Integral University, Lucknow

B.Sc Biotechnology

V^th Semester

Effective from Session: 2020-21							
Course Code	BS301	**Title of the Course**	Animal Biotechnology	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The course has been designed to make students aware of basic animal biotechnology techniques, their applications in Cell culture, Production of transgenic, Expression of Cloned proteins and vaccines						

Course Outcomes	
CO1	Get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells.
CO2	Gain knowledge about Primary Culture, cell lines and Secondary Culture, transformed animal cells and continuous cell lines, Monolayer formation, Synchronization.
CO3	Learn about transfection of animal cell lines, Selectable markers and Transplantation of Cultured Cells. Microinjection, In vitro fertilization and Stem cell technology.
CO4	Learn about the basics of expression of Cloned proteins in animal cells and Production of Vaccines in animal Cells.
CO5	Have knowledge of Production and Applications of monoclonal antibodies, and Transgenic Animals

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	History and Scope of Animal Tissue Culture	Culture Media, Simulating natural conditions for growth of animal cells, Natural media: Plasma Clot, biological fluids tissue extract, Importance of Serum in media, Chemical defined media, serum free media.	8	CO1
2	Primary Culture	Cell lines, and cloning, isolation and mechanical disaggregation of tissue, enzyme. Secondary Culture: transformed animal cells and continuous cell lines. Monolayer formation, Synchronization.	8	CO2
3	Transfection of animal cell lines	Selectable markers and Transplantation of Cultured Cells. Microinjection, *In vitro* fertilization. Stem cell technology.	8	CO3
4	Expression of Cloned proteins in animal cell	Expression vector, over production and downstream processing of the expressed proteins, Production of Vaccines in animal Cells.	8	CO4
5	Production and Applications of monoclonal antibodies	HAT selection, Transgenic Animals: Techniques and Applications and Transgenic mice and sheep.	8	CO5

Reference Books:

1.Ian Freshney Animal cell culture.(4th Edition)

2. Buttler. Elements of Biotechnology – P.k. Gupta (1st Edition -2000) Rastogi Publications.

3.Davis, Cell culture techniques.

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	3	
CO2	3	1			2		2	3	3	3	
CO3	3	1		2	3		3	3	3	3	
CO4	3	1		2	3		3	3	3	3	1
CO5	3	1		1	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	BS302	**Title of the Course**	Plant Biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	3	1	0	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The course has been designed to make students aware of basic plant biotechnology techniques and their applications in plant growth and development, and large scale production of natural products from plant source						

Course Outcomes	
CO1	Get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells.
CO2	The students will learn the role of techniques haploid plant production and its significance.
CO3	The students will learn about the protoplast isolation and somatic hybridization of protoplast and its application.
CO4	The students will learn about the role of plant tissue culture in agriculture, horticulture and forestry.
CO5	The students will learn about the transgenic plants and different strategies to make recombinant and its application

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Aseptic Techniques for Callus and suspension culture	Aseptic Techniques, Nutrient media, and use of growth regulators (Auxins, Cytokininis and Gibberellins). Callus and suspension	8	CO-1
2	Haploid plant production	Microspore and ovule culture, Organ Culture and their applications, Organogenesis and Somatic Embryogenesis: Techniques and applications	8	CO-2
3	Protoplast Culture	Somatic hybridization, methods of protoplast fusion chemical and electro fusion, practical application of somatic hybridization. Somaclonal variation and their significance, In vitro production of secondary metabolites: Techniques and significance	8	CO-3
4	Role of tissue culture in agriculture, horticulture and forestry, Transgenic plants, Technique of transformation	Agrobacterium-mediated and physical methods (Microprojectile bombardment and electroporation)	8	CO-4
5	Applications	Applications of transgenic plants, Edible Vaccines	8	CO-5

Reference Books:

1. Ravishankar G.A and Venkataraman L.V(1997) Biotechnology applications of Plant Tissue & cell culture. Oxford &IBH Publishing co., Pvt Ltd.
2. Bhan (1998) tissue Culture, Mittal Publications, New Delhi
3. H. S. Chawla "Plant Biotechnology: A Practical Approach"
4. Chrispeel M.J. and Sdava D.E. (1994 Plants, Genes and agriculture, Jones and Barlett Publishers, Boston.
5. Lydiane Kyte & John Kleyn (1996) Plants from test tubes. An introduction to Micropropogation (3rd Edition) timber Press, Partland

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	1	3	3	3	
CO2	3	1				2	1	3	3	3	
CO3	3	1				2	1	3	3	3	
CO4	3	1	2	1		2	3	3	3	3	
CO5	3	1	1		2	2	2	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	BS303	**Title of the Course**	Genetic Engineering	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 in Biology	**Co-requisite**					
Course Objectives	The course has been designed to make students aware of DNA manipulative enzymes and Gene cloning vectors, Screening and selection of recombinants, Techniques used as Polymerase chain reaction (PCR), Site directed mutagenes is (SDM), Nucleic acid sequencing and Application of r-DNA techniques						

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

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**DNA manipulative enzymes**	Restriction enzymes and DNA ligases, Gene cloning vectors: Plasmids, Bacteriophage and Chimeric plasmids.	08	CO-1
2	**rDNA**	*In vitro* construction of recombinant DNA molecules (pBR332, pUC19), Isolation of passenger and vector DNA, creation of r-DNA, Transformation of r-DNA by different methods.	08	CO-2
3	**Screening and selection of recombinant host cells**	Immunological screening and colony hybridization, Gene Libraries: Genomic DNA and cDNA cloning techniques, Expression of cloned DNA in *E. coli*.	08	CO-3
4	**Techniques**	Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Sanger's method, Blotting techniques: Southern, Western and Northern blot.	08	CO-4
5	**Applications**	Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.	08	CO-5

Reference Books:

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

e-Learning Source:

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

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

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

Integral University, Lucknow

Effective from Session: 2016-17							
Course Code	BS304	**Title of the Course**	Medical Biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The course has been designed to make students aware of Zoonoses, Fungi and viruses, Pathology of diseases, Therapies and Medico-legal aspects.						

Course Outcomes	
CO1	The student will understand Classifications of pathogenic microbes, Leptospira, Brucella, bacillus anthracis, Medical Parasitology: Amebiasis, Cytosporidiosis, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis, Medical Bacteriology: Staphylococcus, Streptococcus and enterococcus, Peneumococcus, Mycobacterium, Bacillus, Salmonella, Shigella, Pseudomonas and Non-fermenters, Vibrio.
CO2	The student will understand Adenoviruses, Pox viruses, Hepadnaviruses, Arboviruses, Retroviruses, Medical Mycology: Fungi, Yeast, Pathogenic fungi, superficial Mycoses, cutaneous Mycoses, subcutaneous Mycoses, Systemic Mycoses.
CO3	The student will understand Blood formation, Anemia; Blood loss anemia, Magaloblastic anemia, Leukaemia, The Parts of Brain, Brain Tumours, Stem cells: stem cell or Bone marrow transplant, , Pathology of Tuberculosis, Yellow Fever, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS).
CO4	The student will understand Introduction to chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classification of Antibiotics, Combinations of Antibiotics, Doses of Antibiotics, Side Effects of Antibiotics, General Principles for use of Antibiotics
CO5	The student will understand Social: genetic discrimination: insurance and employment, human cloning, foeticide, sex determination, Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Definition of Zoonoses	Classifications of pathogenic microbes, Leptospira, Brucella, bacillus anthracis, Medical Parasitology: Amebiasis, Cytosporidiosis, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis, Medical Bacteriology: Staphylococcus, Streptococcus and enterococcus, Peneumococcus, Mycobacterium, Bacillus, Salmonella, Shigella, Pseudomonas and Non-fermenters, Vibrio.	8	**CO1**
2	Medical Virology	Adenoviruses, Pox viruses, Hepadnaviruses, Arboviruses, Retroviruses, Medical Mycology: Fungi, Yeast, Pathogenic fungi, superficial Mycoses, cutaneous Mycoses, subcutaneous Mycoses, Systemic Mycoses.	8	**CO2**
3	Pathology of diseases	Blood formation, Anemia; Blood loss anemia, Magaloblastic anemia, Leukaemia, The Parts of Brain, Brain Tumours, Stem cells: stem cell or Bone marrow transplant, , Pathology of Tuberculosis, Yellow Fever, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS).	8	**CO3**
4	Therapies	Introduction to chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classification of Antibiotics, Combinations of Antibiotics, Doses of Antibiotics, Side Effects of Antibiotics, General Principles for use of Antibiotics	8	**CO4**
5	Medico-legal aspects	Social: genetic discrimination: insurance and employment, human cloning, foeticide, sex determination, Ethical: somatic and germ line gene therapy, clinical trials, the right to information, ethics committee function.	8	**CO5**

Reference Books:

1.Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.

2. Collee, JG. Duguid JP., Fraser AG., Marimon BP. (1989) Mackie and Mc Cartney Practical Medical Microbiology, 13th Edition. Churchill Livingstone.

3. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.

4. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition. Blackwell Scientific Publication, Oxford.

e-Learning Source:

https://drive.google.com/drive/folders/1bBZ-_edCG9626vNPWW6gatbC0MCHlKI9?usp=sharing

https://drive.google.com/file/d/1SQkoP6pERFCbHMj9RH49aaPUAF2Obed6/view?usp=sharing

https://drive.google.com/drive/folders/1I9ENpJ9H6BPDgl_Tf2riQqgcIUj_yaUy?usp=sharing

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

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1				3	3	3	3	
CO2	3	3	1				3	3	3	3	
CO3	3	3	1				3	3	3	3	
CO4	3	3	1				3	3	3	3	
CO5	3	3	1				3	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	BS306	**Title of the Course**	**APPLIED BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to make students familiar with principle, methodology and application of Drug and target identification, target validation, Bioprospecting and conservation: importance of biodiversity, General theory of free radical and antioxidants, Significance of IPR; Requirement of a patentable novelty and Detailed, information on patenting biological products and biodiversity						

Course Outcomes	
CO1	Get proper knowledge about Genomics and Proteomics and gene expression.
CO2	Gain knowledge about Drug Discovery and Designing: Drug and target identification, target validation.
CO3	Learn about Bioprospecting and conservation: importance of biodiversity.
CO4	Learn about the basics of Free Radical Biology: General theory of free radical and antioxidants.
CO5	Have knowledge of Significance of IPR; Requirement of a patentable novelty and Detailed, information on patenting biological products and biodiversity.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genomics and Proteomics	Introduction to genomics, Genome annotation, Human genome project and its application, Introduction to Proteomics: Protein expression and its analysis	8	CO1
2	Drug Discovery and Designing	Drug and target identification, target validation, Molecular docking studies and its Insilco tools e.g. Autodock, GOLD.	8	CO2
3	Bioprospecting and conservation	Importance of biodiversity. biodiversity informatics, databases in biological materials. International efforts and issues of sustainability.	8	CO3
4	Free Radical Biology	General theory of free radical and antioxidants. Free radical mediated damage to lipids, proteins and DNA; Natural antioxidants and their applications.	8	CO4
5	IPR and Patenting	Significance of IPR; Requirement of a patentable novelty; Issues related to IPR protection of software and database; IPR protection of life forms; International convention in IPR; Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity.	8	CO5

Reference Books:

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	**3**	**1**					**1**	**3**	**3**	**3**			
CO2	**3**	**1**					**2**	**3**	**3**	**3**			
CO3	**3**	**1**			**1**	**3**	**3**	**3**	**3**	**3**	1		
CO4	**3**	**1**					**2**	**3**	**3**	**3**			
CO5	**3**	**1**			**3**	**2**	**3**	**3**	**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	BS307	**Title of the Course**	Tissue Culture Lab	**L**	**T**	**P**	**C**
Year	3rd	**Semester**	Vth	0	0	6	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of Basics of Tissue and cell culture						

Course Outcomes	
CO1	Preparation of plant culture media and its sterilization
CO2	Initiation and maintenance of Callus and suspension Culture, cell culture
CO3	Plant propagation through axillary bud culture and adventitious bud culture
CO4	Isolation of lymphocytes from blood samples. In vitro maintenance of helminth parasites
CO5	In vitro germination of seeds.

Exp. No.	**Title of Experiment**	**Contact hrs.**	**Mapped CO**
Exp-01	Preparation of plant culture media and its sterilization	3	CO-1
Exp-02	In vitro germination of seeds.	3	CO-5
Exp-03	Initiation and maintenance of Callus and suspension Culture	3	CO-2
Exp-04	Plant propagation through axillary bud culture.	3	CO-3
Exp-05	Plant propagation through adventitious bud culture.	3	CO-3
Exp-06	Isolation of lymphocytes from blood samples.	6	CO-4
Exp-07	In vitro maintenance of helminth parasites.	6	CO-5
Exp-08	In vitro maintenance of cell lines.	6	CO-4
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			1	3	3	3	3	
CO2	3	3	1				3	3	3	3	
CO3	3	3	1			1	3	3	3	3	
CO4	3	3	1				3	3	3	3	
CO5	3	3	1			3	3	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	BS308	**Title of the Course**	Genetic Engineering Lab	**L**	**T**	**P**	**C**
Year	3	**Semester**	V	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 basics of genetic engineering and PCR.						

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

Exp. No.	**Title of Experiment**	**Contact hrs.**	**Mapped CO**
Exp-01	Isolation of genomic DNA from bacteria (*E. coli*)	3	CO-1
Exp-02	Isolation of genomic DNA from plant tissue	3	CO-1
Exp-03	Isolation of genomic DNA from animal tissue	3	CO-1
Exp-04	Isolation of plasmid DNA (*E. coli*)	3	CO-2
Exp-05	Restriction digestion of DNA	6	CO-3
Exp-06	Agarose Gel Electrophoresis	6	CO-4
Exp-07	Demonstration of PCR	6	CO-5

Reference Books:

1. Gene Cloning and DNA Analysis: An Introduction, 6th Edition by T. A. Brown
2. Sambrook J, Russell D (2001) Molecular Cloning: A Laboratory Manual, 3rd edn. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

e-Learning Source:

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

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

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

Integral University, Lucknow

VIth Semester

Effective from Session: 2020-21							
Course Code	BS311	**Title of the Course**	Bioinformatics	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**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 basics of Application of Bioinformatics, Sequence Formats, Sequence Alignment, Data mining and Application of Bioinformatics						

Course Outcomes	
CO1	Know basics of Bioinformatics
CO2	Have knowledge of GenBanks, EMBL, DDBJ, Swissprot, PIR/NBRF, IG, GCG, FAST
CO3	Know about basics of Sequence Alignment
CO4	Get insight visualization
CO5	Understand basics of Gene finding tools, Phylogenetic tree, Protein structure visualization, Protein structure prediction, homology modeling.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Bioinformatics	Bioinformatics an introduction, Biological database types, sequence databases - nucleotide and protein sequence databases.	8	CO1
2	Sequence Formats	GenBank, EMBL, DDBJ, Swissprot, PIR/NBRF, IG, GCG, FASTA	8	CO2
3	Sequence Alignment	Pairwise Sequence Alignment, Multiple Sequence Alignment, Dynamic Programming, Progressive Alignment, Smith-Waterman Algorithm, Needleman-Wunsch Algorithm, Scoring Matrices	8	CO3
4	Data mining in Bioinformatics	Introduction to data mining, Categories of data mining, Data mining methods, Knowledge discovery, Data modeling, Data visualization, Application of data mining in bioinformatics.	8	CO4
5	Application of Bioinformatics	Introduction to Gene finding tools, Phylogenetic tree, Protein structure visualization, Protein structure prediction, homology modeling.	8	CO5
Reference Books:				
e-Learning Source:				

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)																	
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1					1						3	3	3			
CO2	3	1				1	1						3	3	3			
CO3	3	1					1						3	3	3			
CO4	3	1				1	1						3	3	3			
CO5	3	1				1	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	BS312	**Title of the Course**	BIONANOTECHNOLOGY	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	**The objective of this course is to develop the understanding of Basics of nanotechnology and overview of nanoscale materials, Nanomaterials: Biosensors: Biophotonics and Bioimaging and Principles of toxicology;**						

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

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

Reference Books:

- Engines of Creation, K E Drexler, Oxford Paperbacks, New York
- .Engines of Creation, K E Drexler, Oxford Paperbacks, New York
- Nanosystems: Molecular Machinery, Manufacturing and Computation, K E Drexler, Wiley, ISBN 0471575186
- Our Molecular Future: How Nanotechnology, Robotics, Genetics and Artificial Intelligence Will Transform the World, Prometheus ISBN 1573929921
- Nanobiotechnology-Concepts, Applications and Perspectives edited by CM Niemeyer and CA Mirkin, Wiley-VCH ISBN 527-30658-7
- NanoBiotechnology Protocols in Methods in Molecular Biology Series Edited by SJ Rosenthal and DW Wright, Humana Press, ISBN: 1-58829-276-2
- Understanding Nanotechnology Scientific American, ISBN: 0446679569 Prey (a novel) by Michael Crichton, ISBN: 006621412

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

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

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

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

Integral University, Lucknow

Effective from Session:2020-21							
Course Code	BS314	**Title of the Course**	BIOINFORMATICS LAB	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	0	0	6	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of sequence databases, Retrieving sequences, Simple sequence comparison using DOTPLOT, Pairwise Sequence Alignment , FASTA & BLAST search, Multiple Sequence Alignment (ClustalX & Treeview), Protein Structure Visualization (RASMOL, Swiss-PDB Viewer) and GeneFinding tools (Grail or Genscan)						

Course Outcomes	
CO1	Learn about types of sequence databases (Nucleotide & Protein)
CO2	Know about Retrieving sequences from the databases and simple sequence comparison using DOTPLOT
CO3	Have knowledge of Pairwise Sequence Alignment (NW and SW approach), FASTA & BLAST search and Multiple Sequence Alignment (ClustalX & Treeview)
CO4	Have basic knowledge of Protein Structure Visualization (RASMOL, Swiss-PDB Viewer)
CO5	Have basic knowledge about Gene Finding tools (Grail or Genscan)

Exp. No.	**Title of Experiment**	**Contact hrs.**	**Mapped CO**
Exp-01	Introduction to types of sequence databases (Nucleotide & Protein).	3	CO-1
Exp-02	Retrieving sequences from the databases.	3	CO-2
Exp-03	Simple sequence comparison using DOTPLOT.	3	CO-2
Exp-04	Pairwise Sequence Alignment (NW and SW approach).	3	CO-3
Exp-05	FASTA & BLAST search.	3	CO-3
Exp-06	Multiple Sequence Alignment (ClustalX & Treeview).	3	CO-4
Exp-07	Protein Structure Visualization (RASMOL, Swiss-PDB Viewer).	6	CO-5
Exp-08	Gene Finding tools (Grail or Genscan).	6	

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	
CO2	3	3	1			1	3	3	3	3	
CO3	3	3	1				3	3	3	3	
CO4	3	3	1			1	3	3	3	3	
CO5	3	3	1			1	3	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	BS315	**Title of the Course**	PROJECT & TRAINING	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI				**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	**The main objective of this course is to acquaint the student with various techniques used in contemporary research in biotechnology or allied areas.**						

Course Outcomes	
CO1	To be able to define a research problem.
CO2	To conduct bench work.
CO3	To prepare the research report and its oral demonstrations.
CO4	To coorealate theoretical knowledge of techniques with practical application
CO5	To promote lifelong learning

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)												
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2		1	1		3	3	3	3			
CO2	3	3	2	1	3		3	3	3	3	3		
CO3	3	3	2	1	3		3	3	3	3			
CO4	3	3					3	3	3	3			
CO5	3	3					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: 2020-21							
Course Code	BS316	**Title of the Course**	EDUCATIONAL TOUR	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI				**2**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The main objective of this course is to provide the students an exposure to various research activities in the country and acquaint the student with state of the art technique/instruments used in various research institutions and industries of national repute. The student needs to submit a report after completion of the tour.						

Course Outcomes	
CO1	Develop understanding of state of the art techniques/instruments used in various reputed research institutions. and industries
CO2	Take part in Group discussion and learn Team work.
CO3	Enhance communication and social skills by communication with peers
CO4	Student shall be able to plan and improve the Technical Report writing skills
CO5	Have created 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	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	1	1				3	3	3	3	1		
CO2	3	2	2	1			3	3	3	3			
CO3	3	2	2	1			3	3	3	3			
CO4	3	2					3	3	3	3			
CO5	3			1		2	3	3	3	3	1		

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

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