Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100501 T / BS309	**Title of the Course**	Biostatistics and Bioinformatics	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of biostatistical and bioinformatical techniques.						

Course Outcomes	
CO1	Learn the need of statistical approach, identify the different axiomatic approach and study the variability of observation
CO2	Know effective use of Office package –word, excel, ppt and publisher etc
CO3	Understand simple calculation using excel
CO4	Understand the basic theories and practical of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts
CO5	Critically analyse and interpret results of their studies with the help of bioinformatical and biostatistical tools.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**History and introduction to Bioinformatics**	Introduction and applications of bioinformatics. Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics	**6**	**CO1**
2	**Databases, Data generation, Data storage and retrieval**	General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases (Primary, Composite, and Secondary); Specialized Genome databases: (SGD, TIGR, and ACeDB); Structure databases (CATH, SCOP, and PDBsum)	**8**	**CO2**
3	**Sequence and Phylogeny analysis**	Introduction to Sequences, Alignments and Dynamic Programming; Local alignment and Global alignment (algorithm), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm)	**8**	**CO2**
4	**Searching Databases**	SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission; Gene identification tools	**6**	**CO3**
5	**Types and Collection of data**	Primary and Secondary data, Classification and Graphical representation of Statistical data; Measures of central tendency and Dispersion; Measures of Skewness and Kurtosis.	**8**	**CO3**
6	**Probability**	Definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.	**8**	**CO4**
7	**Sampling**	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test; Problems on test of significance, t-test, chi-square test; for goodness of fit and analysis of variance (ANOVA)	**8**	**CO4**
8	**Correlation and Regression**	Types, Karl-Pearson's correlation, Spearman's Rank correlation, Regression equation and fitting; Main features of regression analysis-simple and multiple regression analysis; Differences between correlation and regression analysis	**8**	**CO5**

Reference Books:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell
5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A.(2018). A Textbook of Bioinformatics (2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014) Bioinformatics for beginners. (1st edition) Elsevier
8. Rastogi SC. Mendiratta N. Rastogi P. (2013). Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery. (4th edition). Prentice Hall India Learning Private Limited
9. Rastogi VB. (2015). Biostatistics (3rd Edition). MedTec

e-Learning Source:

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					2	3			3
CO2	3	1					2	3			3
CO3	3	1					2	3			3
CO4	3	1					2	3			3
CO5	3	1					2	3			3

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

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

Effective from Session: 2024-25							
Course Code	B100503 T / BS319	**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 mutagenesis (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, In vitro construction of recombinant DNA molecules
CO2	Gain knowledge about isolation of genomic and plasmid DNA, creation of rDNA and methods of 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, DNA ligases, Polymerases, Kinases, Alkaline phosphatases, Reverse Transcriptase	8	CO-1
2	Vectors	Gene cloning vectors: Plasmids, Bacteriophage and Chimeric plasmids. *In vitro* construction of recombinant DNA molecules (pBR332, pUC19)	8	CO-1
3	Isolation of DNA	Isolation of genomic and plasmid DNA	8	CO-2
4	rDNA	Creation of r-DNA, Transformation of r-DNA by different methods.	8	CO-2
5	Screening and selection of recombinant host cells	Immunological screening, colony hybridization and blue-white screening.	6	CO-3
6	Gene Libraries	Preparation and comparison of Genomic DNA and cDNA library, Expression of cloned DNA in *E. coli*.	8	CO-3
7	Techniques	Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Sanger's method, Blotting techniques: Southern, Western and Northern blot.	8	CO-4
8	Applications	Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.	8	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		3	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: 2024-25							
Course Code	B100502P / BS390	**Title of the Course**	Bioinformatics and Biostatistics Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2	**Co-requisite**					
Course Objectives	The course is designed to train the students in bioinformatical and biostatistical tools						

Course Outcomes	
CO1	Understand about information resources.
CO2	To understand the use of data search tools
CO3	Understand use of gene prediction methods and primer designing
CO4	Understand the use of biostatistical methods.
CO5	Learn the designing of diagram, chart and plots

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	Use of sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.	4	CO-1
2	Exp-02	Use of similarity search tools FASTA and BLAST.	2	CO-2
3	Exp-03	Multiple sequence alignment using ClustalW and interpretation of results.	2	CO-2
4	Exp-04	Use of gene prediction methods (GRAIL, Genscan).	2	CO-3
6	Exp-05	Use of different protein structure databases (PDB, SCOP, CATH etc.).	4	CO-3
7	Exp-06	Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation	2	CO-4
8	Exp-07	To perform Regression Analysis, Chi square test, Student test, ANOVA.	4	CO-4
9	Exp-08	Designing of bar diagram, pi chart, histogram, scatter plots	4	CO-5

Reference Books:

1. Lesk, A. M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press
3. Baxevanis, A. D., & Ouellette, B. F. (2001). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ.: Wiley-Blackwell
5. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A.(2018). A Textbook of Bioinformatics (2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014) Bioinformatics for beginners. (1st edition) Elsevier
8. Rastogi SC. Mendiratta N. Rastogi P. (2013). Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery. (4th edition). Prentice Hall India Learning Private Limited
9. Rastogi VB. (2015). Biostatistics (3rd Edition). MedTec

e-Learning Source:

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

Effective from Session: 2024-25							
Course Code	B100504P/ BS320	**Title of the Course**	Genetic Engineering Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**4**	**2**
Pre-Requisite	10+2	**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.

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

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 Ed. 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	1						3		3	
CO2	3	1		3		3	1	3	2	3	
CO3	3	1		3		3	1	1		3	
CO4	3	1		3		3	1				3
CO5	3	1		3	3	3	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: 2024-25							
Course Code	B100505 T/BS300	**Title of the Course**	Bioanalytical Tools	L	T	P	C
Year	III	**Semester**	V	3	1	0	4
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to introduce various techniques like Chromatography, Centrifugation, Electrophoresis, Microscopy, Spectroscopy and Radioactivity to the students used in biological research.						

Course Outcomes	
CO1	Understand the basic concept of chemical bonding.
CO2	Understand the basics and types of Chromatography and Centrifugation.
CO3	Study the principles and applications of Electrophoresis and Microscopy.
CO4	Understand the principles and applications of Spectroscopy techniques.
CO5	Understand the importance of Radioactivity in biological studies, GM counters and Scintillation counting.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Basics of Biophysics	Chemical bonding – Ionic bond, Covalent bond, Hydrogen bond and Vander-Waals force	6	CO1
2	Chromatography	Introduction & principle of Chromatography, Paper, Thin-layer, column chromatography, HPLC, GLC, Ion exchange chromatography, Affinity chromatography	8	CO2
3	Centrifugation	Principle of centrifugation, Basic rules of sedimentation, Sedimentation coefficient, Various types of centrifuges, Low-speed centrifuge, High-speed centrifuge and Ultracentrifuge, Types of rotors, Application of centrifugation, Differential centrifugation, Density gradient centrifugation- Zonal and Isopycnic.	8	CO2
4	Electrophoresis	Basic principle, Instrumentation and types of Electrophoresis, Agarose gel electrophoresis, PAGE, SDS-PAGE	6	CO3
5	Microscopy	Principle of Light microscopy, Phase contrast microscopy, Fluorescence microscopy, Electron microscopy, TEM and SEM, Permanent and temporary slide preparation	8	CO3
6	Spectroscopic techniques I	Colorimetry, UV-Visible spectrophotometry and Beer-Lambert law, Fluorescence spectroscopy, Infra-Red spectroscopy.	8	CO4
7	Spectroscopic techniques II	Circular Dichroism, Nuclear Magnetic Resonance spectrometry, Atomic absorption, Emission spectrometry, X Ray diffraction, Mass spectrometry	8	CO4
8	Radioactivity	Radioactivity, Types, their importance in biological studies, Measure of radioactivity, GM counters, Scintillation counting.	8	**CO5**

Reference Books:

1. Narayanan, P: Essentials of Biophysics, New Age Int. Pub. New Delhi.
2. Keith Wilson & John Walker: Principles and Techniques of Biochemistry and Molecular Biology.
3. Upadhyay, Upadhyay and Nath: Biophysical Chemistry: Principle and Techniques.
4. David Sheehan: Physical Biochemistry Principle and Applications.
5. Sabari Ghosal & A. K. Srivastava: Fundamentals of Bioanalytical techniques and Instrumentation.

e-Learning Source:

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					2	3			3
CO2	3	1					2	3			3
CO3	3	1					2	3			3
CO4	3	1					2	3			3
CO5	3	1					2	3			3

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

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100506T / BS391	**Title of the Course**	Medical Biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 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: Amoebiasis, Cryptosporidium, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis, Medical Bacteriology: Staphylococcus, Streptococcusandenterococcus, Peneumococcus, Mycobacterium, Bacillus, Salmonella, Shigella, Pseudomonas, and Vibrio, , Pathology of Tuberculosis
CO2	The student will understand Adenoviruses, Pox viruses, Hepadnaviruses, Arboviruses, Retroviruses, ellow Fever, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS). 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, BrainTumours, Stem cells: stem cell or Bone marrow transplant
CO4	The student will understand Introduction to chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classificationof 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, different mode of transmissions, types of life cycles, types of hosts, medical definitions	**6**	**CO1**
2	Bacteriology	Leptospira, Brucella, bacillus anthracis, Staphylococcus, Streptococcusandenterococcus, Peneumococcus, Mycobacterium, Bacillus, Salmonella, Shigella, Pseudomonas, and Vibrio, Pathology of Tuberculosis	**8**	**CO2**
3	Parasitology	Amoebiasis, Cryptosporidium, Giardiasis, Malaria, Toxoplasmosis, Trichomoniasis	**6**	**CO2**
4	Medical Virology	Adenoviruses, Pox viruses, Hepadnaviruses, Arboviruses, Retroviruses, Yellow Fever, Japanese Encephalitis, Dengue, Acquired Immune Deficiency Syndrome (AIDS).	**8**	**CO3**
5	Medical mycology	Fungi, Yeast, Pathogenic fungi, superficial Mycoses, cutaneous Mycoses, subcutaneous Mycoses, Systemic Mycoses.	**8**	**CO3**
6	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.	**8**	**CO4**
7	therapies	chemotherapy and radiotherapy, Human Gene Therapy. Antibiotics: Classificationof Antibiotics,Combinations of Antibiotics, Doses of Antibiotics, Side Effects of Antibiotics, General Principles for use of Antibiotics	**8**	**CO4**
8	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

5. Sabari Ghosal & A. K. Srivastava: Fundamentals of Bioanalytical techniques and Instrumentation.

e-Learning Source:

PO-PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4

CO											
CO1	3	1					2	3			3
CO2	3	1					2	3			3
CO3	3	1					2	3			3
CO4	3	1					2	3			3
CO5	3	1					2	3			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: 2024-25							
Course Code	B100507R / BS392	**Title of the Course**	Industrial visit and survey report	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**0**	**0**	**4**	**4**
Pre-Requisite		**Co-requisite**					
Course Objectives	The main objective of this course is to provide the students an exposure to various research activities and acquaint the student with state of the art technique/instruments used in various reputed research institutions and industries.						

Course Outcomes	
CO1	To develop understanding of state of the art technique/instruments used in various reputed research institutions.
CO2	To develop understanding of state of the art technique/instruments used in various reputed research institutions. and industries
CO3	To prepare the tour report.

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	1	3	3	2	3
CO2	3	1				3	2	3	3	2	3
CO3	3	1				3	1	3	3	2	3
CO4	3	1				3	1	3	3	2	3
CO5	3	1				3	1	3	3	2	3

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100601T/BS317	**Title of the Course**	Essentials of Environmental Biotechnology	**L**	**T**	**P**	**C**
Year	2	**Semester**	IV	3	1	0	4
Pre-Requisite	10+2 with Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of environmental biotechnology, bioremediation, waste management, bioleaching, conventional and modern fuels						

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

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Conventional and modern fuels**	Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	8	CO-1
2	**Structural and Functional dynamics of microbes**	Diversity, activity and growth, community profiling, biosensors, bioreporters, Microchips.	6	CO-2
3	**Methanogenesis**	Methanogenesis: methanogenic, acetogenic and fermentative bacteria- technical processes and conditions	8	CO-2
4	**Bioremediation**	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents, Degradation of lignin and cellulose using microbes,.	8	CO-3
5	**Phytoremediation**	Phytoremediation, Degradation of pesticides and other toxic chemicals by microorganisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products	8	CO-3
6	**Waste Management**	Treatment of municipal waste and Industrial effluents,	6	CO-4
7	**Biofertilizers**	Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	8	CO-4
8	**Bioleaching**	Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.	8	CO-5

Reference Books:

1. Microbial Biotechnology (1995) Alexander n. Glazer Hiroshi Nikaido W.H.Freeman and Company

2. Molecular biotechnology: Principles and Applications of Recombinant DNA –Bernaral R. Glick and Jack J. Pastemak ASMPress. Washington, D.C (1994).
3. Fungal Ecology and Biotechnology (1993) Rastogi Publications, Meerut.
e-Learning Source:

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

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

4-

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100603T / BS318	**Title of the Course**	Food microbiology and Biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 in Biology	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of the basic concepts of food and types of microorganisms associated with foods and their origin and role, food preservation and fermentation techniques used in dairy industry, enzymes in food technology, dairy products and value addition products						

Course Outcomes	
CO1	The students will learn about the role of microorganism in food microbiology
CO2	Gain insight on spoilage of foods by microbes and the microbial examination of food
CO3	Learn about food preservation techniques and fermentation of foods
CO4	Learn about history and evolution of food technology, enzymes used in food industry
CO5	Learn about the microbial flavors in food industry

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to food & nutrition	History, Development and Scope of food microbiology; Concept of food and nutrients; Physiochemical properties of food; Importance and types of microorganisms in food (bacteria, mold and yeast); Food as a substrate for microorganism- Intrinsic and extrinsic factors that affect growth and survival of microbes in food, natural flora and source of contamination of foods in general.	8	CO-1
2	Microbial spoilage of various foods and Microbial examination of food	Principal; Spoilage of vegetables, fruits, meats, eggs, milk and butter, bread, canned foods, DMC, viable count, examination of faecal Streptococci. Food quality monitoring, Biosensors and Immunoassays	8	CO-1
3	Food Preservation	Basic Principles, Methods (heating, freezing, dehydration, chemical preservatives, radiation). Modern technologies in food preservation, Packaging material.	6	CO-2
4	Fermentation of foods	Types of fermentation, production and defects. Fermentation of pickles, butter, cheese, creams, yogurt and ice creams. Probiotics: health benefits, types of microorganisms used, probiotic foods available in market.	8	CO-2
5	Introduction to Food Biotechnology	Historical Background of Food technology. Importance, global trends, codex guidelines, nutritional labelling in India, FSSAI guidelines. Improvements through Biotechnology (e.g. Golden Rice, Potato, Flavr Savr Tomato etc.)	8	CO-3
6	Enzymes in Food Industry	Carbohydrases, Proteasase, Lipases, Modification of food using enzymes: Role of endogenous enzymes in food quality, Enzymes use as processing aid and ingredients	8	CO-4
7	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-4
8	Value addition products	Value addition products like High Fructose Syrup, Invert Sugars etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, Edible fungus: Mushrooms. Potential of Probiotics. Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.	8	CO-4

Reference Books:

1. Adams & Moss, Food Microbiology, Published by Royal Society of Chemistry, Cambridge, U.K.
2. R.S. Mehrotra – Plant Pathology, Tata Mc-Graw Hill
3. Frazier & Westhoff., Food Microbiology Tata Mc-Graw Hill (2014)
4. Food processing Biotechnological Applications, S.S. Marwaha and Arora, AsitechPub
5. Lopez GFG, Canaas G, Nathan EV. Food Sciences and Food biotechnology

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4

PSO / CO											
CO1	3	1					1	3			
CO2	3	1						3			
CO3	3	1					1	3			
CO4	3	1					1	3		1	
CO5	3	1					1			3	2

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

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

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Effective from Session: 2024-25							
Course Code	B100607T/BS313	**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 the Basics of nanotechnology and an 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, the effect of length scale on properties,	6	CO.1
2	**Bionanotechnology**	Introduction to bionanotechnology, challenges and opportunities associated with biology on the Nanoscale, bionanotechnology systems, biological and medical applications of Bionanomaterials.	8	CO.1
3	**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 behavior of nanoparticles.	8	CO.2
4	**Characteristics of nanoparticles**	Characteristics of nanoparticles, chemical speciation of dissolved species, Environmental behavior of nanoparticles.	8	CO.2
5	**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
6	**Biophotonics**	Overview of imaging biological systems, from the cellular level through to whole-body medical imaging, Introduction to biophysics,	6	CO.4
7	**Bioimaging**	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
8	**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

2-

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100602P/BS393	Title of the Course	Fundamentals of Environmental Biotechnology Lab	L	T	P	C
Year	2	Semester	IV	0	0	4	2
Pre-Requisite	10+2 with Biology	Co-requisite					
Course Objectives	This course aims to develop the understanding of basics of Algal and fungal culture, estimation of Nitrogen, citric acid, lactic acid, heavy metals, BOD and COD, and examination of bacteria by MPN Count Method.						

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

Exp. No.	**Title of Experiment**	**Contact Hrs.**	**Mapped CO**
Exp-01	Algal and fungal culture – Yeast and Aspergillus	10	CO-1
Exp-02	Estimation of citric acid from Aspergillus culture.	8	CO-1
Exp-03	Estimation of lactic acid.	8	CO-2
Exp-04	Estimation of Total Nitrogen by Kjeldahl method.	8	CO-3
Exp-05	Bacterial Examination of Water by MPN Count Method.	8	CO-3
Exp-06	Estimation of BOD and COD (2 Samples).	10	CO-4
Exp-07	Estimation of heavy metals (Iron, chromium and arsenic) in water sample.	8	CO-5

Reference Books:
e-Learning Source:

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

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

3-

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

Integral University, Lucknow

Effective from Session: 2023-24							
Course Code	B100604P / BS310	**Title of the Course**	Food microbiology and Biotechnology Lab	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**0**	**0**	**4**	**2**
Pre-Requisite	10+2	**Co-requisite**					
Course Objectives	The objective of this course is to develop the understanding of food microbiology and biotechnology.						

Course Outcomes	
CO1	The students will be able to isolate and characterize yeast.
CO2	The students will be able to isolate and identify important microorganisms of food microbiology.
CO3	The students will be able to assess the quality of raw milk and preparation of sauerkraut.
CO4	The students will be able todetermine total proteins by Bradford method.
CO5	The students will be able to analyse moisture, ash, protein, fat, fiber and carbohydrate in food sample.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-01	Isolation and characterization of Yeast used in Bakery/distillery/winery	6	CO-1
2	Exp-02	Isolation & identification of important microorganism of food microbiology	6	CO-1
3	Exp-03	Methylene Blue Dye Reduction Test for Assessing the quality of raw milk.	6	CO-1
4	Exp-04	Preparation of sauerkraut.	6	CO-2
5	Exp-05	Quantitative determination of Total proteins by Bradford method	6	CO-3
6	Exp-06	Proximate analysis of food sample: moisture, ash, protein, fat, fiber and carbohydrate	6	CO-4

Reference Books:

1. Aneja, K.R. 1993. Experiments in Microbiology, Pathology and Tissue Culture, Vishwa Prakashan, New Delhi.
2. Dubey, R.C. and Maheshwari. D.K. 2012. Practical Microbiology, S.Chand & Company, Pvt. Ltd., New Delhi.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)										
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	3			
CO2	3	1						3			
CO3	3	1					1	3			
CO4	3	1					1	3		1	
CO5	3	1					1			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: 2024-25							
Course Code	B100605T/ BS394	**Title of the Course**	Applied Biotechnology	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	10+2 Biology	**Co-requisite**					
Course Objectives	The objective of this course is to make students familiar with Genomics and proteomics, principle, methodology and application of Drug discovery, Bioprospecting and conservation: importance of biodiversity, General theory of free radical and antioxidants, Significance of IPR; Requirement of a patentable novelty, Biosafety and GMOs.						

Course Outcomes	
CO1	Get proper knowledge about Genomics, Proteomics and gene expression.
CO2	Gain knowledge about Drug Discovery and Designing: Drug and target identification, target validation.
CO3	Learn about Bioprospecting and conservation and basics of Free Radical Biology.
CO4	Have knowledge of Significance of IPR.
CO5	Have knowledge of Significance of Biosafety and GMO.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Genomics and Genome annotation**	Introduction to genomics, Genome annotation, Alignment, Whole genome sequencing methods, Human genome project and its application	**8**	**CO1**
2	**Proteomics and its analysis**	Introduction to Proteomics, Proteomics classification, Protein expression and its analysis, Bioinformatics in proteomics	**8**	**CO1**
3	**Drug Discovery and designing**	Drug and target identification, Drug and target validation, Molecular docking studies and its Insilco tools e.g. Autodock, GOLD.	**8**	**CO2**
4	**Bioprospecting and conservation**	Importance of biodiversity. biodiversity informatics, databases in biological materials. International efforts and issues of sustainability.	**8**	**CO3**
5	**Free Radical Biology**	General theory of free radical and antioxidants. Free radical mediated damage to lipids, proteins and DNA; Natural antioxidants and their applications.	**6**	**CO3**
6	**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**	**CO4**
7	**Biosafety**	Primary Containment for Biohazards; Biosafety Levels; Biosafety guidelines Government of India; Roles of Institutional Biosafety Committee, RCGM, GEAC etc.	**8**	**CO5**
8	**GMOs**	Definition of GMOs; GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication	**6**	**CO5**

Reference Books:

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

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

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

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

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

6. Biotechnology- B.D. Singh

e-Learning Source:

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					3	3	1	1	3
CO2	3	1					3	3	1	1	3
CO3	3	1			1	3	3	3	1	1	3

CO4	3	1					3	3	1	1	3
CO5	3	1			3	2	3	3	1	1	3

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

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

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100606T/ BS395	**Title of the Course**	Genomics, Proteomics & Metabolomics	**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 Genome sequencing, Genome databases, Genome analysis, Proteomics and Metabolomics.						

Course Outcomes	
CO1	The students will be able to explain Genome sequencing techniques and Sequencing technology.
CO2	The students will be able to discuss about major Genome databases, Genome analysis, Comparative genomics, Functional genomics techniques.
CO3	The students will be able to describe about basic Proteomics technologies.
CO4	The students will be able to describe the basics technologies used in Metabolomics.
CO5	The students will be able to discuss applications of Genomics and Proteomics in various fields of life.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Genome sequencing	Sequencing technology: Sanger sequencing, Maxam-Gilbert sequencing. Pros and cons of these sequencing technologies. Whole shotgun genome sequencing	**6**	**CO1**
2	Next generation Sequencing	Sequencing technology: Pyrosequencing, Illumina/Solexa, SOLiD System, Ion Torrent. Introduction to third generation sequencing technologies.	**8**	**CO1**
3	Genome databases and Structural genomics	Major Genome databases, Genome analysis and their applications-Structural genomics: Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of Genomes; sequence assembly and annotation.	**8**	**CO2**
4	Functional genomics	Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics. Comparative genomics.	**8**	**CO2**
5	Proteomics	Introduction to basic proteomics technology: 1D-SDS-PAGE, 2D-SDS PAGE. Detection and quantitation of proteins in gels. Pros and cons of various staining methods. Yeast-two-hybrid system, cDNA microarrays.	**8**	**CO3**
6	Mass spectrometry	Basics of mass spectrometry. MALDI-TOF and ESI, and their application in proteomics, Tandem MS/MS spectrometry, Peptide sequencing by tandem mass spectrometry.	**8**	**CO3**
7	Metabolomics	Technologies in metabolomics, Role of Spectroscopy, Electrophoretic and Chromatographic techniques in metabolic profiling. Nutrigenomics.	**8**	**CO4**
8	Applications	Applications of genomics and proteomics in agriculture, human health, and industry.	**6**	**CO5**

Reference Books:

1. Griffiths JF, “An Introduction to Generic Analysis”.
2. Gene Cloning and DNA Analysis: An Introduction, 6th Edition by T. A. Brown
3. Genomics and Proteomics: Functional and Computational Aspects by Suhai and Sándors,
4. Genomics and Proteomics: Principles, Technologies, and Applications by Devarajan Thangadurai and Jeyabalan Sangeetha
5. The Handbook of Metabolomics and Metabolomics by John C. Lindon, Jeremy K. Nicholson and Elaine Holmes

e-Learning Source:

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1					1	3	3	2	1
CO2	3	1					2	3	3	2	1
CO3	3	1					1	3	3	2	1
CO4	3	1					1	3	3	2	1
CO5	3	1					1	3	3	2	1

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

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2024-25							
Course Code	B100608R /BS396	**Title of the Course**	Research Project (minor) and seminar	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**0**	**0**	**6**	**6**
Pre-Requisite		**Co-requisite**					
Course Objectives	The main objective of this course is to acquaint the student with various techniques used in contemporary research in microbiology/biotechnology that will be useful in successful completion of their project work in the fourth semester.						

Course Outcomes	
CO1	To develop synopsis of a defined research problem.
CO2	To conduct the bench work.
CO3	To prepare the research report and its oral demonstrations.

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4
CO1	3	1				3	1	3	3	2	3
CO2	3	1				3	2	3	3	2	3
CO3	3	1				3	1	3	3	2	3
CO4	3	1				3	1	3	3	2	3
CO5	3	1				3	1	3	3	2	3

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

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