Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BS521	**Title of the Course**	Genetic Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The course is designed to make the students understand the concept and basic steps in gene cloning, to acquaint them with various vectors and enzymes used in recombinant DNA technology, transformation and screening techniques. They will also be acquainted with modern techniques such as PCR technology, Real-Time PCR, DNA fingerprinting etc.						

Course Outcomes	
CO1	The students will be introduced to Rapid DNA and RNA sequencing techniques, High throughput Sequencing, and Microarray.
CO2	The students will learn about the Principle & applications of PCR, Real time PCR, Blotting and hybridization (Southern, western, northern).
CO3	The students will be introduced about DNA fingerprinting and Molecular Markers.
CO4	Learn about Recombinant DNA methods – Features of commonly used vectors, strategies for cloning in various vectors and identification of bacterial colonies containing recombinant plasmids and bacteriophage vectors, restriction enzymes
CO5	The students will learn about Genetic engineering and prospects of improving crop productivity. Application in relation to protein quality and disease resistance, resistance to environmental stresses- salt and drought. Methods for the production of transgenic animals: Liposome-mediated, calcium phosphate precipitation, microinjection, electroportaion, microprojectile bombardment.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Rapid DNA and RNA sequencing techniques**	Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; Genomics: High throughput Sequencing: shot gun cloning, Clone contig cloning, Microarray: protein and DNA	8	CO-1
2	**PCR, Blotting and hybridization**	Principle & applications of PCR; RACE, DD-RTPCR, Degenerate PCR, TA cloning, Realtime PCR. Blotting and hybridization (Southern, western, northern).	8	CO-2
3	**DNA fingerprinting**	DNA fingerprinting: Molecular Markers: RFLP, RAPD, AFLP, ARDRA, SCAR, STS, microsatellites	8	CO-3
4	**Recombinant DNA methods**	Recombinant DNA methods – Features of commonly used vectors, strategies for cloning in various vectors and identification of bacterial colonies containing recombinant plasmids and bacteriophage vectors, restriction enzymes	8	CO-4
5	**Genetic engineering**	Genetic engineering and prospects of improving crop productivity. Application in relation to protein quality and disease resistance, resistance to environmental stresses- salt and drought. Methods for the production of transgenic animals: Liposome-mediated, calcium phosphate precipitation, microinjection, electroportaion, microprojectile bombardment.	8	CO-5

Reference Books:

1. Lewin “Gene”
2. Freifelder, DM “Molecular Biology”.
3. Brown, TA “Genome”.
4. Watson, JD, “Molecular Biology of the cell”.
5. Twyman, R.M. “Advanced Molecular Biology”

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3		1	1	1	3	
CO2	3	1				3		1		1	3	
CO3	3	1				3		1	2	2	3	
CO4	3	1				3	2	1	1		3	
CO5	3	1				3	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: 2020-2021							
Course Code	BS522	**Title of the Course**	Plant Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The main objective of this course is to impart students an understanding of plant biochemistry. The course includes biochemistry of plant hormones, cell wall, secondary metabolites, carbon and nitrogen fixation and assimilation in plants.						

Course Outcomes

CO1	The students will be introduced to the structure, biosynthesis and mechanism of action of major plant hormones, plant growth regulators, and photoreceptors in higher plants.
CO2	The students will be able to understand the composition, biosynthesis and degradation of cell wall.
CO3	The students will learn about the biosynthesis and function of major secondary plant metabolites.
CO4	The students will learn about nitrogen metabolism, mechanism of nitrate and nitrite reduction and fixation of nitrogen.
CO5	The students will be able to gain knowledge about electron transport in higher plants and its relation with the carbon fixation pathways, light regulation of photosynthetic enzymes, Calvin cycle, photorespiration, C4 and CAM pathways.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Plant growth hormones and Sensory photobiology**	Structure, biosynthesis, physiological role and mechanism of action of major plant growth hormones (Auxins, Gibberelins, Cytokinins, Ethylene and Abscissic acid); Plant growth regulators; Seed development and germination (biochemical aspects and control); Concept of photoreceptors in higher plants and their role in regulating plant responses; Structure and function of Phytochromes, Cryptochromes, Phototropins and UV receptors.	**8**	1
2	**Plant cell wall**	Chemical and physical composition of cell wall; biosynthesis of cell wall; formation and growth of cell wall after cell division; cell expansion; brief study of cell wall degradation, details of cellulose synthase enzyme; role of cytoskeleton in plants (brief study of herbicides effecting cytoskeleton).	**8**	**2**
3	**Secondary plant metabolism**	Biosynthesis and function of major secondary plant product classes: isoprenoids, phenolics, alkaloids, lignin and chlorophyll (shikimate pathway).	**8**	**3**
4	**Nitrogen metabolism**	Nitrate and nitrite reduction; details of structure, control and catalysis of nitrate reductase and nitrite reductase; fixation of molecular dinitrogen; details of nitrogenase structure and function.	**8**	**4**
5	**Carbon fixation pathways**	Electron transport in higher plants and its relation with the carbon fixation pathways; light regulation of photosynthetic enzymes; Calvin cycle: details of Rubisco structure, biosynthesis and assembly, regulation and mechanism of action, brief study of other enzymes involved in regulation; Photorespiration pathway and its importance as a protectant against photoinhibition; Carbon concentrating mechanism in higher plants, general account and significance, details of C4 and CAM pathways, detailed study of PEP carboxylase.	**8**	**5**

Reference Books:

1. Lehninger AL "Priciples of Biochemistry"
2. Lubert Stryer "Biochemistry"
3. Taiz and Zeiger Physiology of plants
4. Voet & Voet "Biochemistry
5. Alan Fersht "Enzyme Structure and Mechanism".
6. David S. Sigman & Paul S. Sigman "The Enzymes: Mechanisms of Catalysis".
7. Biochemistry of plants by Buchanan and Buchanan.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1				2		1	3			
CO2	3	1				2	1	1	3			
CO3	3	1				2		1	3			
CO4	3	1				2	2	1	3			
CO5	3	1				2	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: 2021-2022							
Course Code	BS503	**Title of the Course**	Immunology	**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 this course is to provide students with detailed understanding of historical aspects of immunology, different cells of the immune system and their role in immune protection and application of immunological techniques. The course will provide knowledge about autoimmunity, hyper sensitivity, complement system, and vaccination etc. One of the major goals of this course is to provide basic understanding of immunology and immune responses in response to various infectious and non- infectious diseases i.e. cancer, diabetes, neurological disorders etc.						

Course Outcomes

CO1	Understand the fundamentals of immune system
CO2	Understand antigen-antibody interactions and various immunological techniques based on these interactions.
CO3	Understand the mechanism of generation of diversity in immune response
CO4	Understand the Differentiation and activation of B and T lymphocytes, antigen presentation, and significance of MHC.
CO5	Students will gain knowledge about the importance of complement, tolerance and hyperactivation of immune response.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamentals of Immunology**	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**	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**	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**	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 activation-interleukins, 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 metabolism**	Tolerance vs. activation of immune response. Complement- components of classical and alternative pathways. Hypersensitivity: Types I, II, III and IV responses. Autoimmunity.	8	CO-5

Reference Books:

1. Coleman, R.M, "Fundamental Immunology"
2. Richard A. Goldsby Thomas J. Kindt Janis Kuby Barbara A. Osborne "Immunology".
3. Peter Parkham Peter Parham "The Immune System".
4. Abul K Abbas, Andrew H. Lichtman, Abdul K. Abbas, Jordan S. Pober "Cellular & Molecular Immunology"

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

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	BS523	**Title of the Course**	Physiological and Clinical Biochemistry	**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 this course is to develop the understanding of basic concepts of physiology as well clinical biochemistry, To understand disorder related with biomolecules metabolism.						

Course Outcomes

CO1	Student will understand composition of blood, leucocytes, thrombocytes and erythrocytes, plasma proteins, blood cells counting and its significance, Blood coagulation – mechanism and regulation, Blood volume regulation, Haematopoiesis, Homeostasis. Disease of Blood: Thalassemia, sickle cell anemia, Anemias; Cardiovascular Disorders – Atherosclerosis
CO2	Student will understand functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids and proteins.
CO3	Student will understand Transfer of blood gases – Oxygen and carbon dioxide, role of 2,3-diphosphoglycerate, Bohr's effect and chloride shift, buffer systems of plasma, carbon dioxide-bicarbonate buffer system, Neural & chemical regulation of respiration.
CO4	Student will understand Structure of nephron, glomerular filtration, reabsorption and tubular secretion. Homeostatic regulation of water and electrolytes, Acid-base balance, composition of urine, hormones of the kidney
CO5	Student will understand Kidney: Uremia & Glomerulonephritis; Liver: Jaundice, Liver Function Tests: SGOT, SGPT, CPK, LDH, Hepatitis. Neurological: Epilepsy, Parkinson & Alzheimer's significance of diagnostic enzymology.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Blood**	composition of blood, leucocytes, thrombocytes and erythrocytes, plasma proteins, blood cells counting and its significance, Blood coagulation – mechanism and regulation, Blood volume regulation, Haematopoiesis, Homeostasis. Disease of Blood: Thalassemia, sickle cell anemia, Anemias; Cardiovascular Disorders – Atherosclerosis	8	CO-1
2	**Digestion**	functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids and proteins.	8	CO-2
3	**Respiration**	Transfer of blood gases – Oxygen and carbon dioxide, role of 2,3-diphosphoglycerate, Bohr's effect and chloride shift, buffer systems of plasma, carbon dioxide-bicarbonate buffer system, Neural & chemical regulation of respiration.	8	CO-3
4	**Excretory system**	Structure of nephron, glomerular filtration, reabsorption and tubular secretion. Homeostatic regulation of water and electrolytes, Acid-base balance, composition of urine, hormones of the kidney	8	CO-4
5	**Diseases**	Kidney: Uremia & Glomerulonephritis; Liver: Jaundice, Liver Function Tests: SGOT, SGPT, CPK, LDH, Hepatitis. Neurological: Epilepsy, Parkinson & Alzheimer's significance of diagnostic enzymology.	8	CO-5

Reference Books:

1. Text-book of Biochemistry with clinical correlations by Thomas M. Devlin, 2nd Edition, J.
1. Wiley and Sons (1986).
2. 2. Physiological chemistry by Harper.
3. 3. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
4. Physiological basis of Medical practice, West J.B., Best and Taylor.
5. Introduction to Physiology by Davidson H and Segal M.B. Academic Press

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)											
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1					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: 2021-2022							
Course Code	BS524	**Title of the Course**	Applied Biotechnology, IPR & Biosafety	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The main objective of this course is to impart students an understanding of Plant biotechnology and its application in agriculture; Medical biotechnology and its application in gene therapy, stem cell therapy and antibody therapy; Industrial biotechnology and its application in food, dairy, leather, cosmetic and pharmaceutical industries; Animal biotechnology and its application in cell cultures, organ and animal cloning etc. Moreover, the course also includes the basic concept of IPR and its significance in biological research along with a detailed understanding of Biosafety, biohazards, and biosafety guidelines in biological research.						

Course Outcomes	
CO1	The student will learn about the basic concept of Plant Biotechnology and applications in agriculture like micro-propagation, haploid plants, embryo culture, hybrids, cybrids etc.
CO2	The student will learn about fundamentals of Medical Biotechnology and its application in stem cell therapy, gene therapy, antibody therapy etc.
CO3	Understanding application of biotechnology in food, beverage, dairy, paper and pulp, leather, detergent, cosmetic, and pharmaceutical industries etc. along with application in animal cell
CO4	The student will learn about IPR, its types and its importance
CO5	The student will learn about biosafety and bioethics

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Plant Biotechnology**	Applications of Biotechnology in agriculture: micro-propagation, haploid plants, embryo culture, hybrids, cybrids, in vitro production of secondary metabolites. Production of edible vaccines, plantibodies.	8	**CO-1**
2	**Medical Biotechnology**	Introduction to stem cells, Stem cell therapy, gene therapy, antibody therapy, Free radical: Basic concept, role of free radicals in development of diseases: Mechanisms of Protein oxdidation, Lipid peroxidation and DNA oxidation.	8	**CO-2**
3	**Industrial Biotechnology**	Applications in food, beverage, dairy, paper and pulp, leather, detergent, cosmetic, pharmaceutical industries, Single Cell Protein. Animal Biotechnology –Animal cell culture, serum free culture, cell cultures for the production of pharmaceuticals. Organ and animal cloning and their significance	8	**CO-3**
4	**IPR**	Introduction to intellectual property rights; Intellectual property laws; significance of IPR. Forms of IPR like patent, design copyright and trademark. Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms. Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity. trade related aspects of Intellectual Property Rights and Budapest treaty.	8	**CO-4**
5	**Biosafety**	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. Chirikjian "Biotechnology Theory & Techniques"
2. Animal cell culture by Ian Freshney
3. Brown, TA "Gene cloning: An introduction"
4. Industrial Microbiology by Prescott and Dunn
5. Comprehensive Biotechnology by Murray Moo Young.
6. Free Radicals in Chemistry and Biology, Milan Lazár

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	1				2	3	
CO2	3	1	1	3	1	2		1	3	2	3	
CO3	3	1	1	3	2	2		2	3	3	3	
CO4	3	1	3	3	3	2		3				3
CO5	3	1	3	3	3	3	1	3		2	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:							
Course Code	BS525	**Title of the Course**	Immunology And Molecular Biology Lab.	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**0**	**0**	**12**	**6**
Pre-Requisite	UG in Biological Science	**Co-requisite**					

Course Objectives	The course is designed to train the students in basic and some advanced techniques of Immunology like qualitative and quantitative analyses of antigen-antibody interaction. It also deals with Molecular biology techniques of isolation and purification of bacterial plasmid and chromosomal DNA and their application in cloning

Course Outcomes

CO1	The student will practically learn and understand the antigen-antibody interaction by Double Immunodiffusion method, Ouchterlony's Method, Immunoelectrophoresis, Western Blotting
CO2	The student will practically learn Blood Group determination
CO3	The student will practically learn isolation of DNA and agrose gel electrophoresis
CO4	The course will aid to learn Restriction digestion of DNA and its application in cloning and to perform PCR
CO5	The student will practically learn and understand Competitive and Direct Binding ELISA

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Exp. 1**	To identify sensitivity of antigen & antibody by double Immunodiffusion method, To identify sensitivity of antigen & antibody by Ouchterlony's Method, Immunoelectrophoresis, Western Blotting	3	CO-1
2	**Exp. 2**	Blood Group determination.	3	CO-2
3	**Exp. 3**	Isolation of plasmid DNA, Isolation of genomic DNA from E. coli, Agarose gel electrophoresis of DNA	3	CO-3
4	**Exp. 4**	Restriction digestion of DNA, Ligation, PCR	3	CO-4
5	**Exp. 5**	ELISA-Competitive and Direct Binding ELISA	3	CO-5

Reference Books:

1. Keith Wilson John Walker John M. Walker "Principles and Techniques of Practical Biochemistry"
2. Chirikjian "Biotechnology Theory & Techniques"
3. Joseph Sambrook David W. Russel Joe Sambrook "Molecular Cloning: A Laboratory Manual"
4. 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	PO8	PSO1	PSO2	PSO4	PSO5
CO1	3	3	1			3		3	3	1	3	2
CO2	3	3	1			3		3	3	1	3	2
CO3	3	3	1			3		3	3	1	3	2
CO4	3	3	1		2	3	1	3	3	1	3	2
CO5	3	3	1		2	3	1	3	3	1	3	2

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

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

Integral University, Lucknow

Effective from Session:							
Course Code	BS512	**Title of the Course**	Free Radical Biology	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					

Course Objectives	The main objective of this course is to impart students an understanding of free radicals, their properties, cause of generation of free radicals, damage caused by free radicals and free radical associated diseases. Moreover, role of antioxidants and antioxidant enzymes in neutralizing the free radicals have also been included for the development of better therapeutic intervention against free radical associated diseases.

Course Outcomes

CO1	Understand free radicals, their classification, physical and chemical properties, sources, biological significance.
CO2	Understand the mineral biochemistry and their association with free radicals
CO3	Students will learn about enzymatic and non-enzymatic antioxidants, their sources, and their role in targeting various diseases.
CO4	Students will learn the free radical-mediated oxidation of various macromolecules and their role in tissue injury.
CO5	Reconstitution of damaged molecules and membranes and the role of de-novo enzymes in the third line of defense.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to free radicals**	Introduction to free radicals, classification, physical and chemical properties, generation of free radicals- environmental factors and biological factors, biological significance.	8	CO-1
2	**Mineral biochemistry and Free radicals**	Mineral biochemistry and Free radicals: Calcium, phosphorus, agnesium. Trace elements: Iron, Iodine, Zinc, Copper.	8	CO-2
3	**Prooxidants, antioxidants, nutritional antioxidants**	Prooxidants, antioxidants, nutritional antioxidants, sources of antioxidants: microbial, plant, marine. Role of free radicals in the development of diseases: Alzheimer's, Parkinson's, Cancer.	8	CO-3
4	**Role of free radicals in development of diseases**	Role of free radicals in development of diseases: Mechanisms of Protein oxdidation, Lipid peroxidation, DNA oxidation. Types of oxidized lesions and their biological importance	8	CO-4
5	**Defense mechanisms against free radicals**	Role of antioxidants in the prevention of diseases. First line of defense: superoxide dismutase (SOD), catalase, glutathione peroxidase, glutathione reductase and xanthine oxidase, Second line of defense: glutathione (GSH), vitamin C, uric acid, albumin, bilirubin, vitamin E, carotenoids, flavonoids and ubiquinol	8	CO-5

Reference Books:

1. Free Radicals in Chemistry and Biology,
2. Milan Lazár Free Radicals in Biology and Medicine (Paperback),
3. Barry Halliwell, John Gutteridge DNA & Free Radicals (Textbook Binding)by Barry Halliwell (Author),
4. Okezie I. Aruoma (Editor) An Introduction to Free Radical Chemistry, A.F.Parsons

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

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

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

Integral University, Lucknow

Effective from Session: 2021-2022							
Course Code	BS513	**Title of the Course**	Food 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 was designed to enable the students to understand various aspects of food biotechnology including food spoilage, food preservation techniques, food borne diseases, dairy products, their contamination, and associated milk-borne diseases, the importance of different flavors in food industry, food laws and standards, and BIS Certification of food products.						

Course Outcomes

CO1	Learn the basic concepts of food spoilage and preservation techniques.
CO2	Learn about the chemical and microbiological examination milk constituents, milk grading, contamination and milk-borne diseases.
CO3	Learn about the microbial flavors in the food industry.
CO4	Understand the food laws and standards, Quality and safety assurance in the food and dairy industry, and BIS product certification and licensing quality systems.
CO5	Determine the microorganisms and their metabolites in different foods using distinct techniques.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Food as substrate for Microorganisms**	Food as substrate for Microorganisms; General principles underlying spoilage of foods and different methods of preservation of foods, Microbial food poisoning and infection; investigation of foodborne outbreaks, prevention and control.	8	**CO-1**
2	**Microbiology and spoilage**	Microbiology and spoilage of meat and meat products, fish and poultry, fruits and vegetables, sugar and sugar products, canned foods, process of canning of foods.	8	**CO-2**
3	**Milk and milk products**	Milk and milk products: Clean milk production, collection, cooling and transportation of milk, Therapeutic value and nutritive value of fermented milk products; Spoilage of milk and milk products; Milkborne diseases; antimicrobial systems in milk; sources of contamination of milk; Chemical and microbiological examination of milk; grading of milk; Starter lactic cultures; management and preparation of starter cultures; starter defects.	8	**CO-3**
4	**Microbial flavors in Dairy and Food industry**	Microbial flavors in Dairy and Food industry; Food adulteration and contamination of food with harmful microorganisms; food laws and standards; Indian and International food safety laws and standards; Quality and safety assurance in food and dairy industry; food and dairy arithmetic; standardization of products and costing; BIS Laboratory Services; BIS product certification and licensing quality systems; Certification by BIS.	8	**CO-4**
5	**Determining Microorganisms and their Products in Foods**	Determining Microorganisms and their Products in Foods: Culture, Microscopic, and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dye- reduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms	8	**CO-5**

Reference Books:

1. Food Microbiology – Frazier 5. Food Microbiology – J.De and De
2. Technology of Food preservation. Norman potter, CBS.
3. Food processing: Biotechnological Applications, S.S. Marwaha and Arora, Asitech Publ.

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		2		1	3			
CO2	3	1		2		2	2	1	2			
CO3	3	1		1		2		1	3			
CO4	3	1	2	3		2		1	2			
CO5	3	1				2	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: 2020-2021							
Course Code	BS531	**Title of the Course**	Nutritional Biochemistry	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV	**3**	**1**	**0**	**4**
Pre-Requisite	UG in Biological Science	**Co-requisite**					
Course Objectives	The objective of this course is to learn and understand the basic concepts of nutritional biochemistry which comprises nutritional values of foods, dietary requirements of carbohydrates, lipids and proteins, nutritional significance of minerals. Moreover, this course is also designed to understand the factors responsible for malnutrition and measures to overcome malnutrition in infants and adults.						

Course Outcomes

CO1	The student will learn and understand the basic concepts of nutrition, and nutritional values of foods, and Basal metabolic rate and measurement of energy requirements.
CO2	The student will also learn and understand and the dietary requirement of carbohydrates, lipids and proteins and their biological significance.
CO3	The course will also aid to learn the nutritional requirement and significance of dietary minerals like calcium, phosphorus, magnesium, iron, iodine, zinc and copper and vitamins like vitamin B complex, C and A, D, E & K.
CO4	The student will be learn about the Condition of malnutrition its prevention, and recommended dietary allowances.
CO5	The student will be able to understand the concept of Obesity, Starvation and Protein metabolism in prolonged fasting.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Basic concept**	Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements.	**8**	**CO-1**
2	**Elements of nutrition**	Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concept of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions.	**8**	**CO-2**
3	**Minerals**	Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.	**8**	**CO-3**
4	**Malnutrition**	Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods. Protein-calorie malnutrition. Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.	**8**	**CO-4**
5	**Obesity**	Definition, Genetic and environmental factors leading to obesity. Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting.	**8**	**CO-5**

Reference Books:

1. Tom Brody: Nutritional Biochemistry (Second Edition), Academic Press.
2. David A. Bender: Nutritional Biochemistry of the Vitamins, IInd edition, University College London, Cambridge University Press.
3. Harper's Illustrated Biochemistry, 29th edition, Mc Graw Hill Education,Lange.
4. Denise R. Ferrier, Richard A. Harvey, Biochemistry (Lippincott Illustrated Reviews Series), 6th edition. Wolters Kluwer/ Lipincott, Williams and Wilkins.

e-Learning Source:

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1		3		3		3	3	2	3	
CO2	3	1		3		3		3	3	2		
CO3	3	1		3		3		3	3	2		
CO4	3	1		3		3		3	3	2	1	
CO5	3	1		3		3		3	3	2	3	
BS531	3	1		3		3		3	3	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	BS514	**Title of the Course**	Seminar	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV				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

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	BS515	**Title of the Course**	Project Work	**L**	**T**	**P**	**C**
Year	II	**Semester**	IV				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**