Integral University, Lucknow

Effective from Session: 2013-14							
Course Code	CH215	**Title of the Course**	Fundamental of Physical Chemistry	**L**	**T**	**P**	**C**
Year	**2**	**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	1
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	2
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	3
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	4
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	5

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	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2	3	2	2	2	1
CO2	3	1				1	3	2	1	2	1
CO3	3	1				2	2	2	1	3	2
CO4	3	1				1	2	1	1	1	1
CO5	3	1				3	2	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	BS201	**Title of the Course**	Metabolism	**L**	**T**	**P**	**C**
Year	2	**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 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	CO-1
2	Carbohydrate metabolism	Glycolysis, TCA cycle, Electron Transport Chain and Oxidative phosphorylation, Gluconeogenesis and Glycogen metabolism.	8	CO-2
3	Lipid metabolism	Degradation of fatty acids: oxidation; Ketone bodies, acidosis, ketosis, cholesterol synthesis.	8	CO-3
4	Protein metabolism	Urea Cycle, transport of ammonia, deamination and transamination reactions. Inborn errors of protein metabolism.	8	CO-4
5	R Nucleic acid metabolism	Purine and Pyrimidine biosynthesis and degradation.	8	CO-5

Reference Books:

1. Principles of Biochemistry- AlbertL. Lehninger CBS Publishers & Distributors.
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. The Biochemistry of Nucleic acid – Tenth Edition-Roger L.P.Adams, John T. Knowler and David P.Leader, Chapman and Hall Publications

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	2	1	
CO2	3	1					2	3	2	1	
CO3	3	1					2	3	2	1	
CO4	3	1					2	3	2	1	
CO5	3	1					2	3	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	BS202	**Title of the Course**	Biophysical Chemistry	**L**	**T**	**P**	**C**
Year	**2**	**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: 2020-21							
Course Code	BS203	**Title of the Course**	CELL BIOLOGY AND GENETICS	**L**	**T**	**P**	**C**
Year	**2**	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	This course is designed to enable the students to understand the cell structure and its functions, signal transduction and genetics.						

Course Outcomes	
CO1	Develop an understanding of the cell structure and their functions, cytoskeleton and prokaryotic and eukaryotic cells
CO2	Learn about Cell Division, Membrane transport, transduction, cell senescence and Programmed Cell Death.
CO3	Learn about Chromosomes, Chromosomal Variations, Chromosome mapping, structural and numerical aberrations
CO4	Learn about basic genetics, epistasis, Concepts of allosomes and autosomes, Linkage and Crossing Over.
CO5	Learn about mutations, human Genetics, DNA damage and repair.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Cell as a Basic unit of Living Systems	Discovery of cell, The Cell theory Ultrastructure of an eukaryotic cell – (both plant and animal cell). Structure and functions of cell organelles, Cytoskeletal structures (Microtubules, Microfilaments); cell motility.	8	CO1
2	Cell Division	Cell cycle, mitosis and meiosis, Membrane transport: active and passive transport, introduction to signal transduction and its molecular mechanism, cell senescence, Programmed Cell Death.	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	8	CO3
4	Mendelism	Mendel's 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-Du- Chat 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. Animal Cytology & Evolution – MJD, White Cambridge University Publications
2. Molecular Cell Biology – Daniel , Scientific American Books.
3. Cell Biology – Jack D. Burke, The William Twilkins Company.
4. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.
5. Cell Biology & Molecular Biology – EDP Roberties & EMF Roberties, Sauder College.
6. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Sons Publications

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

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS 204	**Title of the Course**	IPR and Biosafety	**L**	**T**	**P**	**C**
Year	**2**	**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 Intellectual property, IPR, Biosafety, GMO and bioethics.						

Course Outcomes	
CO1	Have basic concept of Intellectual Property and its types
CO2	Know detailed description of various types of IPRs, its protection and infringement
CO3	Have knowledge of international treaties and case studies
CO4	Display understanding of Biosafety, GMOs and various Institutional committees
CO5	Have knowledge of Bioethics and its legal implications

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Concept of Intellectual Property. Kinds of Property**	Patents, Copyrights, Designs, Trademarks, Geographical Indication. Infringement of IPR, Its protection and Remedies Licensing and its types.	**08**	**CO1**
2	**Requirement of a patentable novelty**	Issues related to IPR protection of software and database; IPR protection of life forms; International convention in IPR; Geographical indication; Distinction among various forms of IPR; Rights / protection, infringement or violation, remedies against infringement: civil and criminal.	**08**	**CO2**
3	**Obtaining patent**	Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity; Appropriate case studies; Indian Patent Act 1970 (amendment 2000); Major changes in Indian patent system as post TRIPS effects; Budapest treaty.	**08**	**CO3**
4	**Biosafety**	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	**08**	**CO4**
5	**Bioethics**	Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics: National and International; Bioethics of genes; Bioethics in health care: Bioethical dilemmas in medical and surgical treatment; Legal implications in bioethics.	**08**	**CO5**

Reference Books:

1.Genome, T.A. Brown, John Willey & Sons Inc.

2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson, Garland Publishing

3. Molecular Cell Biology, H. Lodish, A.Berk, S. Zipursky, P Matsundaira, D. Baltimore and J.E. Barnell, W.H. Freeman and Company.

4. Molecular Biology of the Gene, J.D. Watson, A.M. Weiner and N.H. Hopkins, Addison- Wesley Publishing.

5. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley and Sons Inc.

6. Biotechnology- B.D. Singh

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		3	3	1	1	3
CO2	3	1		3	3		3	3	1	1	3
CO3	3	1		3	2		3	3	1	1	3
CO4	3	1		3	3	3	3	3	1	1	3
CO5	3	1	2	3	3	3	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:2020-21							
Course Code	BS205	**Title of the Course**	Microbiology Lab	**L**	**T**	**P**	**C**
Year	2	**Semester**	3rd	**0**	**0**	**6**	
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	After completion of the course, a student will be able to develop the understanding of basic microbiology, Instruments used to study and work on microbes, Staining Techniques, Enzyme assay and Biochemical tests–starch hydrolysis, gelatin liquefaction, Cleaning and sterilization of glassware, Media preparation and Isolation of bacteria and fungi from various sources, Growth curve of bacteria, Isolation and purification and estimation of DNA and RNA						

CourseOutcomes	
CO1	Develop an understanding of Instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow, centrifuge and Staining Techniques as Simple, Negative staining, Gram staining, Endospore staining, fungal staining.
CO2	Have knowledge of enzyme assay and Biochemical tests–starch hydrolysis, gelatin liquefaction. the cellular organization of prokaryotic and eukaryotic cells.
CO3	Understand processes involved in culturing of microbes as Cleaning and sterilization of glassware, media preparation, isolation of bacteria and fungi from soil/ air/water/ other sources.
CO4	Understand the growth pattern of bacteria.
CO5	Have clear understanding of processes involved in Isolation and purification and estimation of DNA and RNA.

S. No.	**Experiments**	**Mapped CO**
Exp-01	Isolation and purification of genomic DNA. Estimation of DNA and RNA.	CO1
Exp-02	Enzyme assay (one example)	CO2
Exp-03	Biochemical tests–starch hydrolysis, gelatin liquefaction.	CO2
Exp-04	Cleaning and sterilization of glassware.	CO3
Exp-05	Study of instruments: Compound microscope, Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge	CO3
Exp-06	Media preparation: Nutrients agar, Nutrient broth and LB.	CO3
Exp-07	Staining Techniques: Simple, Negative staining, Gram staining, Endospore staining, fungal staining.	CO1
Exp-08	Isolation of bacteria and fungi from soil/ air/water – dilution and pour plate methods.	CO3
Exp-09	Study of Rhizobium from root nodules of legumes.	CO3
Exp-10	Growth curve of bacteria	CO4

Reference Books:

- Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry"
- Chirikjian "Biotechnology Theory & Techniques"
- Joseph Sambrook David W. Russel Joe Sambrook "Molecular Cloning: A Laboratory Manual"
- William M., Ph.D. O'Leary Robert Dony Wu "Practical Handbook of Microbiology"

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

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS206	**Title of the Course**	Cell Biology & Genetics Lab	**L**	**T**	**P**	**C**
Year	2	**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	Comprehend the use of Micrometer and calibration, measurement of cells.
CO2	Have knowledge and can evaluate Cell division: Mitosis and meiosis
CO3	Analyze Chromosomes.
CO4	Have knowledge of types of chromosomes as polytene chromosomes
CO5	Make and analyze Blood smear – differential staining, 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	CO-1
Exp-02	Cell division: Mitotic and meiotic studies in grasshopper testes, onion root tips and flower bud	3	CO-1
Exp-03	Chromosomes: Mounting of polytene chromosomes	3	CO-2
Exp-04	Buccal smear – Barr bodies	3	CO-3
Exp-05	Karyotype analysis – with the help of slides	6	CO-3
Exp-06	Study of polytene chromosomes by slides	6	CO-4
Exp-07	Blood smear – differential staining	6	CO-5

Reference Book

7. Animal Cytology & Evolution – MJD, White Cambridge University Publications
8. Molecular Cell Biology – Daniel , Scientific American Books.
9. Cell Biology – Jack D. Burke, The William Twilkins Company.
10. Principles of Gene Manipulations – Old & Primrose, Black Well Scientific Publications.
11. Cell Biology & Molecular Biology – EDP Roberties & EMF Roberties, Sauder College.
12. Principles of Genetics – E.J. Gardener, M.J. Simmons and D.P. Snustad, John Wiley & Sons Publications

	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	3	3	2
CO2	3	3	1				3	3	3	3	1
CO3	3	3	1				3	3	3	3	1
CO4	3	3	1				3	3	3	3	2
CO5	3	3	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: 2020-2021							
Course Code	BS211	**Title of the Course**	Immunology	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	3	1	0	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	This course aims to develop the understanding of basics of Immunology, types of Immune Responses, antigens and antibodies, histocompatibility, vaccines and Immunization						

Course Outcomes	
CO1	Know the history and scope of Immunology.
CO2	Understand the types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity and the cell and organs of immune responses and their functions, B & T cells
CO3	Have basic knowledge of Antigens as haptens, epitopes and Factors influencing immunogenicity, and Antibodies structure, types, production and functions of immunoglobulins, Clonal selection theory and Antigen Antibody reactions as Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.
CO4	Comprehend Histocompatibility, structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity
CO5	Understand Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and Subunit Vaccines, Peptide and DNA Vaccines.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of Immunology	History and scope of Immunology, Types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity	8	CO-1
2	Immune Responses	Cell and organs of immune responses and their functions, B & T cells.	8	CO-2
3	Antigens and Antibodies	Antigens: haptens, epitopes and Factors influencing immunogenicity, Antibodies: Structure, types, production and functions of immunoglobulins Clonal selection theory. Antigen Antibody reaction: Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.	8	CO-3
4	Histocompatibility:	structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction; Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity.	8	CO-4
5	Vaccines and Immunization	Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and Sub Unit Vaccines, Peptide and DNA Vaccines	8	CO-5

Reference Books:

1. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York
2. Basic Immunology, A.K. Abbas and A.H. Lichtman, Saunders W.B. Company
3. Fundamentals of Immunology, W. Paul, Lippincott Williams and Wilkins
4. Immunology, W.L. Anderson, Fence Creek Publishing (Blackwell)..
5. Immunology: A Short Course, E. Benjamin, R. Coico and G. Sunshine, Wiley-Leiss 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					3	3			
CO2	3	1				1	3	3			
CO3	3	1			1		3	3			
CO4	3	1		3	1		3	3			
CO5	3	1		1	1	1	3	3			

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS212	**Title of the Course**	Molecular Biology	**L**	**T**	**P**	**C**
Year	2	**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	CO-1
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	CO-2
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	CO-3
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	CO-4
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	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

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			

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	BS213	**Title of the Course**	Fundamentals of Environmental Biotechnology	**L**	**T**	**P**	**C**
Year	**2**	**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 environmental biotechnology, bioremediation, waste management, bioleaching, conventional and modern fuels						

Course Outcomes	
CO1	Have knowledge of modern fuels and their environmental impact
CO2	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technical processes and conditions
CO3	Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.
CO4	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).
CO5	Have basic understanding of Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Conventional and modern fuels**	Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	8	CO-1
2	**Structural and Functional dynamics of microbes**	Diversity, activity and growth, community profiling, biosensors, bioreporters, Microchips. Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technical processes and conditions	8	CO-2
3	**Bioremediation**	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents, Degradation of lignin and cellulose using microbes, Phytoremediation, Degradation of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.	8	CO-3
4	**Waste Management**	Treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	8	CO-4
5	**Bioleaching**	Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.	8	CO-5

Reference Books:

1. Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company
2. Molecular biotechnology: Principles and Applications of Recombinant DNA –Bernaral R. Glick and Jack J. Pastemak ASM Press. Washington, D.C (1994).
3. Fungal Ecology and Biotechnology (1993) Rastogi Publications, Meerut.

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**	**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: 2020-21							
Course Code	BS214	**Title of the Course**	Industrial Biotechnology	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	3	1	0	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	After completion of the course, a student will be able to develop the understanding of industrial aspects of biotechnology.						

Course Outcomes	
CO1	The students will be able to discuss about the history of industrial biotechnology and methods of screening, isolation, maintenance and strain improvement of microorganisms.
CO2	The students will be able to explain different types of fermentation media and sterilization techniques.
CO3	The students will be able to describe Fermenters, various processes involved during fermentation and types of fermentation.
CO4	The students will be able to explain various steps involved in Downstream processing (DSP) of fermentation product.
CO5	The students will be able to describe process of industrial production of microbiological fermentation: like Beer, Citric acid, Penicillin, Glutamic acid, and vitamin B12.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to industrial biotechnology	Introduction to industrial biotechnology, Basic principles of fermentation technology, Screening and isolation of microorganisms, Maintenance of strains improvement.	8	CO-1
2	Fermentation media and Sterilization techniques	Fermentation media, Natural and synthetic media, Sterilization techniques: Heat, Radiation and Filtration method.	8	CO-2
3	Types of fermenters and fermentation	Fermenters, Process of Aeration, Agitation, Temperature regulation and Filtration method, Types of fermentation: solid state, submerged fermentation and continuous fermentation, Immobilized enzymes and cell bioreactors.	8	CO-3
4	Process Development	Shake flask fermentation, Downstream processing (DSP), Disintegration of cells, Separation, Extraction, Concentration and purification of products.	8	CO-4
5	Production of Microbial products	Brief account of the following products obtained by industrial microbiological fermentation: Alcoholic Beverage: Beer, Organic acid: Citric acid, Antibiotic: Penicillin, Amino acids: Glutamic acid, Vitamin: vitamin B12.	8	CO-5

Reference Books:

1. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers. Books (P) Ltd.
2. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Pub. Corp.
3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
4. Kumar H.D (1991) A textbook on Biotechnology (2nd Edition). Affiliated East West Press Private Ltd. New Delhi.
5. Karp Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers. Publishers, Boston. Publishing Corp
6. Stanbury P.F, Whitaker H, Hall S.J (1997) Principles of Fermentation Technology. Butterworth-Heinemann, Elsevier Science, MA.

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	3	3	2	2	1
CO2	3	1				2	3	3	3	3	1
CO3	3	1				2	3	3	3	3	
CO4	3	1				2	3	3	3	3	1
CO5	3	1				2	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:							
Course Code	BS 215	**Title of the Course**	Food Biotechnology	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	10+2	**Co-requisite**					
Course Objectives	This course aims to impart an insight into the classification, ingredients and additives of food. Importance of studying this paper is highlighted reflecting on the current changing needs of the students by providing the latest information of food processing and preservation techniques. The students will acquire knowledge about the production of fermented food and beverages. The course also extends comprehensive knowledge about international and national food laws and standards.						

Course Outcomes	
CO1	Recognize sources of microorganisms and food borne illness
CO2	To learn food processing and preservation techniques
CO3	Comprehend the interrelationships among different components of beverages technology
CO4	To learn about culture, microscopic, and sampling methods including membrane filters, microscope colony counts, most probable numbers, Direct microscopic count, Microbiological examination of surfaces and Air sampling
CO5	Understand the food laws and standards, Quality and safety assurance in the food and dairy industry, BIS product certification and licensing quality systems

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Classification of food, major ingredients of food, Microbial role in food process, operation and production	New protein foods SCP, mushroom, food yeasts, algal proteins. Food additives like coloring, flavours and vitamins.	8	**CO1**
2	General principles underlying spoilage of foods	Microbial food poisoning and its prevention or control; Food processing and Preservation techniques. Food adulteration and contamination of food with harmful microorganisms.	8	**CO2**
3	Organisms and their use for production of fermented foods and beverages	pickles, wine, cheese, yogurt and vinegar. Therapeutic and nutritive value of fermented products.	8	**CO3**
4	Determining microorganisms and their products in foods	culture, microscopic, and sampling methods; membrane filters, microscope colony counts, most probable numbers (MPN), Direct microscopic count, Microbiological examination of surfaces, Air sampling.	8	**CO4**
5	Food laws and standards	Indian and international food safety laws and standards; Quality and safety assurance in food and dairy industry; BIS Laboratory Services and Certification by BIS	8	**CO5**

Reference Books:

Frazier, Food Microbiology, TMH Publications.

May JM "Modern food microbiology", CBS Publishers and distributors, New Delhi.

Heller, Genetic Engineering of Food: Detection of Genetic Modifications – Wiley Publications.

Potter NN and Hotchkiss "Food Science" CBS Publ

Hobbs BC and Roberts D "Food poisoning and food hygiene", Edward Arnold (A division of Hodder and Stoughton), London

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	3	2	3	3
CO2	3	1				1	3	3	2	3	1
CO3	3	1				1	3	3	2	3	3
CO4	3	1	1	2	3	2	3	3	2	3	3
CO5	3	1		1	1	2	3	3	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: 2020-21							
Course Code	BS216	**Title of the Course**	Immunology Lab	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	0	0	6	3
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to enable students learn about basics of immunology, types of Blood grouping, cell counts, ELISA, Ouchterlony Double diffusion (ODD) and Separation of serum from blood & precipitation of Immunoglobulins						

Course Outcomes	
CO1	Analyze Blood grouping
CO2	Perform and analyze differential counting of WBC and detergent lysis of RBC
CO3	Perform and analyze Dot Elisa, ELISA
CO4	Have knowledge of and can perform Ouchterlony Double diffusion assay.
CO5	Perform and analyze separation of serum from blood & precipitation of Immunoglobulin

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Blood grouping	3	CO-1
Exp-02	Differential Count of WBC	3	CO-1
Exp-03	Detergent lysis of RBC	3	CO-2
Exp-04	Dot Elisa	3	CO-3
Exp-05	ELISA – Demonstration	6	CO-3
Exp-06	Ouchterlony Double diffusion (ODD)	6	CO-4
Exp-07	Separation of serum from blood & precipitation of Immunoglobulins	6	CO-5

Reference Books:

1. Asim Roy Kumar, IMMUNOLOGY THEORY & PRACTICAL, 5TH SEM. (KALYANI PUB.)
2. Talwar Gupta A Handbook of Practical & Clinical Immunology
3. A.K. Abbas and A.H. Lichtman, Saunders,Basic Immunology, W.B. 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	3	1			3	1	3	3	3	1
CO2	3	3	1			2	1	3	3	3	1
CO3	3	3	1			3	3	3	3	3	1
CO4	3	3	1	1	2	3	3	3	3	3	1
CO5	3	3	1	1	2	3	1	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: 2020-21							
Course Code	BS217	**Title of the Course**	Industrial and Environmental Biotechnology Lab	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	0	0	6	3
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	This course aims to develop the understanding of basics of Algal and fungal culture, estimation of Nitrogen, citric acid, lactic acid, heavy metals, BOD and COD, and examination of bacteria by MPN Count Method.						

Course Outcomes	
CO1	Culture algae and fungi
CO2	Perform and analyze estimation of citric acid and lactic acid.
CO3	Perform and analyze estimation of Total Nitrogen by Kjeldahl method.
CO4	Can perform Bacterial Examination of Water by MPN Count Method and estimate of BOD and COD
CO5	Estimate heavy metals (Iron, chromium and arsenic) in water sample

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Algal and fungal culture – Yeast and Aspergillus	3	CO-1
Exp-02	Estimation of citric acid from Aspergillus culture.	3	CO-1
Exp-03	Estimation of lactic acid.	3	CO-2
Exp-04	Estimation of Total Nitrogen by Kjeldahl method.	3	CO-3
Exp-05	Bacterial Examination of Water by MPN Count Method.	6	CO-3
Exp-06	Estimation of BOD and COD (2 Samples).	6	CO-4
Exp-07	Estimation of heavy metals (Iron, chromium and arsenic) in water sample.	6	CO-5
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	3	3	3	2
CO2	3	3	1				3	3	3	3	1
CO3	3	3	1			2	3	3	3	3	1
CO4	3	3	1			3	3	3	3	3	2
CO5	3	3	1			3	3	3	3	3	1

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

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