower color in sweet peas, Multiple factors: Skin color in human beings, Epistasis: Plumage colour in poultry, Multiple allelism: Blood groups in human beings, Concepts of allosomes and autosomes, XX-XY, XX-XO, ZW-ZZ, ZO-ZZ type, Linkage and Crossing Over, Mechanism and importance.	8	CO4
5	Mutations	Spontaneous and induced mutations, Physical and chemical mutagens, Mutation at the molecular level, Mutations in plants, animals, and microbes for economic benefit of man. Human Genetics: Karyotype in man, inherited disorders: Allosomal (Klinefelter syndrome and Turner's syndrome), Autosomal (Down syndrome and Cri-DuChat syndrome). DNA Damage and Repair: Causes and Types of DNA damage, Major mechanisms of DNA repair: photoreactivation, nucleotide and base excision repairs, mismatch repair, SOS repair.	8	CO5

Reference Books:

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2. 2. .
2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1
3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1- 4292- 2943-8.
4. Molecular Cell Biology – Daniel, Sceintific American Books.
5. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.

e-Learning Source:

https://docs.google.com/presentation/d/1FVva3inQfrPEGT3tn5beaL8kZrPXhL/edit?usp=sharing&ouid=114812600151870954936&rtpof=true&sd=true

https://drive.google.com/drive/folders/1AcAkJligOJD8m1TR8TESPXMXa1uxyhtr?usp=sharing

	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	2
CO2	3	1					1	3		3	2
CO3	3	1					1	3		3	2
CO4	3	1					1	3		3	2
CO5	3	1					1	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	BS242	**Title of the Course**	Introduction to Cell Biology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of Cytoskeleton and Cell Membrane, structure of Microtubules, microfilaments, cellular organization of prokaryotic and eukaryotic cells signal transduction, secondary messengers.						

Course Outcomes	
CO1	Distinguish between prokaryotic and eukaryotic cells and develop an understanding of microscopy.
CO2	Would have deeper understanding of cell at structural and functional level.
CO3	Develop an understanding of the Cytoskeleton, Microtubules, and microfilaments.
CO4	Would have broad knowledge on the molecular interaction between cells.
CO5	Would demonstrate a clear understanding of the signal transduction, secondary messengers.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction and tools of cell biology	Prokaryotic (archaea and eubacteria) and eukaryotic cells (animal and plant cells), Light microscopy, phase contrast microscopy Fluorescence microscopy, confocal microscopy, electron microscopy.	8	CO1
2	Intracellular organization	Cell Membrane and Permeability: Chemical components and organization of biological membranes, Fluid Mosaic Model and membrane transport. Structure and functions of organelles, nucleus, ER, Golgi, Lysosome, mitochondria, chloroplasts and peroxisomes. Zellweger syndrome.	8	CO2
3	Cytoskeleton proteins and protein targeting	Structure and organization of actin filaments. Intermediate filament proteins, Microtubules: assembly and intracellular organization. Organization and movement of cilia and flagella, Concept of protein targeting.	8	CO3
4	Cell wall, extracellular matrix and cell signaling	Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata. Basics of signal transduction, Role of cAMP, G-proteins and inositol phosphates in signal transduction.	8	CO4
5	Cell cycle	Cell death and cell renewal: Eukaryotic cell cycle, restriction point, and checkpoints. Cell division: Mitosis and Meiosis. Apoptosis and necrosis - brief outline.	8	CO5

Reference Books:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0- 87893300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:9781- 4641-0981-2 / ISBN:10: 1-4641-0981-8.

3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153- 1619-4 / ISBN:0-8153-1620-8.

4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.

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	1			
CO2	3	1					1	1			
CO3	3	1					1	1			
CO4	3	1					1	1	2		
CO5	3	1					1	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: 2019-2020							
Course Code	BS243	**Title of the Course**	Fundamentals of Bioinformatics	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basic practical techniques of bioinformatics and biological databases and will be able to apply these methods to research problems.						

Course Outcomes	
CO1	Formulate and justify appropriate choices in technology, strategy, and analysis for a range of projects involving biological sequence data.
CO2	Explain primary, secondary and composite protein databases and their impact on the display and analysis of biological data.
CO3	Understand the layout of biological databases and retrieval of biological literature from NCBI bibliographic databases.
CO4	Explain common methods and applications for sequence similarity and molecular phylogenetics.
CO5	Gain knowledge of drug discovery process and developments, rational approaches to drug design, docking, and virtual screening.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Bioinformatics	Genesis, definition, and need of Bioinformatics, Brief history of biological databases, International nucleotide databases (e.g., GenBank, European Molecular Biology Laboratory (EMBL), Bioinformation and DNA Data Bank of Japan (DDBJ) Center), International Nucleotide Sequence Database Collaboration (INSDC).	8	CO1
2	Protein Databases	Introduction to structural elements of proteins, 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
3	Biological File Formats and Literatures Databases	A 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 (e.g., PubChem Compound, Substance and Bioassay databases), and OMIM (Online Mendelian Inheritance in Man) database.	8	CO3
4	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 phylogenetic analysis	8	CO4
5	Computer-Aided Drug Design	Introduction to drug discovery, drugs derived from natural products, existing drugs as a source for new drug discovery, screening for new drug leads, modern rational approach to drug design, docking, and virtual screening. A brief overview of online databases of Ligands and Drugs.	8	CO5

Reference Books:

Protein Bioinformatics: From Sequence to Function, Academic Press, 2011, ISBN 0123884241, 9780123884244.

Essential Bioinformatics, Cambridge University Press, 2006, ISBN 113945062X, 9781139450621

Kerns EH, Di L. Drug-Like Properties: Concepts, Structure Design and Methods: from ADME to Toxicity Optimization, Academic Press, Oxford, 2008

Principles of Medicinal Chemistry, 7th Edition, edited by TL Lemke, DA Williams, V F Roche, and SW Zito Williams and Wilkins: Philadelphia, 2013.

e-Learning Source:

http://nptel.ac.in/courses/102101040

https://onlinecourses.nptel.ac.in/noc16_bt07

https://onlinecourses.nptel.ac.in/noc21_bt06

https://ftp.ncbi.nih.gov/pub/factsheets/HowTo_BLASTGuide

			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		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		

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	BS244	**Title of the Course**	Physiology Lab	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**0**	**0**	**6**	**3**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the physiological functions of the biological systems						

Course Outcomes	
CO1	Determination of osmotic potential of plant cell sap by plasmolytic method.
CO2	To study the effect of two environmental factors (light and wind) on transpiration.
CO3	To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
CO4	Estimation of hemoglobin.
CO5	Measurement of blood pressure

S.No.	**Experiments**	**Contact Hrs.**	**Mapped CO**
Exp-01	Determination of osmotic potential of plant cell sap by plasmolytic method.	6	CO1
Exp-02	To study the effect of two environmental factors (light and wind) on transpiration by excised twig.	6	CO2
Exp-03	To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.	6	CO3
Exp-04	Estimation of hemoglobin.	6	CO4
Exp-05	Measurement of blood pressure	6	CO5
Reference Books:			
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			2	3	1			
CO2	3	3	1			2	3	1			
CO3	3	3	1			2	3	1			
CO4	3	3	1			2	3	1			
CO5	3	3	1			3	3	1		2	

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS206	**Title of the Course**	Cell Biology & Genetics Lab	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	0	0	6	3
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of use of Micrometer and calibration, measurement of onion epidermal cells and yeast, Cell division processes: Mitotic and meiotic studies, Chromosomes: polytene chromosomes, Karyotype analysis – with the help of slides and how to make Blood smear – differential staining and Buccal smear – Barr bodies.						

Course Outcomes	
CO1	The students will be able to comprehend the use of Micrometer and calibration, measurement of cells.
CO2	The students will have able to explain Cell division: Mitosis and meiosis
CO3	The students will be able to compare different types of Chromosomes.
CO4	The students will have knowledge of types of chromosomes as polytene chromosomes
CO5	The students will be able to perform experiments related to differential staining of blood and Buccal smear – Barr bodies

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Use of Micrometer and calibration, measurement of onion epidermal cells and yeast.	3	CO1
Exp-02	Cell division: Mitotic and meiotic studies in grasshopper testes, onion root tips and flower bud	3	CO2
Exp-03	Karyotype analysis – with the help of slides	6	CO3
Exp-04	Chromosomes: Mounting of polytene chromosomes	6	CO4
Exp-05	Blood smear – differential staining	6	CO5
Exp-06	Buccal smear – Barr bodies	6	CO5
Reference Books:			
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	3	1		
CO2	3	3	1				3	3	1		
CO3	3	3	1				3	3	1		2
CO4	3	3	1				3	3	1		3
CO5	3	3	1				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: 2020-21							
Course Code	BS251	**Title of the Course**	Enzymes & Hormones	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the concepts of enzyme and hormones enzyme kinetics.						

Course Outcomes	
CO1	General properties and modes of actions of enzymes
CO2	Activation energy and thermodynamics of enzyme action.
CO3	Structure, source, biochemical role and deficiency disease of Vitamins
CO4	Hormones: classification, structural features & functions in Plants: auxins, gibberellins,
CO5	Hormones and their functions secreted by endocrine glands

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	General properties and modes of actions of enzymes	Criteria of purity of enzymes Specific activity. Enzyme units-Katal and IU. Chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes- Ribozymes and DNAzymes. Activation energy and thermodynamics of enzyme action. Classification of proteases with their mechanism of action.	8	CO1
2	Enzyme Kinetics	Enzyme Kinetics, Briggs-Haldane steady state approach, methods for the determination of Km and Vmax normalized initial rate equation and normalized curves. Enzyme inhibition and activation, Effect of enzymes concentration, pH and temperature on kinetics of enzyme reactions.	8	CO2
3	Vitamins	Structure, source, biochemical role and deficiency disease: Fat soluble vitamins A, D & Water soluble vitamin – B1, B2, niacin, pyridoxine, folic acid, B12 and C	8	CO3
4	Plant Hormones	Classification, structural features & functions in Plants: auxins, gibberellins, cytokinins, ethylene, and abscisic acid	8	CO4
5	Animal Hormones	Hormones and their functions secreted by endocrine glands: Hypothalamus, pituitary gland-anterior pituitary and posterior pituitary; thyroid gland; adrenal gland; Pancreas; gonads.	8	CO5

Reference Books:

1. Lehninger, AL "Principles of Biochemistry"
2. Lubert Stryer "Biochemistry".
3. Alan Fersht "Enzyme Structure and Mechanism."
4. Palmer "Enzymes" Dixon & Webb "Enzymes.

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		2	2	
CO2	3	1					1		3		3
CO3	3	1					1		3		
CO4	3	1					1		3		
CO5	3	1		2	3		1		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: 2020-21							
Course Code	BS212	**Title of the Course**	Molecular Biology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to enable students to understand the concept of different types of genes, DNA replication, Transcription, Translation, regulation of Gene expression in prokaryotes and eukaryotes.						

Course Outcomes	
CO1	The students will be able to explain the concept of genetic organization in prokaryotes and eukaryotes.
CO2	The students will be able to explain the process of DNA replication and its regulation in prokaryotes and eukaryotes.
CO3	The students will be able to explain the process of transcription in prokaryotes and eukaryotes and post transcriptional modifications.
CO4	The students will be able to describe the basics of translation in prokaryotes and eukaryotes and post translational modification.
CO5	The students will be able to discuss regulation in gene expression and DNA repair systems.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genome organization	Central Dogma, Definition of gene, types of genes (split genes, overlapping genes; pseudogenes, cryptic genes), concept of intron and exon. Genome organization in prokaryotes. Complexity of eukaryotic genome, nucleosome model and higher order structure of DNA. Organellar genome (Mitochondria and chloroplast). Insertion elements and transposons.	8	CO1
2	DNA Replication	DNA as genetic material. Semiconservative mode of replication. Mechanism of Replication in prokaryotes and eukaryotes. Enzymes and proteins involved in replication, Theta model and Rolling circle model	8	CO2
3	Transcription	Properties of prokaryotic and eukaryotic promoters. RNA polymerase, transcription factors. Mechanism of transcription. Post-transcriptional modifications of eukaryotic mRNA (capping, polyadenylation and splicing)	8	CO3
4	Genetic code	Genetic code, adaptor role of t-RNA, Wobble hypothesis. Mechanism of translation in Prokaryotes and Eukaryotes, Post-translational modifications of proteins.	8	CO4
5	Regulation of Gene expression	Operon concept (Lac operon), transcriptional activation, galactose metabolism in yeast. Introduction to DNA repair systems (Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair)	8	CO5

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

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**					**1**	**3**			
CO3	**3**	**1**					**1**	**3**			
CO4	**3**	**1**					**1**	**3**			
CO5	**3**	**1**					**1**	**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: 2019-20							
Course Code	BS252	**Title of the Course**	Clinical Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of basic concepts of clinical biochemistry, To understand disorder related with biomolecules metabolism.						

Course Outcomes	
CO1	Anticoagulant preservatives for blood and urine. Transport of specimens.
CO2	Composition and their functions, Anemia:- classifications, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count,
CO3	Oral glucose tolerance test in normal and diabetic condition.
CO4	Cholesterol: Factors affecting blood cholesterol level. Dyslipoproteinemia, atherosclerosis, risk factor and fatty liver.
CO5	Metabolism of bilirubin, jaundice - types, differential diagnosis. Liver function test – Icteric index, Vandenberg test, plasma protein changes.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basic concepts of Clinical Biochemistry	A brief review of units and abbreviations used in expressing concentrations and standard solutions. Specimen collection and processing (Blood, urine, faeces). Anticoagulant preservatives for blood and urine. Transport of specimens.	8	CO1
2	Hematology	Blood: Composition and their functions, Anemia:- classifications, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count, Platelet count, Differential count, determination of Hb, PCV and ESR. Hemoglobinopathies, Thalassemias.	8	CO2
3	Disorder in carbohydrate metabolism:	Regulation of blood sugar, Glycosuria-types of glycosuria. Oral glucose tolerance test in normal and diabetic condition. Diabetes mellitus and Diabetic insipidus - hypoglycemia, hyperglycemia. Ketonuria, ketosis.	8	CO3
4	Disorder in lipid metabolism	Lipid and lipoproteins: Classifications, composition, mode of action. Cholesterol: Factors affecting blood cholesterol level. Dyslipoproteinemias, atherosclerosis, risk factor and fatty liver. Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.	8	CO4
5	Liver function test	Metabolism of bilirubin, jaundice - types, differential diagnosis. Liver function test - Icteric index, Vandenberg test, plasma protein changes. Renal function test: Clearance test–Urea, Creatinine, Inulin, para-aminohippuric acid (PAH) test, Concentration and dilution test. Enzymology: Clinical significance of SGOT, SGPT, ALP, ACP, CPK and LDH	8	CO5

Reference Books:

1. Medical Biochemistry by MN Chatterjee, Rana Shinde, 8 edition, 2013, Jaypee publications.
2. Textbook of Medical Laboratory Technology by Praful B. Godkar and Darshan P. Godkar th
3. Medical Laboratory Technology by Ramnik sood, 5 Edition, 1999, Jaypee publishers.
4. Text book of Biochemistry with clinical correlation, Thomas M. Devlin, 3rd edition, A. JohnWiley-Liss Inc. Publication.
5. Practical Clinical Biochemistry, Harold Varley, 4th edition, CBS Publication and Distributors, New Delhi.

e-Learning Source:

https://classroom.google.com/c/NTM3Njg5MTE4NjNa/p/OTI0Njc2NjAzMDFa/detai

https://docs.google.com/document/d/1xDyJSzt1GZ GSxrCG1fPEdGjaBCu9yKPw/edit?usp=sharing&ouid=114812600151870954936&rtpof=true&sd=t

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

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS253	**Title of the Course**	Fundamentals Of Plant Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of carbon assimilation, respiration and nitrogen metabolism, terpenoids and representative examples from each class, biological functions of terpenoids. Concept of phytoalexins.						

Course Outcomes	
CO1	Overview of photosynthesis and different cycles operates in the plant.
CO2	Develop understanding of glycolysis, Alternative reactions of glycolysis, Fate of pyruvate, Regulation of plant glycolysis.
CO3	Gain knowledge of Nitrogen metabolism.
CO4	Structural organization of plant cell wall and effect of plant hormones on growth and development.
CO5	Overview of secondary metabolites.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Photosynthesis	Photosynthesis and Carbon assimilation: Structure of PSI and PSII complexes, Light reaction, Cyclic and noncyclic Photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.	8	CO1
2	Respiration	Respiration: Overview of glycolysis, Alternative reactions of glycolysis, Fate of pyruvate, Regulation of plant glycolysis, TCA cycle, oxidative phosphorylation and electron transport system.	8	CO2
3	Nitrogen metabolism	Nitrogen metabolism: Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase.	8	CO3
4	Cell wall & plant hormones	Cell wall structure and plant growth Regulation: Components and structure of plant cell wall, Plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light. Plant growth regulators – salicylic acid, polyamines, brassinosteroids.	8	CO4
5	Secondary metabolites	Secondary metabolites: Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids. Concept of phytoalexins	8	CO5

Reference Books:

1. Taiz, L., Zeiger, E.,. Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.

1. Hopkins, W.G., Huner, N.P.,. Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.

3 Bajracharya, D.,. Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

4. Frank B. Salisbury, Cleon W. Ross: Plant Physiology. Wadsworth Publishing Company

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

4- 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	BS201	**Title of the Course**	Metabolism	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of characteristics of Enzymes, enzyme inhibition and kinetics, carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes, lipid metabolism and production of ketone bodies, protein metabolism, role of urea cycle and errors of protein metabolism, biosynthesis and degradation of purine and pyrimidine						

Course Outcomes	
CO1	Understand the characteristic of Enzymes, enzyme inhibition and kinetics
CO2	Know the basics of carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes
CO3	Know the basics of Lipid metabolism and production of ketone bodies
CO4	Know the basics of Protein metabolism, role of urea cycle and errors of protein metabolism
CO5	Know the biosynthesis and degradation of purine and pyrimidine

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Enzymes	Classification, properties and factors influencing enzyme activity, coenzymes, prosthetic group and co-factors, Lock & key hypothesis, induced fit hypothesis, Enzyme kinetics: Michaelis Menten equation, Lineweaver-Burk plot, Enzyme inhibition, Allosteric enzymes.	8	CO1
2	Carbohydrate metabolism	Glycolysis, TCA cycle, Electron Transport Chain and Oxidative phosphorylation, Gluconeogenesis and Glycogen metabolism.	8	CO2
3	Lipid metabolism	Degradation of fatty acids: oxidation; Ketone bodies, acidosis, ketosis, cholesterol synthesis.	8	CO3
4	Protein metabolism	Urea Cycle, transport of ammonia, deamination and transamination reactions. Inborn errors of protein metabolism.	8	CO4
5	Nucleic acid metabolism	Purine and Pyrimidine biosynthesis and degradation.	8	CO5

Reference Books:

1. Principles of Biochemistry- AlbertL. Lehninger CBS Publishers & Distributors Publications
2. Biochemistry – Lubert stryer Freeman International Edition.
3. Biochemistry – Keshav Trehan Wiley Eastern Publications
4. Fundamentals of Biochemistry-J.L.Jain S.Chand and Company
5. Biochemistry- Prasaranga, Bangalore University
6. Fundamental of Biochemistry – Dr.A.C.Deb
7. Textbook of Organic Chemistry (A Modern Approach)
8. The Biochemistry of Nucleic acid – Tenth Edition-Roger L.P.Adams, John T. Knowler and David P.Leader, Chapman and Hall

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

5- 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	BS255	**Title of the Course**	Enzymology Lab	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**0**	**0**	**6**	**3**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the concepts of enzyme dynamics.						

Course Outcomes	
CO1	Know how to detect Amino acids by Paper chromatography and TLC.
CO2	Know how to isolate enzyme and determine enzyme activity.
CO3	Know how to study the effect of varying substrate and inhibitor concentration on the enzyme activity
CO4	Know how to study the effect of pH and temperature on the enzyme activity.
CO5	Know how to perform Poly Acrylamide Gel Electrophoresis (PAGE).

S.No.	**Experiments**	**Contact Hrs.**	**Mapped CO**
Exp-01	Amino acid detections (Paper chromatography/ TLC).	3	CO1
Exp-02	Isolation of enzyme and determination of enzyme activity	3	CO2
Exp-03	Study of the effect of pH on the enzyme activity.	3	CO4
Exp-04	Study of the effect of varying substrate concentration on the enzyme activity and determination of Km and Vmax	3	CO3
Exp-05	Study of the effect of temperature on the enzyme activity.	6	CO4
Exp-06	Study of the effect of inhibitors on the enzyme activity.	6	CO3
Exp-07	Poly Acrylamide Gel Electrophoresis Technique	6	CO5

Reference Books:

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	3			
CO2	3	3	1				3	3			
CO3	3	3	1		2		3	3			
CO4	3	3	1				3	3		1	
CO5	3	3	1				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	BS308	**Title of the Course**	Genetic Engineering Lab	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**0**	**0**	**6**	**3**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of genetic engineering.						

Course Outcomes	
CO1	Isolate genomic DNA from bacteria, plant and animal tissues
CO2	Isolate plasmid DNA (*E. coli*)
CO3	Perform restriction digestion of DNA
CO4	Perform Agarose Gel Electrophoresis
CO5	Understand basics of PCR

S.No.	**Experiments**	**Contact Hrs.**	**Mapped CO**
Exp-01	Isolation of genomic DNA from bacteria, plant and animal tissue	6	CO1
Exp-02	Isolation of plasmid DNA (E. coli)	6	CO2
Exp-03	Restriction digestion of DNA	6	CO3
Exp-04	Agarose Gel Electrophoresis	6	CO4
Exp-05	Demonstration of PCR	6	CO5

Reference Books:

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

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

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