Code of the Course/Subject Title of the Course/Subject (Total Number of Periods)

Code of the Course	**Title of the Course**	**Total Number of Period**
DSC-1.3BT	**Genetic Engineering**	**45**

COs Students after completion of this course would be able toé ..

1. Get an insight of tools of genetic engineering
2. Create Genomic Library
3. Develop and use technology for molecular diagnostics
4. Develop recombinant proteins as well as primers as tools for developing diagnostics kits.
5. Develop recombinant therapeutics, Biopharmaceuticals and Biosimilars
6. Design and develop Genetically modified as well as genetically edited plants

Unit	Content
Unit I	**Introduction and tools for genetic engineering (9 periods)** Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; Enzymes in Genetic Engineering: restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, Taq polymerase and other polymerases for PCR, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and nonradioactiveprobes,.
Unit II	**Different types of vectors (9 periods)** Plasmids; Bacteriophages; M13 vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression vectors; pMal; pET-based vectors; Protein purification; His-tag; GSTtag; MBP-tag etc.; Intein-based vectors; mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors. Novel Vectors, co-transfections, super transfections, clone selection, importance of monoclonality
Unit III	**Gene manipulation and protein-DNA interaction (9 periods)** Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays ï genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: Recently strategies, such as clustered regularly interspaced short palindromic repeats (CRISPR)-Cas9, multiplex automated genome engineering (MAGE), promoter engineering, CRISPR-based regulations, and synthetic small regulatory RNA (sRNA)-based knockdown, for genome-scale engineering in microbiological systems. And their applications in metabolic engineering. ZFN, TALEN
Unit IV	**Hybridization techniques (9 periods)** Northern, southern, south-western and far-western and colony hybridization, fluorescence in situ hybridization, electrophoretic mobility shift assay; DNase foot printing; methyl interference assay, chromatin immune precipitation; protein-protein interactions using yeast two-hybrid system; phage display, FRET.
Unit V	**PCR technology (9 periods)** Different types of PCR techniques Principles of PCR: primer design; Various thermostable enzymes and their fidelity; DNA polymerases; types of PCR ï multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection . Current genetic manipulation techniques in the recent therapeutics field: Mabs, Bispecific Mabs, Fabs, Cell and gene therapy.
Unit VI	**Gene silencing and genome editing technologies (9 periods)** Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene

	silencing; gene knockouts and gene therapy; creation of transgenic plants; Cre-Lox Technology, debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies (Drosophila), worms (C. elegans), frogs (Xenopus), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Course Material/Learning Resources

1. Old, R. W., Primrose, S. B., & Twyman, R. M. (2001). Principles of Gene Manipulation: an Introduction to Genetic Engineering. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). Genomes (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
6. Bernard R. Glick, Jack J. Pasternak, and Cheryl L. Patten. (2003) Molecular Biotechnology: principles and applications of recombinant DNA

Code of the Course	Title of the Course	Total Number of Period
DSC-LC-I.3BT	**Genetic Engineering**	**6H/Week**

(Laboratory/Practical/practicum/hands on/Activity)

Laboratory - Genetic Engineering

COs After completion of the course student would be able to

1. Formulate an experiment for the gene transfer.
2. Design the in-silico PCR primer and perform e-PCR.
3. Develop the gene amplification protocol
4. Determine the gene transfer efficiency
5. Design an experiment for the expression of genes.

***List of Practical/Laboratory Experiments/Activities, etc.**

1 Vector and Insert Ligation
2 Preparation of competent cells
3 Transformation of E.coli with standard plasmids, Calculation of transformation efficiency
4 Confirmation of the insert by Colony PCR
5 Restriction mapping
6 In-silico primer designing and e-PCR
7 Polymerase Chain Reaction and analysis by agarose gel electrophoresis
8 Expression of recombinant protein, concept of soluble proteins and inclusion body formation in E.coli, SDS-PAGE analysis/GFP
9 Purification of His-Tagged protein on Ni-NTA columns a) Random Primer labeling b) Southern hybridization.

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology Semester III

Code of the Course	Title of the Course	Total Number of Period
DSC-II.3BT	**Bioprocess Engineering & Technology**	**45 hrs**

Cos:The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Student should be able to:

1. Appreciate relevance of microorganisms from industrial context;
2. Carry out stoichiometriccal calculations and specify models of their growth;
3. Give an account of design and operations of various fermenters;
4. Presentunitoperationstogetherwiththefundamentalprinciplesforbasicmethodsinproductio ntechniqueforbio-basedproducts;
5. Calculateyieldandproductionratesinabiologicalproductionprocess,andalsointerpretdata;
6. Calculate the need for oxygen and oxygen transfer;
7. Critically analyze any bioprocess from market point of view;
8. Giveanaccountofimportantmicrobial/enzymaticindustrialprocessesinfoodandfuelindustry.
9. Toprovideanoverviewofvariousaspectsofrecoveryandprocessingofbiologicalproducts
10. Identifyanddesignrelevantunitoperationsforrecoveryofabiologicalproduct

Unit	Content
UnitI	**Basic principles of biochemical engineering- (8 Periods)** Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics. **Stoichiometry and models of microbial growth-** Elemental balance equations; metabolic coupling ï ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth.
UnitII	**Bioreactor design and analysis- (6 Periods)** Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation.
Unit III	**Fermentation economics- (7 Periods)** Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.
Unit IV	**Biomass Removal (8 Periods)** Characteristics of biological materials: pretreatment methods; Separation of cellmass: centrifugation, sedimentation, flocculation and filtration; Continuous operation. Cell disruption-Mechanical approaches: sonication, bead mills, homogenizers; non-mechanical approaches: freeze/thaw, osmotic shock, chemical lysis, enzymatic lysis; measurement of cell disruption. **MembraneProcess-** Filtrationtheory;Microandultrafiltration;Reverseosmosis;dialysis;electrodialysis,diafiltration;pervaporation;perstraction;Multistage and continuous operation.

Unit V	**Adsorption and Chromatography (9 Periods)** Adsorption equilibrium, Van Deemter equation; Chromatography: size, charge, polarity, shape, hydrophobic interactions; Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds) **Concentrationsteps-** Solventextraction:phaseequilibriumanddistribution,counter-currentoperation,dissociativeextraction,multiplestageanalysis;Reciprocating-plateandcentrifugalextractors;Reversemicellarextraction;Aqueoustwophase,Supercriticalfluidextraction. Precipitation: effect of size and charge, solvent effects, ionic strength effects, precipitate growth and aging models. Crystallization:nucleationandgrowthaspects;Drying:solventremovalaspects,dryers(vacuum,freeze, spray); Scale up aspects.
Unit VI	**Product Characterization (7 Periods)** Biophysical characterization, chemical characterization, modern spectroscopy, QBD, stability Bioassays: Cell based assay, recept or mediated assay, in vivo evaluation, immunogenicity

Course Material/ Learning Resources:

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: PrenticeHall.
2. Stanbury,P.F.,&Whitaker,A.(2010).PrinciplesofFermentationTechnology.Oxford:PergamonPress.
3. Blanch,H.W.,&Clark,D.S.(1997).BiochemicalEngineering.NewYork:M.Dekker.
4. Bailey,J.E.,&Ollis,D.F.(1986).BiochemicalEngineeringFundamentals.NewYork:McGraw-Hill.
5. El-Mansi,M.,&Bryce,C.F.(2007).FermentationMicrobiologyandBiotechnology.BocaRaton:CRC/Taylor&Francis.
6. Doelle HW, Mitchell DA and RolzCE.Ed. (1992). Solid Substrate Cultivation. Elsevier Applied Science, London, 1992.
7. Rao DG (2005). Introduction to Biochemical Engineering Pauline M. Doranbby Tata McGraw-Hill Pub Co Ltd., New Delhi.
8. PepplerHJandPerlmanD(2004).MicrobialTechnology:FermentationTechnology(2ndEdition)Vol.I&II,by.Academic Press,NY,USA.
9. Venko N. Beschkov and Dragomir Yankov (2021). Downstream Processing in Biotechnology
10. National Research Council (US) Committee on Bioprocess Engineering. Putting Biotechnology to Work: Bioprocess Engineering. Washington (DC): National Academies Press (US); 1992. 4, Current Bioprocess Technology, Products, and Opportunities. Available from: https://www.ncbi.nlm.nih.gov/books/NBK236005/
11. Pauline M. Doran (2013) Bioprocess Engineering Principles. Academic Press.
12. Sarfaraz K. Niazi, Justin L. Brown (2017). Fundamentals of Modern Bioprocessing. CRC Press
13. Syllabus Prescribed for TWO Year PG Programme

Code of the Course	Title of the Course	Total Number of Period
DSC-LC-II.3BT	**Bioprocess Engineering &Technology &Down Stream Processing**	**6H/Week**

(Laboratory/Practical/practicum/hands on/Activity)

1. Basic Microbiology techniques

a) Scaleup from frozen vial/slant to agar plate to shake flask culture.

b) Instrumentation: Microplate reader, spectrophotometer, microscopy.

c) Isolation of microorganisms from soil samples.

2. Experimental set-up

a) Assembly of bioreactor and sterilization.

b) Growth kinetics.

c) Substrate and product inhibitions.

d) Measurement of residual substrates.

3. Data Analysis

a)Introduction to Metabolic Flux Analysis(MFA).

4. Fermentation

a) Batch.

b) Fed-batch.

c) Continuous.

5. Unit operations

a) Microfiltrations: Separation of cells from broth.

b) Bioseparations: Various chromatographic techniques and extractions.

6. Bioanalytics- AnalyticaltechniqueslikeHPLC,FPLC,GC,GC-MSetc.formeasurementofamountsofproducts/substrates

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology
Semester III

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
DSC-III.3BT	**Bioinformatics and Computation Biology**	**45**

Cos

Students after completion of this course would be able toé ..

1. Develop an understanding of basic theory of these computational tools;
2. Gain working knowledge of these computational tools and methods;
3. Appreciate their relevance for investigating specific contemporary biological questions;
4. Critically analyse and interpret results of their study.
5. Gain knowledge of basic databases and the need of data compilation.
6. Develop understanding of the methods and tools for data retrieval.

Unit	Content
Unit I	**Introduction to computational biology basics and biological databases (7 Hours)** Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.
Unit II	**Pairwise and multiple sequence alignments (8 Hours)** Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification
Unit III	**Genome Analysis (8 Hours)**

	Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies
Unit IV	**Structure visualization** **(8 Hours)** Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD
Unit V	**Structure-based drug development** **(7 Hours)** Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information.
Unit VI	**Ligand-based drug development (7 Hours)** Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modelling, Pharmacophore-based screenings of compound library, analysis and experimental validation

Recommended Textbooks and References:

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), Discovering Genomics, Proteomics and Bioinformatics, Pearson Education.
5. Oprea, T. (2005). Chemoinformatics in Drug Discovery, Volume 23. Wiley Online Library.
6. Gasteiger, J. &Engel,T. (2003), Chemoinformatics: a Textbook, Wiley Online Library

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology
Semester III
Code of the Course/Subject Title of the Course/Subject (Total Number of Periods)
DSC-LC-III.3BT **Bio**informatics and Computation 6H/ Week
Biology

On completion of this course, students should be able to:
1. Describe contents and properties of most important bioinformatics databases;
2. Perform text- and sequence-based searches and analyze and discuss results in light of molecular biological knowledge;
3. Explain major steps in pairwise and multiple sequence alignment, explain principle and execute pairwise sequence alignment by dynamic programming;
4. Predict secondary and tertiary structures of protein sequences.

1. Using NCBI and Uniprot web resources.

2. Introduction and use of various genome databases.

3. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt.

4. Similarity searches using tools like BLAST and interpretation of results.

5. Multiple sequence alignment using ClustalW.

6. Phylogenetic analysis of protein and nucleotide sequences.

7. Use of gene prediction methods (GRAIL, Genscan, Glimmer).

8. Using RNA structure prediction tools.

9. Use of various primer designing and restriction site prediction tools.

10. Use of different protein structure prediction databases (PDB, SCOP, CATH).

11. Construction and study of protein structures using Deepview/PyMol.

12. Homology modelling of proteins.

13. Use of tools for mutation and analysis of the energy minimization of protein structures.

14. Use of miRNA prediction, designing and target prediction tools.

Learning Resources:

1. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
https://www.ncbi.nlm.nih.gov/home/analyze/

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology Semester IV

Code of the Course **Title of the Course** **Total Number of Period**

DSC-I.4BT **Animal Cell Science and Technology** **45hrs**

COs

The objectives of this course is to educate students about the fundamental concepts of animal cell system, bioprocess technology using eukaryotic system and their related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Studentsshouldbeabletogainstrongunderstandingonanimalbasedcellculturessystem.Thiswillhelpthemtotake up animal based biological research as well as placement in the relevant biotech industry. They will be able to analyse the bioprocess from an economics /market point of view.

Unit	Course
Unit I	**Cell culture laboratory design and equipments** (7 Hours) Planning, construction and services; Layout; Sterilehandlingarea;Incubation;Hotroom;Aircirculation;Servicebench;Laminarflow;Sterilizer;Incubator;CO_2incubator;Refrigeratorsandfreezers;Centrifuge;Invertedstagemicroscope;Magneticstirrer;Liquidnitrogenfreezers;Slowcoolingsystemforcellfreezing;Waterbath;Autoclavesandhotair oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in animal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.
Unit II	**Media and reagents** (7 Hours) Types of cell culture media; Ingredients of media; Physiochemical properties;CO_2 and bicarbonates; Buffers; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Foetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.
Unit III	**Different types of cell cultures** (8 Hours) History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organculture;Behaviourofcellsinculturecconditions:division,growthpattern,metabolismofestimationofcell number; Development of cell lines; Characterization and maintenance of cell lines, stem cells; Cryopreservation; Common cell culture contaminants.
Unit IV	**Applications of cell culture** (8 Hours) Cell cloning and selection; Transfection and transformation of cells; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for invitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application

	ofcellculturetechnologyinproductionofhumanandanimalviralvaccinesandpharmaceutic alproteins.
Unit V	**Large scale cell cultures**(8 Hours) Cell culture reactors; Scale-up in suspension; Scale and complexity; Mixing and aeration;Rotatingchambers;Perfusedsuspensioncultures;Fluidizedbedreactorsforsuspen sionculture;Scale-upinmonolayers;Multisurfacepropagators;Multiarraydisks,spiralsandtubes;Rollercultur e;Microcarriers;DisposablebioreactorsPerfusedmonolayercultures;Membraneperfusion ;Hollowfibreperfusion;Matrixperfusion;Microencapsulation;Growthmonitoring.
Unit VI	**Commercial products and tissue engineering.**(7 Hours) Interleukins, growth factors, vaccines. Scaffolds, biomaterials, 3d printing, IVF, embryo sexing and itôs importance in dairy technology.

Recommended Text books and References:

1. Freshney,(2005),CultureofAnimalCells,5thEdition,Wiley-Liss.
2. Ed. John R.W. Masters, (2000), Animal Cell Culture - Practical Approach, 3rd Edition, Oxford UniversityPress.
3. Ed.MartinClynes,(1998),AnimalCellCultureTechniques.Springer
4. Verma A, Verma M, Singh A. Animal tissue culture principles and applications. Animal Biotechnology. 2020:269ï 93. doi: 10.1016/B978-0-12-811710-1.00012-4. Epub 2020 Jun 26. PMCID: PMC7325846.
5. Yao T, Asayama Y. Animal-cell culture media: History, characteristics, and current issues. Reprod Med Biol. 2017 Mar 21;16(2):99-117. doi: 10.1002/rmb2.12024. PMID: 29259457; PMCID: PMC5661806.
6. https://www.qiagen.com/us/knowledge-and-support/knowledge-hub/bench-guide/animal-cell-culture/introduction/animal-cell-cultures
7. https://www.corning.com/catalog/cls/documents/application-notes/CLS-AN-042.pdf

https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics/introduction-to-cell-culture.html

Syllabus Prescribed for M.Sc. II Year PG Programme

Programme: M.Sc. Biotechnology Semester IV

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Period**
DSC-LC-I.4BT	**Animal Cell Science &Technology**	6hr/w

Cos

The objectives of this course is to educate students about the fundamental concepts of animal cell system, bioprocess technology using eukaryotic system and their related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Students should be able to gain strong understanding on animal based cell cultures system. This will help them to take up animal based biological research as well as placement in the relevant biotech industry. They will be able to analyze the bioprocess from an economics/market point of view.

1. Aseptic Techniques I:PipetingandTransferoffluids
2. Aseptic Techniques II: Preparation of medium for use.
3. Introduction to cell culture
4. Preparation and sterilization of water
5. Preparation and sterilization of Dulbeccoôs Phosphate Buffer Saline(D-PBS)withoutCa++andMg++.
6. Preparation of Stock medium from powder and sterilization by filtration.
7. Preparation of pH standards for comparison of cell culture media.
8. Counting cells by Haemocytometer and Electronic counter
9. Primary culture technique for chicken embryo fibroblast.
10. Secondary culture of chicken embryo fibroblast.
11. Cultivation of continuous cell lines.
12. Quantification of cells by trypan blue exclusion dye.
13. Isolation of lymphocytes and cultivation of lymphocytes.
14. Staining of monolayer cell culture
15. Study of effect of toxic chemicals on cultured mammalian cells
16. Study of effect of virus on mammalian cells.
17. Suspension culture technique
18. Cryopreservation of primary cell cultures and cell lines.

Recommended Text books and References:

1. Freshney,(2005),CultureofAnimalCells,5thEdition,Wiley-Liss.
2. Ed. John R.W. Masters, (2000), Animal Cell Culture - Practical Approach, 3rd Edition, Oxford UniversityPress.
3. Ed.MartinClynes,(1998),Animal Cell Culture Techniques.Springer
4. ATCCAnimalCellCultureGuide-https://www.atcc.org/resources/culture-guides/animal-cell-culture-guide
5. Animaltissuecultureprinciplesandapplications-https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7325846/

Code of the Course/Subject	Title of the Course/Subject	Total Number of Period
DSC-II.4BT	**Industrial Biotechnology**	**45 hrs**

CO: The objectives of this course are to provide students with hands on knowledge of the primary unit operations involved in downstream processing involved in food and agriculture industry. Students can get complete knowledge about the agro or food industry, thus they will be capable of design the goal.

Unit I:	**Fermentation products:** Dairy products: Milk processing - Cheese - principles of cheese making. Cheddar Cheese, Swiss Cheese, Surface ripened Cheeses; Mold ripened Cheeses. Cottage and Indian Channa cheese. General principles of manufacture of Yogurt, acidophilus milk, Kefir, Koumiss Fermented foods: Soy sauce, Miso, Sufu, Natto, Idli, fermented fish products, Sauer Krant, pickles, fermentation of Olives, fermented sausages; Production of distilled beverage alcohol, wine, brandy and beer.
Unit II:	**Biopesticide and biofertilizers** **Biopesticides :**Biological control, plant biopesticides or botanical pest control (BPC), Recent interest in Bt biopesticides, Nuclear polyhydrosis virus (NPV), Baculoviruses, Trichoderma and Trichogramma as biopesticides, Genetically engineered bacteria as biopesticide, Impact of biopesticides in sustainable agriculture. **Biofertilizers :**Principles and objectives of Biofertilizers and Integrated Nutrient Management (INM), Need for integrated nutrient management, Components of integrated nutrient management: Chemical fertilizers, organic fertilizers, legumes as a green manures, vermicompost for sugarcane, organic Farming and organic Food.
Unit III:	**Bioprospecting:** Introduction: Biodiversity prospecting; Biochemical resources from plants and fungi, natural products: the role of natural products in drug discovery, natural products as modern drugs; Prospecting for New Compounds from Plants particularly from Melghat forest: Discovery of novel compounds, Screening of traditional knowledge-based herbal drugs, Preparation of crude compounds, Isolation of pure compounds, bio- assay guided isolation, high throughput screening of extracts. **Bioprospecting from microbes** (Actinomycetes, Bacteria, fungi) with special reference to marine actinomycetes, endophytes and metagenomics by products. Anticancer, antiviral, antibacterial, antifungal, antidiabetics from microbial origin.
Unit IV:	**Industrially important products** Industrial production of alcohol, Acetone, Citric acid, Gluconic acid, Acetic acid, lactic acid; Production of polysaccharides, Penicillin, Xanthan; Industrial enzymes (proteases, pectinases, cellulases and lipases)
Unit V:	**Bio-nanotechnology and industrial applications** Introduction to bio-nanotechnology and overview of nanoscale materials; effect of length scale on properties; challenges and opportunities associated with biology on the Nanoscale; top-down and bottom-up approach, methods of nanoparticle synthesis, its characterization and analysis of nanoparticles by different techniques such as UV-Visible spectroscopy, NMR, SEM, TEM, X-RD, FTIR. Synthesis of Nanoparticles by Biological system, Extracellular biosynthesis with a case study of silver and gold nanoparticles ,Intracellular biosynthesis

	case by bacteria. Applications of bio-nanotechnology in various fields.
Unit VI:	**Industrial Forensic Science and safety** Contaminant identification to allow the control of contamination in raw materials, processes, and products; Materials failure analysis, cause of fractures, processing issues or weaknesses in the design of components; Identification of the source of unknown particles or deposits causing environmental, health or safety problems; Root cause identification of product defects including degradation etc

Recommended Textbooks and References:

1. Reinhold company, New York. Modern Food Micro-Biology by J. M. Jay, (1986), Van Nostrand 2.
2. Pergamon Press. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young (Eds.)
3. Biotechnology : A Text Book of Industrial Microbiology : T.D. Brock, Smaeur Associates, 1990.
4. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
5. 1987. Industrial Microbiology : Prescott & Dunn, CBS Publishers,
6. Enfors & L Hagstrom (1992), RIT, Stockholm. Bioprocess Technology- fundamentals and applications, S O
7. Ratledge & A Sasson, Cambridge Univ. Press, Cambridge. Biotechnology, Economic & Social Aspects : E.J.

Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge

8. Crueger and A. Crueger. Biotechnology - a hand book of industrial microbiology : W.
9. Microbial Biotechnology : A. N. Glazer and H. Nikaids.

Code of the Course/Subject Title of the Course/Subject Total Number of Period

DSC- LC-II 4BT Industrial Biotechnology **6H/Week**

1. Lab scale production of alcohol and acetic acid.
2. Production of amylase, pectinase and cellulose using microbial cultures.
3. Preparation, production and formulation of microbial biopesticide (bacteria, fungi, viruses) in lab.
4. Demonstration of modern techniques used in food analysis for quality assurance.
5. Demonstrate the various techniques to assess the microbial contamination in food products.
6. Demonstrate the presence of food adulterine in given samples.
7. .Demonstrate the presence anti-microbial metabolites from medicinal plants.
8. Demonstrate the effect of addition of organic fertilizers, vermin-compost and bio-pesticides on growth of plant in
pot culture.
9. Isolation and characterization of mycorrhizal fungi (AMF) from root nodules.
10. To demonstrate the production of nanoparticles from microbial culture.

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology Semester IV

Code of the Course	**Title of the Course**	**Total Number of Period**
DSC-III.4BT	**Environmental Biotechnology**	**45 Hrs.**

On completion of course, students will be able to

CO:

At the end of the course the students should be able to:

1. Understand use of basic microbiological, molecular and analytical methods, which are extensively used in environmental biotechnology.
2. Use the microorganisms as tools in biotechnology and their most important environmental applications.
3. Detect pollution in water, air and soil.
4. Suggest the sustainable measuresfor environmental protection.
5. Suggest the sustainable measures for waste management and treatment.

Unit	Content
Unit I	**Introduction to environment (7 Hours)** Pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology
Unit II	**Bioremediation (8 Hours)** Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) ï examples, bioremediation of metals (Cr, As, Se, Hg),

	radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ).
Unit III	**Application of bacteria and fungi in bioremediation**: **(8 Hours)** White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization, Bio control mechanism.
Unit IV	**Environmental forensic**: **(7 Hours)** Introduction and application of Environmental forensic, principle and methods of chemical fingerprinting (crude oil and refined products), forensic techniques in litigation, environmental forensic microscopy and case studies in environmental forensic
Unit V	**Environmental Biotechnology and biofuels**:**(8 Hours)** Biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.
Unit VI	**Global Environmental Problems**: **(7 Hours)** Ozone depletion, UV-B and greenhouse effect, Acid rain, its impact and biotechnological approaches for management, Sustainable Development Goals of UN (SDG) and role of Biotechnology in achieving these goals.

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for Air Pollution Control, CRC Press.
5. H. J. Rehm and G. Reed, (2001), Biotechnology ï A Multi-volume Comprehensive Treatise, Vol. 11, 2nd Ed., VCH Publishers Inc.
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), Environmental Engineering, McGraw-Hill Inc.
7. https://sdgs.un.org/goals

Syllabus Prescribed for TWO Year PG Programme
Programme: M.Sc. Biotechnology Semester IV

Code of the Course	Title of the Course	Total Number of Period
DSC-LC-III.4BT	**Environmental Biotechnology**	**6H/Week**

1. Detection of coliforms for determination of the purity of potable water.
2. Determination of total dissolved solids of water
3. Determination of dissolved oxygen concentration of water sample
4. Determination of biological oxygen demand (BOD) of sewage sample
5. Determination of chemical oxygen demand (COD) of sewage sample
6. Determine the efficiency of removal of air pollutant using fibrous air filter.
7. Isolation of xenobiont degrading bacteria by selective enrichment technique
8. Test for the degradation of a aromatic hydrocarbons by bacteria
9. Survey of degradative plasmids in microbes growing in polluted environment
10. Effect of Sulphur dioxide on crop plants
11. Estimation of heavy metals in water/soil by Atomic absorption spectrophotometry
12. Estimation of nitrate in drinking water.
13. Role of microorganisms in elevation of heavy metal induced stress I plants

Recommended Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theory and Applications, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle & Applications, 2 nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for Air Pollution Control, CRC Press.
5. H. J. Rehm and G. Reed, (2001), Biotechnology ï A Multi-volume Comprehensive Treatise, Vol. 11, 2 nd Ed., VCH Publishers Inc.
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), Environmental Engineering, McGraw-Hill Inc.

*****