Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS541	**Title of the Course**	Medical Microbiology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	UG with Biological Science	**Co-requisite**					
Course Objectives	To introduce basic principles and application relevance of clinical disease. It covers all biology of bacteria, viruses and other pathogens related with infectious diseases in humans.						

Course Outcomes	
CO1	Gain information about the concepts of medical microbiology and gain knowledge on medically important micro-organisms, classification and normal flora of human body.
CO2	Gain knowledge of diseases and types of infections; mechanism of microbial pathogenesis; endo and exotoxins; sample collection and identification.
CO3	Understand Systematic Microbiology; diagnosis, identification and prevention of pathogenic microorganisms.
CO4	Gain knowledge on Water borne infections caused by bacteria.
CO5	Gain knowledge on Nosocomial infections and various chemotherapeutic agents and their

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Principles of Medical Microbiology	Classification of medically important micro-organisms. Normal flora of human body– Origin of normal flora, role of the resident flora, effect of antimicrobial agents on normal flora, factors influencing normal flora (Skin, conjunctiva, nose, nasopharynx, sinuses, mouth, upper respiratory tract, intestinal tract, urogenital tract).	8	CO-1
2	Clinical conditions and diagnosis	Factors that influence pathogenicity; Type of infections, source of infections, different modes/means of infections; Diagnostic microbiology – Types of specimen, specimen collection, transportation of specimen, processing; Laboratory diagnosis- haematology, biochemistry, microbiology, serology, radiology and other special methods.	8	CO-2
3	Systematic Microbiology	Detailed study of morphology, cultural characteristics, antigenic structure, pathogenesis, epidemiology, prevention and treatment of the following bacterial pathogens. Air borne infections caused by bacteria–Haemolytic streptococci, Pneumococci, Corynebacterium diphtheriae, Mycobacterium spp., Neisseria meningitidis, Haemophilus influenzae. Sexually transmitted diseases caused by bacteria, Treponema pallidum, Neisseria gonorrhoeae.	8	CO-3
4	Water borne infections	*E. coli*, *Salmonella typhi*, *Shigella dysenteriae*, *Vibrio cholera*; Wound infections caused by bacteria – Staphylococcus aureus, Clostridium tetani, Pseudomonas; Important fungal diseases and their prevention.	8	CO-4
5	Nosocomial infections & Therapies	Factors that influence hospital infection, hospital pathogens, route of transmission, investigation, prevention and control. Preventive Measures: Antibiotics and chemotherapeutic agents-drug resistance and antibiotic policy; Epidemiology and control of community infection. Alternative and Complimentary medicine-Chinese, European and Indian (Siddha, Ayurveda, Unani etc).	8	CO-5

Reference Books:

1. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition.
2. Williams and Wilkins, Baltimore.
3. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1			1	3	1	2	3			
CO2	3	1			1	3	1	2	3		2	
CO3	3	1				3	1	2	3			
CO4	3	1				3	1	2	3			
CO5	3	1		1	1	3	1	3	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	BS542	**Title of the Course**	Fundamentals of Infection & Immunity	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of the course is to apprise the students about components associated with immune system and molecular mechanism of their working. The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.						

Course Outcomes	
CO1	The student will learn the fundamental principles of immune response including molecular, biochemical and cellular basis of immune homeostasis
CO2	The course will aid in understanding various aspects of immunological response and how its triggered and regulated.
CO3	The student will learn and understand the rationale behind various assays used in immunodiagnosis of diseases and will be able to transfer knowledge of immunology in clinical scenario.
CO4	The course will aid in understanding the principles of Graft rejection, Auto immunity and Antibody based therapy.
CO5	The student will develop the capacity for problem-solving about immune responsiveness, knowledge of the pathogenesis of diseases and designing of immunology-based interventions for effective treatment.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Fundamentals of Immunology	Cells and organs of immunity: Memory, specificity, diversity, self vs. non-self-discrimination, Structure of primary and secondary lymphoid organs, Cell mediated vs. humoral immunity, T and B-lymphocytes; Nature of antigen and antibody: Antigen vs. Immunogen, Structure of antibody: constant and variable regions, Fab and Fc; isotype, allotype and idiotype; Abzymes..	8	CO-1
2	Antigen-antibody interactions and its measurement	Direct binding assays, Agglutination and precipitation, radioimmunoassay and ELISA, fluorescence analysis, Hybridoma technology, applications of monoclonal antibodies in biomedical research, clinical diagnosis and treatment.	8	CO-2
3	Generation of diversity in the immune response	Clonal selection theory-concept of antigen specific receptors, genes encoding antigen specific receptors on T and B-lymphocytes, genetic rearrangement, class switch, Comparison of receptors and B and T lymphocytes.	8	CO-3
4	Differentiation of B and T lymphocyte	Activation of T cells and B cells by antigen: Antigen processing, Antigen presentation to T cells, Products and factors released by T cell activationinterleukins, interferons, B cell activating factors, T cell and B cell interactions leading to antibody synthesis. Central role of major histocompatibility complex (MHC), genes and products in immune response: T cell recognition of antigen and MHC products, Structure of MHC gene complex and its products polymorphism of MHC gene products, Associated MHC functions-allograft, graft vs. host and mixed leucocyte responses.	8	CO-4
5	Tolerance vs. activation of immune response	Complement- components of classical and alternative pathways. Hypersensitivity: Types I, II, III and IV responses. Autoimmunity. Host Immune Response against intracellular and extracellular microbes; Principles and strategy for developing vaccines	8	CO-5

Reference Books:

1. Ivan M. Roit. (1994) Essential Immunology - Blackwell Scientific Publications, Oxford.
2. Janeway travers. (1997). Immuno biology - The immuno system in health and disease 3rd edition Current
3. Biology Ltd., London, New York
4. Immunology: Kuby
5. Instant Notes : Lydyard, Whelan, Fanger

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3		1		3		
CO2	3	1				3		1		3	3	
CO3	3	1				3		1		3		
CO4	3	1				3		1		3		
CO5	3	1				3		1		3	3	

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS543	**Title of the Course**	Recombinant DNA Technology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objectives of this course are to develop the understanding of Genetic Manipulations and introduce the concepts of different Enzymes, Gene Cloning and its expression and other techniques used in genetic engineering.						

Course Outcomes	
CO1	The students will be able to design experiments related to different enzymes used in genetic engineering for DNA manipulations.
CO2	The students will be able to describe different types of plasmid vectors and their characteristics.
CO3	The students will be able to discuss characteristics of phage and yeast cloning vectors.
CO4	The students will be able to explain creation methods and selection parameters of different gene libraries.
CO5	The students will be able to explain the principle and applications of sequencing techniques, mutagenesis, gene silencing, and amplification of DNA.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Restriction endonucleases	Class I, II & III restriction enzymes, Nomenclature, Isoschizomers, Heterohypekomers, Unit of restriction enzymes, Restriction digestion: partial and complete, Star activity; Homopolymer tailing, Synthetic Linkers, Adaptors; Roles of DNA ligase, T4 DNA polymerase, Alkaline phosphatase, Reverse transcriptase in cloning.	8	CO-1
2	Plasmids	Plasmid size range, Plasmid classification on basis of phenotypic traits: Cryptic, Fertility, Resistance, Bacteriocinogenic, Degradative, Virulence; Conjugative / non conjugative plasmids; Relaxed and stringent control of copy number; Plasmid incompatibility; Plasmid host range, Mobilizable plasmids and Triparental mating; Plasmid as cloning vector (recombinant plasmids): Properties of ideal plasmid cloning vectors, Plasmid vectors for E. coli and Agrobacterium; Transcriptional and translational fusion vectors; Selectable markers; Reporter genes.	8	CO-2
3	Cloning vectors	Phage lambda vector, *In vitro* packaging, Insertional and replacement vectors; Cosmid vectors; M13 phage; Phagemids; Yeast as cloning vector: Basic principles of development of yeast vectors, 2μ plasmid, YEP, YRP YCP, YIP; Artificial chromosomes: YACs, BACs and PACs.	8	CO-3
4	Basic Techniques - I	Gene bank / Genomic library and cDNA library construction; Overview of techniques for recombinant selection and screening: Functional and nutritional complementation, Colony/ plaque Immunological screening, HART, HAT.	8	CO-4
5	Basic Techniques - II	Rapid DNA sequencing techniques: Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; Genomics: High throughput Sequencing: Microarray; Principle & applications of PCR: RT PCR, Inverse PCR, RACE, Degenerate PCR, Real time PCR, Scorpion PCR, Applications of PCR in gene cloning, TA cloning, pathogen diagnostics, environmental monitoring; Site directed mutagenesis; Antisense RNA technology and its applications.	8	CO-5

Reference Books:

1. Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
2. Brown, TA (2020) Gene Cloning and DNA Analysis: An Introduction, 8th edition. John Wiley & Sons
3. Old & Primrose (1980). Principles of Gene Manipulation: An introduction to Genetic Engineering, University of California Press
4. Rastogi & Pathak (2009). Genetic Engineering, 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	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3		1		3		
CO2	3	1				3		1		3		
CO3	3	1				3		1		3		
CO4	3	1				3		1		3		
CO5	3	1		1	2	3	1	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: 2020-21							
Course Code	BS544	**Title of the Course**	Virology & Biosafety	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course is designed to introduce the structure of viruses, provide knowledge on fundamentals of virology; Develop understanding of infection processes at the molecular level; introduce a concept of biosafety against infection or genetic modification.						

Course Outcomes	
CO1	Know how viruses are classified, diverse viral architecture and genome structure and know the methods used in studying them.
CO2	Understand the architecture of plant viruses and their genomes, gene expression, mode of replication and transmission.
CO3	Understand the architecture of animal viruses and their genomes, gene expression, mode of replication, the intricate interaction between viruses and host immune cells and pathogenesis of virus-induced diseases and oncogenesis and know about new and emerging animal viruses as: Ebola Virus, Zika Virus, SARS and SARS-CoV2
CO4	Understand the replication and growth of bacteriophages and lysogenic switch, study other virus-related structures and evolution of viruses.
CO5	Assess the proper use of biological containment, and be introduced to safely conduct research, and bioethics in research, identify the role of the biosafety professional in biomedical research laboratories.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	General Virology	Brief outline of virology; Discovery and origin of virus; Early development of virology– nomenclature - classification and taxonomy of viruses - based on host, nucleic acids and structure; Concept of ICTV nomenclature and classification of viruses (as per 9th Edition, 2008); Detection and isolation of viruses.	8	CO-1
2	Plant Viruses	Effects of viruses on plants: Morphological, histological and physiological changes; Transmission of plant viruses: a. through vectors- insects, nematodes and fungi b. without vectors- contact, seed and pollens; Life cycles of plant viruses– TMV, Cauliflower Mosaic Virus.	8	CO-2
3	Animal viruses	Retro virus-HIV; Hepatitis viruses–HBV, Influenza virus; Polio virus: General characters, life cycle, pathogenicity and diseases. Immunologic responses of the viruses in Animals; Oncogenic viruses: Virus induced cell transformation and oncogenesis. New and Emerging Animal Viruses: Ebola Virus, Zika Virus, SARS and SARS-CoV2	8	CO-3
4	Bacteriophages, Evolution of viruses and other viral types	Replication of single and double stranded nucleic acids of bacterial viruses, Onestep growth curves of bacteriophages, structure and genetics of phage lambda. Evolution of viruses and brief account of other viral types: Evolution of viruses; Virus related structures – viroids and prions; Satellite RNAs, Virusoids.	8	CO-4
5	Biosafety and Bioethics	Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines - Government of India; Definition of GMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication. Bioethics: Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics.	8	CO-5

Reference Books:

1. Edward K. Wagner, Martinez J. Hewlett, (2004), Basic Virology, Blackwell Publishing
2. Flint S. J., V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka, (2003), Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society Microbiology
3. Dimmock NJ, Primrose SB. (1994) Introduction to Modern Virology IV edi. Blackwell
4. Alan Cann (2001) Molecular Virology

e-Learning Source:

International Congress on Taxonomy of Viruses: http://www.ncbi.nlm.nih.gov/ICTV

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	1	1	3			
CO2	3	1				3	1	2	3			
CO3	3	1				3	1	2	3			
CO4	3	1				3	1	1	3			
CO5	3	1	3	3	3	3	2	3	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: 2020-2021							
Course Code	BS545	**Title of the Course**	Food & Dairy Microbiology	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To provide knowledge of microorganisms (pro-technological, probiotic, pathogens and spoilage) associated with foods and their origin and role; Knowledge of the factors that determine the presence, growth and survival of microorganisms in food and gain knowledge about fermentation techniques used in dairy industry, role of microorganisms in fermentation and to gain skills to control fermentation process.						

Course Outcomes	
CO1	Learn about fundamentals of food microbiology.
CO2	Gain insight on spoilage of foods by microbes, microbial food poisoning.
CO3	Understand the process of fermentation of milk and other food items.
CO4	Assessment of food quality in reference to microbial contamination.
CO5	Quality control, packaging, processing parameters of various foods, BIS Laboratory services, certification and licensing of food products.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Foods and their composition	Types of microorganisms with reference to food and dairy industry- Psychrophiles, osmophiles, halophiles, thermophiles, pH-tolerance and spore formers. Food spoilage - Causes of spoilage, classification of foods by ease of spoilage, Factors affecting the growth of microorganisms in foods. Chemical changes caused by microorganisms.	8	CO-1
2	Microbial flora & their spoilage	Microbial flora and spoilage of meat, fish and fish products, eggs, milk and milk products, fruits, vegetables, bakery products and canned foods. Canned foods: processes, advantages and defects. Methods of food preservation - General principles, preservation by use of chemicals, high temperature, low temperature, irradiation and drying processes, aseptic packaging of materials.	8	CO-2
3	Fermentation of foods	Types of fermentation, production and defects. Fermentation of pickles, butter, cheese, creams, yogurt and ice creams. Role of microbes and microbial enzymes in the fermentation of tea, coffee and cocoa and production of silage.	8	CO-3
4	Milk and milk products	Composition of milk, factors affecting composition of milk, Spoilage of milk and milk products. Milk borne disease, antimicrobial systems in milk, sources of contamination of milk. Chemical and microbiological examination of milk, grading of milk. Starter lactic cultures, biochemical basis of culturing dairy product, management and preparation of starter cultures, starter defects, probiotics.	8	CO-4
5	Food sanitation, Indicator organism	Detection of microorganisms in foods. Food poisoning and food infections. Food quality and assurance: Quality control parameters of various foods with special reference to microbiological quality. Importance of microbiological quality during food processing and packaging. Food borne diseases, their causative agents and control measures.	8	CO-5

Reference Books:

1. Milk and Milk Products –Fourth ed. Clarence Henry Eckles TMH Publ.
2. Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Pub. Food
3. Microbiology – J.De and De.
4. Food processing: Biotechnological Applications –(2000) S.S. Marwaha & Arora, Asitech Adams.
5. MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry,Cambridge.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	2	3	3			
CO2	3	1				3	2	3	3			
CO3	3	1				3	2	3	3	1	3	
CO4	3	1		1		3	2	3	3		3	
CO5	3	1	1	2	3	3		3				3
BS545	3	1		1	1	3	2	3	3	1	2	1

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS546	**Title of the Course**	RDT and Immunology Lab	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	0	0	12	6
Pre-Requisite	UG in Biological Science	**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 perform chromatography techniques: Paper/Column/TLC
CO2	The students will be able to isolate and visualize plasmid DNA, prepare competent cells and carry out transformation and restriction digestion.
CO3	The students will be capable of setting up PCR reactions, blotting (Southern and Northern) and separating proteins by SDS-PAGE
CO4	The students will be able to identify antigen & antibody interactions by double Immunodiffusion: Ouchterlony's Method, perform Immunoelectrophoresis and Enzyme Linked Immunosorbent Assay (ELISA)
CO5	The students will be able to determine blood Group, Total WBC count and Total RBC count

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Chromatography techniques: Paper/Column/TLC	9	CO-1
Exp-02	Isolation of plasmid DNA from bacteria	3	CO-2
Exp-03	Size characterization of DNA by agarose gel electrophoresis.	3	CO-2
Exp-04	Preparation of competent *E. coli* cells and transformation of plasmid DNA to the *E. coli* cells	6	CO-3
Exp-05	Restriction digestion & ligation	6	CO-3
Exp-06	Southern blotting and northern blotting	9	CO-3
Exp-07	PCR amplification – demonstration.	3	CO-3
Exp-08	Separation of proteins by SDS – PAGE and native gel.	12	CO-3
Exp-09	To identify sensitivity of antigen & antibody by double Immunodiffusion: Ouchterlony's Method, Immunoelectrophoresis	3	CO-4
Exp-10	Enzyme Linked Immunosorbent Assay (ELISA)	3	CO-4
Exp-11	Determination of blood Group, Total WBC count and Total RBC count	3	CO-5

Reference Books:

1. Keith Wilson John Walker John M. Walker "Principles and Techniques of PracticalBiochemistry" Chirikjian "Biotechnology Theory & Techniques"
2. Joseph Sambrook David W. Russell Joe Sambrook "Molecular Cloning: A Laboratory Manual"
3. William M., Ph.D. O'Leary Robert Dony Wu "Practical Handbook of Microbiology"
4. Brown, TA "Gene cloning: An introduction"
5. Plummer David T., (1988), An introduction to practical biochemistry, 3rd Ed., Tata McGraw-Hill Publishing Co. Ltd. New Delhi, 109-121
6. Talwar G. P. (1983) *Handbook of Immunology*, Vikas Publishing Pvt. Ltd. NewDelhi

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1			3		3		2	3	2
CO2	3	3	1			3		3		2	3	2
CO3	3	3	1			3		3		2	3	2
CO4	3	3	1			3		3		2	3	2
CO5	3	3	1			3		3		2	3	2

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS551	**Title of the Course**	Environmental Microbiology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	To know and understand the role of microbes in biogeochemical processes within different ecosystems. The students will learn the basic microbiological principles, the methods in microbial ecology, and their theoretical and practical use						

Course Outcomes	
CO1	Understanding about water and air microbiology, biological indicators of pollution, bacteriological examination of water, BOD and anthropogenic pollution.
CO2	Environmental pollution: types, xenobiotics, genotoxicity, Mutation detection by ames test, bioremediation and toxicogenomics.
CO3	Recycling of organic wastes: recycling crop, human and animal wastes. Composting and vermicomposting; biogas production and waste treatment.
CO4	Knowledge about microbes of toxic environments, microbial degradation of xenobiotics, pesticides, heavy metals, acid mine drainage.
CO5	Understanding biodeterioration concept: biodeterioration of wood, stonework, pharmaceutical products, rubber, plastic paints, lubricants, cosmetics and control of biodeterioration.

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

Reference Books:

1. Environmental biotechnology (Industrial pollution Management).Jogdand S.N., Himalaya pub. house.
2. Water and water pollution hand book, Vol. 1, Leonard L., Ciaccio
3. Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment Longman Scientific Technical
4. Grant WD, Long PL. (1981) Environmental Microbiology. Blackie Glasgow and London

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	1	1	3	1	3	
CO2	3	1				1		1	3	1	3	
CO3	3	1				1		1	3	1	3	
CO4	3	1				3	1	1	3	1	3	
CO5	3	1				3	1	1	3	1	3	

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS552	**Title of the Course**	Commercial & Applied Microbiology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The aim of this course is to impart the knowledge of basic principles of Microbiology and their applications to humankind.						

Course Outcomes	
CO1	The students will be able to discuss the biotechnological application of microalgae.
CO2	The students will be able to explain the production and significance of biofertilizers
CO3	The students will be able to compare genomes and proteomes of different microbes.
CO4	The students will be able to describe the production of single cell protein and its merits and demerits.
CO5	The students will be able to explain the application of microbes in industrial production of in antibiotics, alcohols etc.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Microbial Biotechnology	Microbial Biotechnology - Definition, Concepts and history, biotechnological potentials of micro algae – food – feed – colourant – fuel and pharmaceutically valuable compounds.	8	CO-1
2	Production of microbial biofertilizers	Production of microbial biofertilizers–Cyanobacteria, *Rhizobium*, *Azotobacter*, *Azospirillum*, *Phosphobacteria* and vesicular arbuscular mycorrhiza.	8	CO-2
3	Microbial Genomics & Proteomics	Microbial Genomics –whole genome analysis –cDNA microarrays and microchips. Proteomics—multidimensional protein identification technology, DNase Footprinting assay, Yeast two hybrid system	8	CO-3
4	Production of single cell protein	Production of single cell protein - Microorganisms and substrates used, techniques of production, nutritional value of single cell protein, economics of production, merits and demerits of single cell protein.	8	CO-4
5	Industrial microbes and their products	Industrial microbes and their products: A brief idea about the products obtained from microbes – biology of industrial microorganisms such as Streptomyces, yeasts, *Spirulina* and *Penicillium* – commercial production of penicillin, ethanol, vinegar, vitamin B12, Protease, citric acid and glutamic acid from microbial sources– production of commercially useful non-microbial products produced through recombinant microbes.	8	CO-5

Reference Books:

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, Jayaraman K. (1996). Concepts in Biotechnology University Press, India.
2. Borowitzka MA, Borowitzka LJ. (1989), Microalgal Biotechnology, Cambridge University Press.
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e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2	1	1	1		3	
CO2	3	1				3	1	1	1		3	
CO3	3	1				3		1	1		3	
CO4	3	1				3	1	1	1		3	
CO5	3	1				3	1	1	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: 2020-21							
Course Code	BS553	**Title of the Course**	Pharmaceutical Biotechnology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	3	1	0	4
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	This course enables the students to learn the various aspects of pharmaceutical sciences. In this course, students get exposed to the insights into various therapeutic strategies against infectious and non-infectious diseases i.e. via monoclonal antibodies (mABs), peptide based therapeutics, liposome/emulsion-based drug delivery systems, PEG-conjugates-based drug delivery and various factors affecting the drug delivery, its release, and absorption						

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

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

Reference Books:

1. Groves MJ „Pharmaceutical Biotechnology", Taylor and Francis Group.
2. Crommelin DJA, Robert D, Sindelar „Pharmaceutical Biotechnology".
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5. Walker J.M. and Gingold, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1		1		3		2		2	3	
CO2	3	1		1		3		2			3	
CO3	3	1		1		3		2			3	
CO4	3	1		1		3		2		1	3	
CO5	3	1		1		3		2		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: 2020-21							
Course Code	BS514	**Title of the Course**	Seminar	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	3	1	0	2
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The students will be able to summarize and present the existing data related to a specific topic in the form of a report. Every student will present a seminar on a topic related to theoretical or experimental, advanced topic.						

Course Outcomes	
CO1	The students will understand and interpret latest advancements through different technical papers, reports, Journals, Data sheets, books etc
CO2	The students will inculcate the skills for literature survey and will learn to manage resources effectively.
CO3	The students will be able to summarize the recent research and technologies in the form of review and will be able to deliver power point presentations on an assigned topic.
CO4	The students will be able to communicate his/her ideas with his peers as audience, which will enhance both oral and written communication skills.
CO5	The students will be able to create interest to pursue lifelong learning.

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2			1	2	1	2	3		1	3
CO2	3					2		2				3
CO3	3	2	1			2		2			1	3
CO4	3	3	3					2	3			3
CO5	3							3				3

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	BS515	**Title of the Course**	Project Work	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	0	0	12	8
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The main objective of this course is to develop independence in experimental design and interpretation and to develop research skills. To promote education and research in biotechnology and provide academic and professional excellence for immediate productivity in industrial, governmental, or clinical settings for an ultimate benefit of society and environment.						

Course Outcomes	
CO1	The students will be able to perform literature review, identify state of the art in that field.
CO2	The students will be able to define the problem and develop synopsis of a defined research problem
CO3	The students will be able to establish a methodology using advanced tools / techniques for solving the problem including project management and finances.
CO4	The students will be able to prepare the research report and its oral demonstrations.
CO5	The students will be gain practical experience in project management in biotechnological industry, be able to use various techniques in contemporary research for project, perform numerical analysis and interpret the results

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3					3	1	3	2	1	3	3
CO2	3					3	1	3	2	1		3
CO3	3					3		3			3	3
CO4	3	2				3		3	2	1		3
CO5	3		2	3		3		3	2	1	3	3

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

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