Integral University, Lucknow

Effective from Session: 2020 -21							
Course Code	BE 601	**Title of the Course**	Bioinformatics, Genomics and Proteomics	**L**	**T**	**P**	**C**
Year	2	**Semester**	3	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The objective of the course is learning and understanding the detailed developments and applications of the field of Bioinformatics in varied area of biological research. The course generally focuses on genomics, proteomics and computational biology studies and their relevance on research platform.						

Course Outcomes	
CO1	Given a single biological sequence as an input, would be able to perform its pairwise alignment with a template sequence or its pair wise similarity searching with the list of sequences present in a reference database.
CO2	Given an input protein sequence, would be able to predict its secondary & tertiary structure data. Given an input nucleotide sequence would be able to predict its genetic sequence. Given a protein and ligand molecule, would be able to draw out its various physiological, molecular and clinical level of interaction data in a pipeline manner.
CO3	For a particular species of interest, would be able to draw out its structural and functional genomics data.
CO4	Given an input protein sequence, draw out its proteomics related data involving its structural, functional and protein –protein interactional data from the various available online resources.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Bioinformatics & Sequence Analysis**	Nucleic acid sequence data banks, GenBank; EMBL; Brief overview of Human Genome Project (HGP): goals and applications. Pair wise sequence alignment: Needleman and Wunsch; Smith Waterman algorithms; Database Similarity Searches: Basic Local Alignment Search Tool (BLAST) & FASTA methods.	8	CO1
2	**Applied Bioinformatics**	Drug Designing, Stages of Drug Designing, DNA microarrays and its applications, Determination of Secondary & Tertiary structure of proteins: Chou Fasman method, Homology Modeling and its applications; Gene prediction studies: Promoter and regulatory regions scanning.	8	CO2
3	**Structural & Functional Genomics**	Multiple sequence alignments: Strategies and applications in Phylogenetics. Structural genomics (SG): Basic principles and applications, approaches for target selection. Functional genomics: application of sequence based and structure-based approaches to assignment of gene functions e.g. sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification.	8	CO3
4	**Proteomics: Tools and Databases**	Proteomics: an introduction; Study of transcriptome and proteome; Protein-protein interactions: databases such as DIP, PPI server and tools for analysis of protein protein interactions. Protein arrays: basic principles; bioinformatics-based tools for analysis of proteomics data, Tools available at ExPASy Proteomics server; Introduction to Protein Sequence Data Banks: UniProt, SwissProt.	8	CO4

Reference Books:

Baxevanis AD, Ouelettte BFF; Bioinformatics: A practical Guide to the analysis of genes and proteins., Wiley 2004, ISBN: 978-0-471-47878-2

Stephen A., David K, Womble D; Introduction to Bioinformatics: A Theoretical and Practical Approach., 2003, Humana Press, ISBN-13: 978-1588292414

Harren Jhoti, Andrew R. Leach; Structure- based Drug Discovery, Springer, 2007, ISBN 1402044070

Andrew Leach; Molecular Modelling: Principles and Applications (2nd Edition), Prentice Hall, 2001, ISBN 13: 9780582382107

e-Learning Source:

Computational chemistry in drug discovery. European Bioinformatics Institute - EMBL-EBIhttps://www.youtube.com/watch?v=9DESulCWbRQ

National Center for Biotechnology Information, www.ncbi.nlm.nih.gov

Auto Dock, autodock.scripps.edu

Webinar recording: a sequel for beginners: ligand-based drug design — the basics https://www.youtube.com/watch?v=ef5EaooBYUU

	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
CO1	2	3	3	2	2	1	1	1	2	2	1	2	3	1	3
CO2	2	3	3	2	2	1	1	1	2	2	1	2	3	3	2
CO3	2	3	3	3	3	1	1	1	2	2	1	2	3	3	2
CO4	2	2	2	2	1	1	1	2	2	1	2	1	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	BE602	**Title of the Course**	Immunotechnology	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The objective of the course is to apprise the students about components associated with immune system and molecular mechanism of their working. The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders.						

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

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Humoral and Cell Mediated Immunity	B-cell and T cell activation, Structure and function of MHC molecules. Exogenous and endogenous pathways of antigen processing and presentation. Antibodies and antibody based therapy: Production of Polyclonal antibodies with different types of antigens: antigen preparation and modification, adjuvant, dose and route of antigen administration, collection of sera, purification of antibodies; Inhibitors of tumor necrosis factor, targeting the IL2 receptor with antibodies or chimeric toxins, monoclonal antibodies to CD3.	8	CO1
2	Hybridoma Techniques and Monoclonal Antibody Production	Myeloma cell lines - fusion of myeloma cells with antibody producing B-cells-fusion methods - selection and screening methods for positive hybrids - cloning methods - production, purification and characterization of monoclonal antibodies. Application of monoclonal antibodies in biomedical research, in clinical diagnosis and treatment; Production of human monoclonal antibodies and their applications.	8	CO2
3	Immunotherapy for Allergic Diseases	Specific and nonspecific immunotherapy for Asthma and allergic diseases, Drug therapy in HIV: AIDS and other Immunodeficiencies; Vaccine and peptide therapy, newer methods of vaccine preparation, sub-unit vaccines, immuno-diagnosis of infectious diseases, serological techniques-ELISA, RIA and Immunoblotting.	8	CO3
4	Transplantation	Graft rejection, evidence and mechanisms of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, Xenotransplantation. Drugs: Antimetabolites, corticosteroids, anti-inflammatory agents; Cytokines: Cytokines regulating immune inflammation: interleukin-4, interleukin-20, interleukin-12; The interferons: Basic biology and therapeutic potential.	8	CO4, CO5

Reference Books:

1. "Cellular & Molecular Immunology* by Abbas AK. Lichtman AH. Abbas AK. Pober JS. Publisher: Elsevier; Year: 2012: Edition: 7th
2. "Immunology" by Kuby; Publisher: WI Freeman and Company, New York: Year: 2007; Edition:6th
3. "Elements of Immunology" by Fahim Halim Khan: Publisher: Pearson: Year: 2009; Edition: 1st
4. "'Immunology" by Roitt, Publisher: Edinburg Mosby: Year: 2002; Edition: 6th

e-Learning Source:

1. https://aacijournal.biomedcentral.com/articles/10.1186/s13223-018-0278-1
2. https://www.ncbi.nlm.nih.gov/books/NBK7795/

	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
CO1	1	2	1	3	2	2	1	1	1			3	3	3	1
CO2	3	3	1	1	3	1	1	1	1			3	3	3	1
CO3	3	3	1	1	3	1	1	1	1			3	3	3	2
CO4	2	3	1	1	3	1	1	1	2			3	3	3	1
CO5	3	3	1	1	3	1	1	1	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	BE 603	**Title of the Course**	Colloquium	**L**	**T**	**P**	**C**
Year	2	**Semester**	3	**0**	**0**	**4**	**2**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The main objective of this course is to acquaint the student with various techniques used in contemporary research that will be useful in successful completion of their project work in the final year						

Course Outcomes	
CO1	The students will learn about the basic search engine of scientific journal and indexing
CO2	The students will learn about the different statistical tools for optimizing parameters
CO3	The students will learn about the different manuscript formats, referencing and plagiarism check
CO4	The students will learn about the thesis writing and presentation
CO5	The students will learn about the ethics in conducting research

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1		Searching for scientific literature (Science direct, SCOPUS, Google scholar, exposure to different manuscript forms (Review, Short note, Research Article, Communication	8	1
2		Design of experiments in research, Basic statistical analysis (ANOVA, RSM, ANN)	8	2
3		Different manuscript formats and referencing styles (Use of Mendeley, Endnotes)	8	3
4		Publishing manuscripts (plagiarism check, cover letter, suggesting reviewer etc) Thesis writing and presentation.	8	4
5		Exposure of students to research in laboratory, Ethics in conducting research	8	5

Reference Books:

Gupta, S.P., Statistical Methods; S. Chand & Sons, New Delhi

Jerold H. Zar (2009): Bio-statistical Analysis, 4th Edition, Pearson Education

e-Learning Source:

Sciencedirect:https://www.sciencedirect.com

Mendeley:https://www.mendeley.com

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	2				3				3	2	2
CO2	3	3	2	3	3			1	3				3	3	3
CO3	1	3			3			1	3			1	3	3	2
CO4	1	2	2	2	3			1	3	1		1	3	1	1
CO5	1	1	2	1	1			2	1		1	1	1	2	1

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

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

Integral University, Lucknow

Effective from Session:							
Course Code	BE-604	**Title of the Course**	**ADVANCES IN MOLECULAR TECHNIQUES**	**L**	**T**	**P**	**C**
Year	**IInd**	**Semester**	IIIIrd	**2**	**1**	**0**	**3**
Pre-Requisite	**None**	**Co-requisite**	**None**				
Course Objectives	To demonstrate proficiency in advanced molecular biology techniques and to inculcate an understanding of advanced molecular techniques, including advanced background information and theory, applications, limitations, advantages and disadvantages, common problems and troubleshooting.						

Course Outcomes	
CO1	The students will learn different techniques of DNA amplification, their principle and applications.
CO2	The students will understand the application of gene therapy by the use of gene silencing technique
CO3	The students will learn about the different DNA sequencing techniques, there principle, method, result interpretation and applications.
CO4	To make students understand about the importance and use of Molecular markers and techniques in molecular biology and biotechnology to identify a particular sequence of DNA in a pool of unknown DNA

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**PCR-based Techniques**	Principle and applications of PCR; RACE; DD-RTPCR; Degenerate PCR, TA cloning, Realtime PCR, Scorpion probes, Site directed mutagenesis, PCR-based mutagenesis, Error-prone PCR	8	1
2	**Gene Silencing**	Antisense RNA technique, Sense co-supression in plants and animals, RNAi, Gene silencing, Ribozymes	8	2
3	**Sequencing Techniques**	Rapid DNA and RNA sequencing techniques, Sanger method, Maxam and Gilbert procedure, Automated DNA sequencing, Pyrosequencing, Genomics: High throughput, Shot gun, Clone contig, Microarray, Protein microarray	8	3
4	**Molecular Markers and other Molecular Techniques**	Molecular markers, RFLP, RAPD, AFLP, SCAR, STS, Microsatellites, SSCP, Yeast two-hybrid system, DNase foot printing	8	4

Reference Books:

1. Molecular Cloning; Sambrook and Russel, Cold Spring Harbor Laboratory
2. Gene Cloning and DNA Analysis: An Introduction, T.A. Brown; Blackwell Publications
3. Principles of Gene manipulation and genomics; Primrose and Twyman; Wiley Publishing

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
CO1	3	2	2	1	3			1				1	2	1	2
CO2	3	1	2		2		1	2				1	2	1	
CO3	2	1	2		3			1	2			2	3	1	1
CO4	2		3	1	2	1		1				1	3	1	2
CO5															

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	BE605	**Title of the Course**	Animal Cell Engineering	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	**III**	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course will help students to understand mechanisms of gene manipulation of animal cells, stem cell therapeutics and other frontier areas associated with molecular medicine.						

Course Outcomes	
CO1	The student will be able to describe the vast potential of animal biotechnology to eliminate or control many diseases and improve the health of animals and humans.
CO2	Relate the basic principles of biotechnology by application of genetics and techniques of molecular biology to animals for providing new medical services viz. stem cell therapy, gene therapy, vaccines, transplants, transgenic, organotypic cultures etc.
CO3	Describe the understanding of impact of engineering solutions on the society and also show awareness of contemporary issues of ethical and regulatory bodies exhibited by the biosafety risk associated with GMO construction in mammalian models.
CO4	Understand the technical aspects of existing technologies that will help them to address the complex medical challenges by applying their knowledge for the welfare of humankind.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to animal biotechnology	Animal Biotechnology and its scope, Principles of sterile techniques and cell propagation, Cell culture media: Physicochemical Properties, Chemically defined and Serum free media. Culture Environment, Cell Adhesion. Types of culture system: monolayer culture, Roller bottle, Suspension culture, static suspension culture, agar culture, agitated micro carrier suspension culture, hollow fiber systems, Scaling up factors. Strategies of medium optimization, Organotypic cultures, Animal Tissue Engineering, Bioartificial Organs, Scaffolds and Biomaterials used in Tissue Engineering.	8	CO1
2	Primary Culture	Isolation of Tissue, isolation of cells from explants by enzymatic disaggregation, mechanical disaggregation, EDTA treatment. Steps involved in primary cell culture, Cell line characterization: Morphology, Chromosome Analysis, Antigenic Markers, Transformation, Immortalization, Cell counting, Rates of Synthesis, Generation Time. Measurement of cell growth and viability, cell synchronization, cell transformation, maintenance of cell culture through sub-culturing and cloning, cryo-preservation, application of cell cultures. Types of microbial contamination and Eradication of Contamination	8	CO2
3	Mammalian Cell Lines	Mammalian cell expression system, gene transfer techniques in Mammalian cells, Stem cell culture: principles for identification, purifications, assessment of proliferation heterogeneity, long-term maintenance and characterization, Embryonic and adult stem cells and their applications. Genetically modified stem cells in gene therapy, Markers for stem cell identification, characterization of differentiated cell types, Applications of stem cells.	8	CO3
4	Transgenic Animals	Animal virus vectors; Shuttle vectors. Cloning in mammalian cells, Integration of DNA into mammalian genome, Methods of transformation: (Microinjection, Electroporation, Microprojectile bombardment, Liposomal packaging), Animal as bioreactors, problems after developing transgenic animals. Applications of transgenic animals, In vitro-fertilization, Gene Therapy: Ex-vivo gene therapy, In vivo gene therapy, Prodrug activation therapy, Nucleic acid therapeutic agents. Protein production by genetically engineered mammalian cell lines, Manipulation of Growth hormone: somatotropic hormone, Thyroid horomone; Probiotics as growth promoters, Ideal characteristics probiotics, uses of probiotics.	8	CO4

Reference Books:

1. "Gene Cloning and DNA Analysis" by TA Brown, Publisher: Oxford Balckwell Science, Year: 2008, 2011, Edition: 4th, 5th.
2. “Old & Primrose "Principles of Gene Manipulation", Publisher: Balckwell; Year: 2014, Edition: 7th
3. "Methods of Tissue Engineering" Anthony Atala, Robert P. Lanza; Publisher: Elsevier; Year: 2005,
4 : "Animal Cell Biotechnology: Methods and Protocols" by Nigel Jenkins; Publisher: New Jersey: Humana Press; Year: 2005.

e-Learning Source:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/

	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
CO1	3	2	3	3	3	2	1					3	3	3	1
CO2	3	3	3	3	3	1	1					3	3	3	1
CO3	3	2	3	3	3	1	1					3	3	3	1
CO4	3	3	3	3	3	1	1					3	3	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	BE606	**Title of the Course**	Biochemical Reaction Engineering	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	BE311	**Co-requisite**	None				
Course Objectives	The course will help students to understand mechanisms of gene manipulation of animal cells, stem cell therapeutics and other frontier areas associated with molecular medicine.						

CourseOutcomes	
CO1	Determine the reaction order and specific reaction rate from experimental data.
CO2	Calculate the size of bioreactor for continuous reaction.
CO3	Analyze multiple reactions carried out isothermally in continuous, batch and semi batch reactors to determine selectivity and choose the reactor for maximizing the selectivity.
CO4	Understand the factors causing non-ideality in bioreactors
CO5	Understand the different factors affecting the oxygen mass transfer in bioreactors

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Reaction basics	Rate of reaction, reaction order and rate laws, Rate-limiting step. Chain reactions. Pyrolysis reactions. Steady state ideal reactors: completely mixed and plug flow.	8	CO1
2	Reactor Engineering I	Reactor size comparisons for PFR and CSTR. Reactors in series and in parallel. How choice of reactor affects selectivity vs. conversion. Theory of the continuous and semi-continuous fermentor operation.	8	CO2 and CO3
3	Reactor Engineering II	Non-ideal reactor mixing patterns, Residence time distribution, Tanks in series model. Combinations of ideal reactors. Non isothermal reactors. Equilibrium limitations, stability. Derivation of energy balances for ideal reactors; equilibrium conversion, adiabatic and nonadiabatic reactor operation.	8	CO3
4	Mass transfer in bioreactor	Oxygen transfer in fermentors. Applications of gas-liquid transport with reaction. Reaction and diffusion in porous catalysts. Combined internal and external transport resistances.	8	CO4

Reference Books:

Fogler H.S. Elements of chemical reaction Engineering. 4th edition, Prentice- Hall of India Pvt Ltd, 2006.

Levenspiel O., Chemical Reaction Engineering. 3rd edition, Wiley New York. 1992.

Smith J.M., Chemical Engineering Kinetics. 3rd edition. New York, McGraw-Hill, 1981.

Holland, C. D., & Anthony, R. G. Fundamentals of Chemical Reaction Engineering, JohnWiley and Sons, 1990.

e-Learning Source:

https://archive.nptel.ac.in/courses/102/106/102106086/

https://youtu.be/F5hXo1fU0hg

https://youtu.be/QBFP2MEHtuk

https://youtu.be/prmNu7b7KYc

https://youtu.be/oxHLdNQrGhw

	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
CO1	**3**	**3**	**3**	**3**	**1**	**1**						2	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**1**						2	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**1**	**1**						2	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**1**						2	**3**	**3**	**3**
	3	**3**	**3**	**3**	**1**	**1**						2	**3**	**3**	**3**

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

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

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	**BE607**	**Title of the Course**	**Environmental Biotechnology**	**L**	**T**	**P**	**C**
Year	**2**	**Semester**	3	**2**	**1**	**0**	**3**
Pre-Requisite	**BE401**	**Co-requisite**					
Course Objectives	The main objective of this course is to impart students an understanding of environmental pollution and the factors responsible for degradation of natural resources and biodiversity. It also familiarizes them with various remediation techniques, non polluting technologies viz. bioenergy and biomining.						

Course Outcomes	
CO1	The student will be able to distinguish the exact root cause of environmental pollution problems.
CO2	They will be comprehend various biotechnological techniques and applications useful to predict and deal with environmental problems
CO3	They will be able to apply the biotechnology core principles in waste treatment system and to design the novel biological treatment system at institutional as well as industrial scale
CO4	The students will be able to understand the regulatory mechanism in the area of environmental compliance laid down by various agencies

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Ecosystem & Environmental Pollution**	Source of air, water and solid wastes, Ecosystem, Ecosystem Management, Renewable resources, Role of biotechnology in environmental protection,. Air, water and soil pollution: cause and control measures. Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste.	8	1
2	**Bioreactors & Rural Biotechnology**	Biocompositing, Biofertilizers; Vermiculture; Organic farming; Biomineralization; Biofuels; Bioethanol and Biohydrogen; Energy management and safety.	8	2
3	**Water Quality Modeling For Streams**	Characterization of effluents, effluent standards, Waste water collection; control and management; waste water treatment, sewage treatment through chemical, microbial and biotech techniques, Treatment of waste water from dairy, tannery, sugar and antibiotic industries. Waste recovery system. Primary methods; setting, pH control, chemical treatment. Secondary methods; Biological treatment, Tertiary treatments; like ozonization	8	3
4	**Environmental Regulations and Technology**	Regulatory Concerns, Technology; Laws, regulations and permits, Air, Water, Solid Waste, Environmental Auditing, National Environmental Policy act, Occupational Safety and Health Act (OSHA), Storm Water Regulations; Technology (waste water); Recycling of Industrial wastes: paper, plastics, leather and chemicals.	8	4

Reference Books:

1. E.P. Odum "Fundamentals of Ecology" V.B. Saunders and Co. 1974.
2. W.J. Weber "Physics-Chemical Process for water quality control, Wiley-international Ed.
3. Allan Scagg "Environmental Biotechnology" Oxford University Press, Canada. 2004.
4. Environmental Biotechnology by Prof. Jogdand, Himalayan publishing House, 2010.

e-Learning Source:

https://drive.google.com/drive/u/0/folders/1oC53Ffor4ZGqdSHUmcipeOgvaus21Jzu

	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
CO1	2	2	1	1	3	1	3	1					3	3	3
CO2	3	3	2	3	3	2	3	2					3	3	3
CO3	3	3	2	3	3	2	3	2					3	3	3
CO4	1	1	2	2	1	3	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	BE 608	**Title of the Course**	Secondary Metabolism in Plants	**L**	**T**	**P**	**C**
Year	2	**Semester**	3	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The main objective of this course is to impart students an understanding of biologically active compounds accumulated in plants especially as secondary metabolites that have been used as a source of major, essential oils, anti-oxidants and phytopharmaceutical ranging from anti-cancer activity to HIV. There has been an exclusive demand for herbal plants and extracts which can be used to improve human health and well being.						

Course Outcomes	
CO1	Introduction to primary & secondary metabolism: structure, biosynthesis and metabolism of important secondary products; Glycosides, isoprenoids, cardenolides, alkaloids, phenylpropanoids and antibiotics.
CO2	The students will be able to understand the major enzymes involved in secondary metabolism and their significance.
CO3	The students will learn about the Regulation and expression of secondary metabolism.
CO4	To make students understand about the metabolic pathway engineering for production of secondary metabolites This course will help the students to gain knowledge about bioactive compounds and their metabolism in plant system which is used to improve the human health and their well being.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Types of secondary metabolites and their synthesis	Microbiology and its scope, Biogenesis and Abiogenesis theories, Koch's postulates. Microbial diversity: Morphology, structure and microbial diversity of bacteria, fungi, viruses and protozoa. Characteristic of prokaryotic and eukaryotic cells	8	1
2	Enzymes involved in secondary metabolism	Important groups of secondary metabolic enzymes; Significance of 8 secondary metabolism and products for the producer organism.	8	2
3	Regulation of secondary metabolism	Regulation and expression of secondary metabolism; regulation of enzyme activity; regulation of enzyme amount; integration with differentiation and development; action of inducers; coordinated enzyme expression and sequential gene expression.	8	3
4	Culture systems and biotransformation	Metabolic products produced by in vitro culturing of plant cells, selection 8 of plant cells/tissues for the production of a specific product, Culture system in secondary plant product biosynthesis-batch continuous cultures and immobilized plant cells, Biotransformation of precursors by cell culturing. Metabolic pathway engineering for production of secondary metabolites	8	4

Reference Books:

Slater A, Scott NW, Fowler MR "Plant Biotechnology: The Genetic Manipulation of Plants".

Mantell SH, Matthews JA, McKee RA, "Principles of Plant Biotechnology: An Introduction to Genetic Engineering in Plants".
.

Brown TA, "Gene cloning: An Introduction".

Old, Primrose, "Principles of Gene Manipulation".

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1			2		1					3	3	1	1
CO2	1	1		1	2		1					3	3	2	1
CO3	3	2	2	1	2		1		1	1	1	3	3	3	2
CO4	3	2	3	1	1		1	1	2	1	2	2	3	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	BE609	**Title of te Course**	PLANT DEVELOPMENTAL BIOLOGY	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**0**	**0**	**8**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To develop the understanding of developmental processes taking place in plants.						

Course Outcomes	
CO1	Understand the concept of totipotency and differentiation.
CO2	Understand the development of seed and embryo with respect to hormonal control and signaling.s .
CO3	Understand the role of homeotic genes and organ development in plants.
CO4	Understand the aging process in plants and the physiological, ecological and evolutionary aspects of photosynthesis in C4 plants..

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Basics of Differentiation	Concept of totipotency and differentiation, Mechanisms of differentiation: cellular differentiation, induction, asymmetric division, morphogens.	8	CO1
2	Seed and Embryo Development	Seed Germination, Hormonal control of seed germination, Embryo development, Signalling and cell development, Plant cell division, Meristem development and patterning.	8	CO2
3	Organ Development in Plants	Root development, shoot development, Flower development, Stomata development and patterning, Homeotic genes and its role in development, Developmental plasticity.	8	CO3
4	Aging and Regulation of Development	Aging; Senescence, Environmental regulation and development, the problem with Rubisco and photorespiration: the physiological, ecological and evolutionary aspects of photosynthesis in C4 plants.	8	CO4

Reference Books:

1. Raghavan, V. Developmental Biology of Flowering Plants, Springer publications, 2000.
2. Claudia Köhler and Lars Hennig . Plant Developmental Biology: Methods and Protocols, Springer publications, 2010.
3. Cutler, Sean, Bonetta, Dario (Eds.). Plant Hormones Methods and Protocols, Springer publications, 2009.
4. L. D. Noodén , Aldo Carl Leopold , Senescence and aging in plants, Academic Press, 1988.

e-Learning Source:

https://www.youtube.com/watch?v=PwrADWcoyTs&list=PLLy_2iUCG87CTiGgwV-TU0zWDBOGm_9l1

https://www.youtube.com/watch?v=SfpPjTkoFCk

	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
CO1	1	1	1	2	2	2	2	1	1	1	2	3	2	2	2
CO2	1	1	1	2	2	2	2	1	1	1	2	3	2	1	2
CO3	1	1	1	3	2	1	1	1	1	1	1	3	3	2	1
CO4	1	2	3	3	3	1	1	1	1	2	2	3	3	2	1

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

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

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE610	**Title of the Course**	BIOSENSORS: DESIGN AND APPLICATIONS	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To develop an understanding about various principles and mechanisms involved in development of different types of biosensor and their applications.						

Course Outcomes	
CO1	Develop an understanding of the fundamental principles for designing and calibrating a biosensor.
CO2	Analyse the requirements and choose a suitable biosensor or design a biosensor as per requirements.
CO3	Develop an understanding of the fabrication methods of various biosensors.
CO4	Develop an understanding of the applications of biosensors and allied novel technologies like Lab-on-a-chip and Point-of-care systems.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Biosensors : An overview**	Overview of biosensors and bio-electronic devices, History, concepts and applications. Fundamental elements of biosensor devices and design considerations, calibration, dynamic range, signal to noise, sensitivity. Fundamentals of surfaces and interfaces, modifications of sensor surface. Bio-electrochemistry, Electrochemistry for biosensors, Principles of potentiometry and potentiometric biosensors; amperometry and amperometric biosensors; Conductimetric and Impedimetric Biosensors.	8	CO1
2	**Molecular recognition elements**	Molecular recognition elements: Enzymes, Antibodies and DNA. Kinetics and thermodynamics of bio-recognition reactions. Enzyme sensors and affinity sensors: immune sensors, oligo-nucleotides sensors, SPR, FRET, Membrane protein sensors: ion channels, receptors, whole cell sensors – bacteria, yeast, mammalian cells, non-biological and bio-mimicry: molecularly imprinted polymers, non-biological organic molecules.	8	CO2
3	**Basic Fabrication of biosensors**	Immobilization: adsorption, encapsulation - (hydro-gel, sol-gel glass, etc.), covalent attachment, diffusion issues. Optical Biosensor, Microlithography for biosensors, FETS and Bio-FETS, MEMS and Bio-MEMS. Lab-on-a-chip: TAS and m-TAS devices, Sensors based on Fiber Optic. Electro-chemiluminescence, pH sensors, artificial receptors.	8	CO3
4	**Application**	Physical sensors: piezoelectric, resistive, bridge, displacement measurement, blood pressure measurement, quartz crystal microbalance. Applications of biosensors in Agriculture, food safety, food processing, Biomedical: Point-Of-Care system, Non-invasive Biosensors in Clinical Analysis. Biosensor-based instruments; Blood chemistry sensors, sensors for Genetic testing. Applications of biosensors in Bio-security, environmental.	8	CO4

Reference Books:

1. "Handbook of Chemical and Biological Sensors", Richard F Taylor; IOP Publishing Ltd; Edition Year: 1996
2. "Handbook of Biosensors and Biosensor Kinetics"; Ajit Sadana & Neeti Sadana, Elsevier; Edition Year: 2011.
3. "Biosensors"; Jonathan M. Cooper; Oxford University Press; Edition Year: 2003

e-Learning Source:

1. http://www.nature.com/subjects/biosensors

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
CO1	**3**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**2**	**2**
CO2	**3**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**3**	**2**
CO3	**3**	**1**	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**2**	**2**
CO4	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**3**	**3**	**3**	**3**

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

Name & Sign of Program Coordinator	Sign & Seal of HoD

IntegralUniversity,Lucknow

EffectivefromSession: 2020-2021							
CourseCode	BE611	**TitleoftheCourse**	**IPR, Biosafety and Bioethics**	**L**	**T**	**P**	**C**
Year	**II**	**Semester**	III	**2**	**1**	**0**	**3**
Pre-Requisite	None	**Co-requisite**	None				
CourseObjectives	The knowledge of IPR, Biosafety and bioethics recognizes the need for possibility to exchange views and ides of the students as a form of patent in the field of science and technology development. The basic knowledge of the subject paper is very useful and for student in term of how they save and product their invention or intellectual property in proper ways.						

CourseOutcomes	
CO1	Students will gain the basic knowledge of legal issues and terminology related to IPRs
CO2	The learners also gain and practice the patent legality and filing procedure of patent
CO3	Students will gain the basic and fundamental knowledge of biosafety guidelines and their issues.
CO4	Students will apply the applications part and impart the sense of bioethics in life science

Unit No.	TitleoftheUnit	ContentofUnit	ContactHrs.	Mapped CO
1	**History Of IPR**	Jurisprudential definitions and concepts of property, rights, duties and their correlation; History and evolution of IPR like patent, design and copyright. 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; Geographical indication; Distinction among various forms of IPR; Rights / protection, infringement or violation, remedies against infringement: civil and criminal.	8	1
2	**Patent Process**	Obtaining patent; Invention step and prior art and state of art procedure; Detailed information on patenting biological products and biodiversity; Appropriate case studies; Indian Patent Act 1970 (amendment 2000); Major changes in Indian patent system as post TRIPS effects; Budapest treaty.	8	2
3	**Biosafety Levels**	Biosafety Levels: Safety guidelines for rDNA research and infectious agents; Containment facilities and its disposal; Radiation hazards; Safety concerns about transgenics: Environmental, Health, Economic. Safety concerns related to Animal Models.	8	3
4	**Bioethics**	Bioethics: Introduction, necessity and limitation; Ethical conflicts in Biotechnology; Different paradigms of bioethics: National and International guidelines; Bioethics of genes; Bioethics in health care: Bioethical dilemmas in medical and surgical treatment; Legal implications in bioethics.	8	4

ReferenceBooks:

1. Old and Primrose "Principles of Gene Manipulation".
2. Keru M "Ethical Biotechnology", Global Vision Publishing House.

Huxley TH "Evolution and ethics", Princeton University Press.

3. Arya R "Bioethics". And Glick and Pasternak "Molecular Biotechnology".
4. Erbisch FH and Maredia KM "Intellectual Property Rights", Universities Press.

Knight 'Patent strategy for researches and research managers'

E contents:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	2	3	3	3	-	-	-	2	3	3	3
CO2	2	2	2	2	2	2	2	2	-	-	-	2	2	2	2
CO3	2	2	2	2	2	2	2	2	-	-	-	2	2	2	2
CO4	2	2	1	1	3	2	1	1	-	-	-	3	2	2	1

1-**LowCorrelation;2-ModerateCorrelation;3-SubstantialCorrelation**

Name &SignofProgramCoordinator	**Sign&SealofHoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE612	**Title of the Course**	Medical Biotechnology	**L**	**T**	**P**	**C**
Year	2	**Semester**	3	2	1	0	3
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course will acquaint the students with pathogenesis and management of different diseases.						

Course Outcomes	
CO1	To acquire knowledge about genetic disorders and its treatments.
CO2	To understand the molecularbasis of human diseases, its prevention and cures.
CO3	To develop knowledge of pathogenesis of various diseases caused by different microbes and suggestive treatment.
CO4	To equip with the knowledge of various laboratory techniques to diagnose various human diseases.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Genetic Disorders	General, systemic and specific syndromes. Classification of genetic diseases. Chromosomal abberations–Numerical disorders e.g.trisomies& monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Genetic diseases–Autosomal, X-linked and Y-linked disorders and Mitochondrial disorders.	8	CO1
2	Molecular Basis of Human Diseases	Pathogenic mutations and Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Prevention and treatment of human diseases Avoiding exposure to pathogen Antibiotics and chemotherapeutic agents - drug resistance and antibiotic policy Using body's immune responses Alternative systems - Chinese, European and Indian (Siddha, Ayurveda, Naturopathy, etc.) Gene therapy; Chemotherapy and radiotherapy of tumors; Stem cell therapy.	8	CO2
3	Pathogenesis of Different Diseases	Pathogen, pathogenesis, clinical condition, laboratory diagnosis, epidemiology, chemotherapy and prevention of the following diseases. Viral - influenza, measles, hepatitis, Bacterial - pneumonia, tuberculosis, Typhoid, Fungal-histoplasmosis, Protozoan - Amoebic dysentery. AIDS. Nosocomial infections, Factors that influence hospital infection, hospital pathogens, route of transmission, investigation, prevention and control.	8	CO3
4	Techniques in Laboratory Diagnosis	Haematology, biochemistry, microbiology, serology, radiology and other special methods. Prenatal diagnosis–Amniocentesis, Chorionic Villi Sampling (CVS), Non-invasive techniques-Ultrasonography, X-ray, Diagnosis using protein and enzyme markers, monoclonal antibodies. Microarray technology- genomic and cDNA arrays, application to diseases. Biosignalanalyzer, CT scan and Magnetic Resonance Imaging assisting the heart and kidney.	8	CO4

Reference Books:

1. Mackie and McCartney; Practical Medical Microbiology; Elsevier; Edition: 14th; Year: 2012.
2. Pratibha Nallari and V. Venugopal Rao; Medical Biotechnology; Oxford University Press; Edition: 2nd; 2012.
   a. Name of the authors: Jochen Decker (Editor), Udo Reischl (Editor)
   b. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicin; Humana Press; 2003.
3. Infectious Disease: Pathogenesis, Prevention, and Case Studies. Authors: Nandini Shetty, Julian W Tang, Julie Andrews; (2009)

e-Learning Source:

https://nptel.ac.in/courses/102104052

https://www.youtube.com/watch?v=uOFMFoxKmwQ

	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
CO1	3	3	3	3	1	3	2	2				3	3	3	2
CO2	3	3	3	3	1	3	2	2				3	3	3	2
CO3	3	3	3	3	3	3	3	2				3	3	3	2
CO4	3	3	3	3	3	3	2	2				3	3	3	2
CO5															

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

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

Integral University, Lucknow

Effective from Session: 2022-23							
Course Code	BE613	**Title of the Course**	Environmental Sustainability	**L**	**T**	**P**	**C**
Year	**2**	**Semester**	3	**2**	**1**	**0**	**3**
Pre-Requisite	BE401	**Co-requisite**					
Course Objectives	To impart deeper understanding of environmental sustainability - a wiser use of resources in the context of economic, social and environment nexus.						

Course Outcomes	
CO1	The students will be able to understand about the economic, social, and environmental aspects of sustainability and some frameworks for defining and measuring progress toward a sustainable society.
CO2	The students will be acquainted with the knowledge of the methods tools and incentives for sustainable development.
CO3	They will be able to synthesize alternative solutions to multi-dimensional challenges for sustainable society.
CO4	They will be able to understand the regulatory mechanism in the area of environmental compliance laid down by various agencies

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Environmental Pollution and its impact**	Air Pollution: impacts and control measures; Water Pollution: sources, sustainable water treatment strategies; Solid waste: sources and impact of solid waste accumulation, solid waste management,zero waste concept, 3R concept; Environmental issues: climate change, Global warming, Resource depletion, Ozone depletion etc.	8	1
2	**Environmental Management Standards**	Aims and objectives of Environmental Impact Assessment (EIA). Environmental Impact Statement (EIS) and Environmental Management Plan (EMP). Impact Assessment Methodologies. Life-cycle analysis (LCA), Guidelines for Environmental Audit. Environmental Planning as a part of EIA and Environmental Audit. Environmental Management System Standards (ISO14000 series). Carbon credits; Carbon trading; Carbon foot print.	8	2
3	**Sustainable Energy Resources**	Basic concepts-Conventional and Non-conventional energy, Solar energy, Hydro power, Nuclear power, Tidal energy, Wave Energy, Ocean Thermal Energy Conversion (OTEC), Geothermal energy, bio-energy.	8	3
4	**Environmental Legislation and Policy**	Role of Ministry of Environment, forest and climate, role of central and state pollution control boards, Environmental Legislation in India- the Environmental Protection Act, The Forest Act, The Water (Prevention and control of pollution) act, The air act, Occupational safety and health act (OSHA), National Green tribunal: Ganga Tanneries case: M. C. Mehta vs. Union of India 1988.	8	4
5				

Reference Books:

1. Environmental Biotechnology, Principles and Applications by Bruce E Rittman and Perry L McCarty, McGrawhill Higher education.
2. Environmental Biotechnology Edited by Hans-Joachim Jördening and J Winter, WILEY-VCH VerlagGmbh& Co.
3. Environmental Biotechnology Edited by Hans-Joachim Jördening and J Winter, WILEY-VCH VerlagGmbh& Co.
4. A text book on biotechnology. Kumar H.D II Edition, Affiliated east west press 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	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	3	2					3	3	3
CO2	3	3	2	2	2	2	3	2					3	3	3
CO3	3	3	2	2	2	2	3	2					3	3	3
CO4	1	1	1	2	1	2	3	1					3	3	3

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

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

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE699	**Title of te Course**	M.Tech. Dissertation	**L**	**T**	**P**	**C**
Year	II	**Semester**	III	**0**	**0**	**8**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To acquaint the student with the various techniques used in contemporary research in biotechnology that will be useful in the successful completion of their project work in the fourth semester.						

Course Outcomes	
CO1	Understand biological databases and in silico tools required to explain homology searching and 3D structure prediction of biomacromolecules.
CO2	Understand the basics of plant tissue culture media and in vitro establishment of different types of cultures.
CO3	Understand basic knowledge of animal cell culture technology including media preparation, cell maintenance, cell viability analysis and morphological studies.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Biological Databases	Biological Databases (e.g.; sequence databases, structure databases and specialized databases) and their retrieval tools and methods.	4	CO1
2	Sequence similarity searching	Sequence similarity searching (e.g., BLAST and FASTA).	4	CO1
3	Protein sequence analysis	Protein sequence analysis using ExPASy Bioinformatics resource portal and multiple sequence alignment using Clustal W tool.	4	CO1
4	3D structure prediction	3D structure prediction of protein through homology modeling and their visualization by PyMol/DS Visualizer/RasMol	4	CO1
5	Media preparation	To prepare media for plant tissue culture (MS media).	4	CO2
6	Maintenance of callus and suspension cultures	Induction of callus and suspension culture.	4	CO2
7	Induction of multiple shoots	Multiple shooting and organogenesis from buds.	4	CO2
8	Micropropagation	Plant regeneration by micropropagation.	4	CO2
9	Media preparation	To prepare media for animal cell culture (A549 cell line).	4	CO3
10	Maintenance of cell lines.	*In-vitro* maintenance of cell lines.	4	CO3
11	Viability analysis of cells	To check viability of cells using 3-4, 5 dimethylthiazol-2yl-2, 5-diphenyl tetrazolium bromide (MTT) assay.	4	CO3
12	Morphological analysis of cells	To perform Hematoxylin and Eosin (HE) staining for morphological analysis of cells.	4	CO3

Reference Books:

Bioinformatics: A Practical Approach by K Mani and N Vijayaraj, Aparna Publications, Coimbatore.

Bioinformatics: Sequence, Structure, and Databanks- A Practical Approach by Des Heggins and Willie Taylor, Oxford University Press.

Plant Tissue Culture: Techniques and experiments by Roberta Smith, Elsevier.

Plant Tissue Culture: Theory and Practice, a Revised Edition by S.S. Bhojwani and M.K. Razdan, Elsevier.

Animal Cell Culture and Technology (THE BASICS (Garland Science)

Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications 7th Edition 2016 By R. Ian Freshney

e-Learning Source:

https://www.vlab.co.in/

https://www.youtube.com/watch?v=Cqle28h9G9w&t=7s

https://rc.med.sumdu.edu.ua/wp-content/uploads/2019/06/Tissue-culture-lab-manual.pdf

	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
CO1	1	1	1	2	2	2	2	1	1	1	2	3	2	2	2
CO2	1	1	1	3	3	2	2	1	1	1	2	3	3	1	2
CO3	1	1	1	3	1	1	1	1	1	1	1	3	3	2	1

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

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

Integral University, Lucknow

Effective from Session: 2020 -21							
Course Code	BE 699	**Title of the Course**	M Tech Dissertation	**L**	**T**	**P**	**C**
Year	2	**Semester**	4	**0**	**0**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To develop research comprehension and problem solving skills. To nurture ability to perform literature review. To improve critical thinking ability for formulation of research plan. To develop skills to use various engineering and technological tools. To develop skill to think critically on research results. To enhance the writing skills for research paper and dissertation.						

Course Outcomes	
CO1	Capability to work independently on a research-based problem.
CO2	Skill to perform review of available literature effectively to present research gap.
CO3	Aptitude to plan methodology for the attainment of various research objectives.
CO4	Competency to apply of various engineering and technological tools to carry research.
CO5	Ability to conclude work using critical thinking.
CO6	Proficiency in preparing presentation and report.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
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
CO1	1	1	1	3	3	1	1	3	3	3	1	3	3	3	3
CO2	1	1	1	3	3	1	1	3	3	3	1	3	3	3	3
CO3	1	1	1	1	3	1	1	1	3	3	1	3	3	3	3
CO4	1	1	1	3	3	1	1	1	3	1	1	3	3	3	3
CO5	1	1	1	3	3	1	1	3	3	3	1	3	3	3	3
CO6	1	1	1	1	3	1	1	3	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**