

PROGRAMME OUTCOMES (POs)

The programme of master's in Biotechnology focuses in-depth the use of technologies pertaining to microorganisms, plant and animals with special emphasis to irradiate environmental issues along with developing skill sets for the imparting competence for sustenance in research and industries pertaining to pharmaceuticals, bioprocess technology, environmental protection and in the domains of intellectual property rights and bioethics.

- **PO1** Impart training that develop critical thinking, problem solving, inculcating research aptitude and knowledge, teamwork, planning, interpretation and analysis in the domain of Biotechnology.
- **PO2** Learn technical skills through laboratory sessions, research projects and develop self-directed experiential learning.
- **PO3** Develop a technical skill set for employability, entrepreneurship and a basic research aptitude.
- **PO4** Inculcating the wisdom and subtleties of work ethics of an industry and research organization in biotechnology and allied domains.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- **PSO1** Consolidation the fundamentals and principles of basic and applied aspects of biotechnology with an aim to serve the society.
- **PSO2** Develop a technical skill set for generating, analyzing and interpreting scientific data for employability, entrepreneurship and research aptitude.
- **PSO3** Introducing scientific cognition, critical thinking, analysis using in age computational tools to develop competence for academic research and industry at par with the global scenario.
- **PSO4** Making students aware to the needs of a society for constructive contribution towards its sustainable growth and development of products of high socio-economic importance such as improved crops, vaccines, diagnostic tools, improve microbial strains for enhancing the production of high value compounds.
- **PSO5** Understand the social aspects, ethical concerns, issues of intellectual properties and policies of the Biotechnology industry along with evaluating the ethical, legal and social issues pertaining to use of biological systems.

M.Sc. BIOTECHNOLOGY SYLLABUS
SEMESTER 1 & 2

Paper no.	Title	No. of Hours per Week				Course Credits
		Lecture	Others	Practicals	Total	
Semester 1						
BT 401	Cellular Biology	3	1	-	4	4
BT 402	Cellular Biochemistry and Enzymology	3	1	-	4	4
BT 403	Genetics and Biostatistics	3	1	-	4	4
BT 404 E	Physiology and Immunology	3	1	-	4	4
BT 405 PR	Lab 1	-	-	12	12	4
BT 406 PR	Lab 2	-	-	12	12	4
Total		12	4	24	40	24
Semester 2						
BT 407	Bioprocess Technology	3	1	-	4	4
BT 408	Concepts in Genetic Engineering	3	1	-	4	4
BT 409	Synthetic and Systems biology	3	1	-	4	4
BT 410 E	Microbial and Animal Cell culture products	3	1	-	4	4
BT 411 PR	Lab 3	-	-	12	12	4
BT 412 PR	Lab4	-	-	12	12	4
Total		12	4	24	40	24

SEMESTER 1
BT 401: Cellular Biology

COURSE CODE: BT 401

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **CO1** Acquainting students with the cellular composition and mechanisms of all domains of life forms, prokaryotes, eukaryotes and archaea.
- **CO2** Familiarizing students with various methods for cultivation, isolation and general characterization of microorganisms.
- **CO3** Comparing and contrasting the cellular morphologies and functions of prokaryotes and eukaryotes.
- **CO4** Depicting the significance of eukaryotic microorganisms in nature and industry.

Unit 1: Understanding prokaryotes

- Fundamental understanding and classification of prokaryotes, their types based on size shape and arrangement
- Structure and function of external cellular components: pilli, flagella, cell wall, and cytoplasmic membrane
- Structure and function of internal cellular components: inclusion bodies, nucleolus, and plasmids
- Basic techniques to study prokaryotes: inoculation, incubation, isolation, inspection, identification
- Fundamentals of magnification and types of light microscopes
- Introduction to Bergey's manual of systematic bacteriology

Unit 2: Eukaryotic cell structure

- Evolution of Mitochondria and Chloroplast into eukaryotic cells, and Endosymbiont Theory.
- Smooth and Rough Endoplasmic reticulum and their functions
- Golgi Apparatus and its function
- Process of Glycosylation
- Ribosomes, its discovery, structure, and function.
- Functions of Lysosomes, Peroxisomes and Vacuoles in plant cells
- Structure and function of Nucleus and its biology during different stages of cell division

Unit 3: Eukaryotic cell functioning

- Composition and function of Cell membrane,
- Cellular functions of Lipid rafts, chaperon proteins, and Proteosomes
- Endocytosis, exocytosis and Autophagy with key factors of regulation.
- Cytoskeleton and its function
- Mitosis, Meiosis, and Cell cycle checkpoints,
- Apoptosis and its pathways
- Understanding of Aging and Necrosis

Unit 4: Eukaryotic microorganisms

- Structure, reproduction, classification of molds
- Structure of yeast cell, budding and fission yeast and their role in biotechnology
- Fungal cell factories: pharmaceuticals and enzymes
- Fungal diseases in plants and humans
- Biological understanding of algae and protozoa along with their role in biotechnological applications and as human pathogens

REFERENCE

No.	Name	Author
1.	A guide to identifying and classifying yeast	Burnet et.al
2.	Agricultural statistics-techniques and procedures	Mandal & Nambiar
3.	Analytical biochemistry	D.J. Holme & H.Peck
4.	Annual review of microbiology	Volumes
5.	Bacteria in their natural environment	Fletcher
6.	Bacterial metabolism	Gottschalk, G.
7.	Bacterial respiration and photosynthesis	C.W. Jones
8.	Bergey's manual of systematic bacteriology vol.: I-V	Krieg & Holt
9.	Biodiversity of microbial life	Ed. J. T. Staley & A.L. Reysenbach
10.	Bioinformatics databases, tools and algorithms	O. Bosu & S. K. Thukral
11.	Biology of the conidial fungi	Cole & Kendrick
12.	Biology of the fungi	I.K. Ross
13.	Brock's biology of the microorganisms 8 th edition	M.T.Madigan,T.M.
14.	Microbial diversity	Colwd. D
15.	Microbial ecology	Bartha and Atlas, Pearson Edu
16.	Moulds and filamentous fungi in technical microbiology	O. Fassatiova

WEBLINKS

1. Strategies and challenges for the development of industrial enzymes using fungal cell factories:

https://link.springer.com/chapter/10.1007/978-3-030-29541-7_7

2. Growing a circular economy with fungal biotechnology: a white paper:

<https://fungalbiolbiotech.biomedcentral.com/articles/10.1186/s40694-020-00095-z>

3. Fungal biology. Deacon, J. W. (2013). John Wiley & Sons:

<https://yeastwonderfulworld.files.wordpress.com/2016/10/fungal-biology.pdf>

4. Fungi: Biology and applications:

[https://www.wiley.com/en-](https://www.wiley.com/en-us/Fungi%3A+Biology+and+Applications%2C+3rd+Edition-p-9781119374275)

[us/Fungi%3A+Biology+and+Applications%2C+3rd+Edition-p-9781119374275](https://www.wiley.com/en-us/Fungi%3A+Biology+and+Applications%2C+3rd+Edition-p-9781119374275)

5. Yeast biotechnology: teaching the old dog new tricks:

<https://link.springer.com/article/10.1186/1475-2859-13-34>

6. Yeast as a Versatile Tool in Biotechnology. In A. Morata, & I. Loira (Eds.), Yeast - Industrial Applications:

<https://www.intechopen.com/chapters/56515>

BT 402: Cellular Biochemistry and Enzymology

COURSE CODE: BT 402

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **CO1** Illustrating the exemplary role of biomolecules and enzymes in metabolism of sugars, proteins and lipids.
- **CO2** Acquainting students with the molecular mechanisms of biomolecule syntheses with emphasis on nitrogen metabolism.
- **CO3** Appreciating the intensive biochemistry and thermodynamics of enzyme catalyzed reactions.
- **CO4** Discussing the kinetics and regulation of enzymes along with portraying their clinical, analytical and industrial applications.

Unit 1: Biochemistry of Carbohydrates and Lipids

- Carbohydrates, types, structure and function
- Lipids: Fatty acids, simple lipids, phospholipids, and cholesterol
- Glycoconjugates- glycoproteins, proteoglycans, and glycolipids
- Central metabolic pathways, feeder pathways and Fate of pyruvate under anaerobic condition
- PHA and PHB in cells; degradation of fatty acids by beta-oxidation
- Metabolism of C 1 compounds

Unit 2: Biochemistry of Proteins and Nucleic acids

- Amino acids and proteins, structure, classification, and properties
- Structure and function of Nucleic acids, Nucleotides- types, derivatives and functions
- Nitrogen metabolism: Nitrate and Ammonia Assimilation, Nitrogen fixation and Nitrogenase
- Biosynthesis and regulation of amino acids
- Biosynthesis and regulation of nucleotides

Unit 3 Enzymology 1

- Extraction and purification enzymes
- Protein folding and denaturation
- Enzyme Kinetics
- Mechanism of enzyme action-catalysis mechanisms and lysozyme
- Enzyme regulation

Unit 4 Enzymology 2

- Enzyme inhibition
- Enzyme turnover
- Immobilisation of Enzymes
- Biotechnological applications of enzymes
- Abzymes and ribozymes

REFERENCE

No.	Name	Author
1.	Biochemistry and molecular biology	W. H. Elliott & D. C. Elliott
2.	Biochemistry Stryer 5 th edition	W.H. Freeman
3.	Biochemical methods	Pingoud A. etl.
4.	Enzymes and immobilized cells in biotechnology	A. L. Laskin
5.	Enzymes, biochemistry, biotechnology, clinical chemistry	Trevor Palmer
6.	Principle of biochemistry 3 rd edition	Lehninger Nelson & Cox
7.	Biotechnology	U. Satayanarayan

WEBLINKS

1. Carbohydrates:

<https://www.presentica.com/doc/11089287/module-11-carbohydrates-lecture-29-carbohydrates-i-pdf-document>

2. e-PGPathshala:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQIU+6LM40KjY1Q==>

- Paper-11 Module-17 Nitrogen fixation and cycles
- Paper-04 Module-06 Entry of fructose and galactose
- Paper-04 Module-08 Fate of pyruvate
- Paper-04 Module-23 Gluconeogenesis
- Paper-14 Module-10 Enzyme kinetics
- Paper-14 Module-11 Enzyme inhibition
- Paper-14 Module-26 Enzyme immobilization

BT 403: Genetics and Biostatistics

COURSE CODE: BT 403

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Conveying vital concepts of molecular biology and modes of gene exchange in prokaryotes.
- **C02** Conveying the information on fungal and bacteriophage genetics.
- **C03** Discussing the extensive concepts of molecular biology and genetic engineering.
- **C04** Familiarizing the concept of biological data generation, management and its analysis using statistical tools and techniques.

Unit 1 Bacterial genetics and plasmid

- Methods of gene exchange in bacteria: Transformation, Conjugation and Transduction
- Application and use of gene exchange processes
- Plasmid biology: Types, Replication, Compatibility, Control of copy number and segregation
- Plasmid designing and application

Unit 2: Genetics of microorganisms

- Ordered tetrad analysis and mitotic recombination of *Neurospora*.
- Unordered tetrad analysis in yeast.
- Bacteriophage genetics of T-even phages with detail emphasis on T4.
- Bacteriophage genetics of T-odd phages with detail emphasis on T7.
- M13 phage genetic assembly and function with emphasis for its role in genetic engineering.

Unit 3 Concepts of molecular biology

- Organization of eukaryotic chromosome
- Enzymes involved in prokaryotic DNA replication
- Molecular mechanism of prokaryotic DNA replication
- Introduction to eukaryotic DNA replication.
- Structure of RNA Polymerase and molecular mechanism of transcription
- Molecular mechanism of translation
- Mutation and DNA damage
- Repair mechanisms

Unit 4: Biostatistics

- Meaning of data and their representation in biostatistics
- Measures of central tendency with computation and their application in biostatistics
- Measures of dispersion with computation: Standard deviation and Variance
- Correlation: meaning, types and methods of correlation
- Chi-squared test and their role in biostatistics
- F test and Student's t-test in hypothesis testing
- Normal distribution curve, characteristics and uses with computation

REFERENCE

No.	Name	Author
1.	Biotechnology and genomics	P. K. Gupta, Rastogi Publication
2.	Cell and molecular microbiology	Garald Karp
3.	Gene function	Robert Glass
4.	Gene V- VII	Benjamin Lewin
5.	General genetics	L. Snyder et. al
6.	Genetics 3 rd edition	Peter J. Russel
7.	Genetics as a tool in microbiology	Gloover & Hopwood
8.	Genetics of bacteria	Scaife et.al
9.	Growth of bacterial cell	Ingraham et. al
10.	Molecular biology and biotechnology	Robert A., Meyers Eds.
11.	Molecular biology of gene	J.D.Watson
12.	Molecular biomethods handbook	Rapley & Walker
13.	Molecular biotechnology	Primrose
14.	Molecular cell biology	Lodish et.al
15.	Molecular genetics of bacteria	Snyder & champnes
16.	Biostatistics	Lewis A.E.
17.	Statistical methods in Biology	N. T. J. Bailey
18.	Elements of biostatistics	S. Prasad
19.	Introduction to biostatistics	R. N. Forthofer & Lee

WEBLINKS

e-PGPathshala:

1. Genetics and Molecular biology

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-04 Module-08 DNA replication in Prokaryotes
- Paper-04 Module-09 DNA replication in Eukaryotes
- Paper-04 Module-05 DNA Topoisomerase
- Paper-04 Module-06 DNA Methyltransferase
- Paper-04 Module-07 DNA Polymerases

2. Biostatistics

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=31BI+Y/jyQo+vltwaZoj+g==>

- Paper-02 Module- Introduction to statistics and bio statistics

BT 404: Physiology and Immunology

COURSE CODE: BT 404

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Interactions of microbes with humans with knowledge in the field of immunology is provided that enables students to understand the impact pathogenic microbes on human health.
- **C02** Imparting the in-depth knowledge of microbial growth and physiology.
- **C03** Understanding the interplay of various components on Immune system during infection.
- **C04** Learning the deficiencies and disorders of Immune system.

Unit 1: Principles of physiology

- Nutrient transport in prokaryotic cell
- Signal transduction in bacteria
- Mechanism of drug resistance
- Quorum sensing
- Bacterial Bioluminescence
- Bacterial differentiation

Unit 2: Microbial growth

- Batch growth and its kinetics: definition, trophophase and idiophase, diauxic growth, maximum growth rate, specific growth rate, yield co-efficient
- Continuous growth and its kinetics: continuous culture, dilution rate, residual substrate concentration
- Factors affecting growth: temperature, pH, oxygen, salt concentration, pressure, water activity, radiation
- Growth measurement: direct methods and indirect methods
- Control of microbial growth: physical agents and chemical agents

Unit 3: Functioning of Immune system

- Antigen processing and presentation
- MHC: structure and function
- Cytokines and cytokine bias in diseases
- Compliment components and activation
- T cell receptors and activation of T cells
- B cell receptors and activation of B cells

Unit 4: Immune disorders and immunological techniques

- Hypersensitivity (Hypersensitive reactions)
- Autoimmunity and autoimmune diseases
- Transplantation immunology
- AIDS and other immunodeficiency
- Cancer and the immune system

REFERENCE

No.	Name	Author
1.	Advances in microbial physiology	Robert K. Poole
2.	Biochemistry Stryer 5 th edition	W.H. Freeman
3.	Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology	Wilson, Walker
4.	Biophysical chemistry	A Upadhyay, K Upadhyay
5.	Growth of bacterial cell	Ingraham et. al
6.	Harper's biochemistry	Murray et. al
7.	Microbial cell-cell interaction	Martin
8.	Microbial ecology	Bartha and Atlas, Pearson Edu
9.	Microbial physiology	Dawes & Southerland
10.	Principle of biochemistry 3 rd edition	Lehninger Nelson & Cox
11.	Principles of microbiology	RM. Atlas
12.	The microbial cell cycle	C. Edwards
13.	Text book on principles of bacteriology, virology, and Immunology, IX Edition (5 Volumes), Edward, London, 1995	Topley and Wilson's
14.	Immunology	Janis Kuby
15.	Immunology and immunotechnology	A. K. Chakravarty
16.	Immunology	I. R. Tizard

WEBLINKS

e-PGPathshala:

1. Principles of physiology

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=SbxpZDmQJ9L1h7rf83v6ow==>

- Paper-12 Module-19 Active transport
- Paper-12 Module-15, 16 & 17 Diffusion
- Paper-11 Module-26 Signal transduction

2. Microbial Growth:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=SbxpZDmQJ9L1h7rf83v6ow==>

- Paper-11 Module-03 & 04 Cell growth and division

3. Immunology:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQIU+6LM40KjY1Q==>

- Paper-16 Module-22 Antigen processing
- Paper-16 Module-20 MHC
- Paper-16 Module-19 & 21 T-Cells
- Paper-16 Module-17 & 23 B-Cells
- Paper-16 Module-27 to 30 Hypersensitivity
- Paper-16 Module-31 Autoimmune diseases
- Paper-16 Module-34 Cancer and AIDS

BT 405: Practicals

COURSE CODE: BT 405

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **CO1** Laboratory skills to cultivate microbes, characterize them and identify their use for betterment of humanity is provided to the students with practical exercises.
 - **CO2** Visualization of microbes using various staining techniques.
 - **CO3** Developing aptitude to perform biochemical characterization of microbes.
 - **CO4** Imparting skillsets to quantify various biomolecules like carbohydrates, lipids, proteins and nucleic acids.
 - **CO5** Acclimatizing students with molecular biology experiments.
1. Demonstration of basic laboratory instruments
 2. Preparation of standard solutions, Buffers and their standardisation
 3. Microbial Diversity : Cultural, Morphological (Spore, Capsule, Flagella and inclusion bodies) and Biochemical
 4. Study of Microbial Diversity Indices
 5. Measurement of microbial cell size using Micrometry
 6. Isolation and study of Molds, Yeast and Actinomycetes
 7. Isolation and characterization of microorganisms from extreme environments
 8. Quantification of biomolecules:
 - Carbohydrates: Cole's, DNSA method, Anthrone method
 - Proteins: Folin Lowry's, Bradford's method
 - Nucleic Acids: DNA by DPA; and RNA by Orcinol method
 9. Qualitative analysis of biomolecules by chromatography: sugars, amino acids & organic acids

BT 406: Practicals

COURSE CODE: BT 406

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **CO1** Acquiring expertise in experimentation pertaining to microbial physiology and enzymology.
 - **CO2** Implementing training to familiarize sophisticated instruments.
 - **CO3** Teaching to acquire and analyze the experimental data using biostatistics.
1. PHB staining by Nile Blue method
 2. Study of bacterial growth curve and its kinetics
 3. Determination of bacterial growth rate and factors influencing it
 4. Study of enzyme kinetics (Determination of K_m , V_{max} and Double reciprocal curve) of amylase
 5. Determination of enzyme activity: protease, lipase
 6. Immunological interaction between Ag and ab:
 - Immunoprecipitation
 - Agglutination
 7. Isolation and titration of bacteriophage
 8. Statistical analysis of data: Measures of central tendency, Assessment of Graphs, and standard deviation

SEMESTER 2

BT 407: Bioprocess Technology

COURSE CODE: BT 407

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Familiarizing students with industrially important microbes.
- **C02** Imbibing the concepts of bioprocesses involving microbes at an industrial scale.
- **C03** Biotechnological roles of microbes in dairy and food industry is imparted.
- **C04** Microbial derived products of therapeutic significance are focused.

Unit 1 Elements of bioprocess

- Isolation, screening and preservation of industrially important microorganisms
- Strain Improvement: Isolation of mutants producing primary metabolites, secondary metabolites, auxotrophic mutants, resistant and revertant mutants
- Media formulation energy sources, antifoams
- Optimization of fermentation medium

Unit 2 Fermenter Design & control

- Design of Fermenter
- Types of Fermenter
- Instrumentation and control of process variables
- Control systems

Unit 3: Upstream processing

- Sterilization of media, air, and reactor
- Development of inoculum for industrial fermentations
- Aeration-agitation system,
- Heat transfer, mass transfer of oxygen, K_La and factors affecting K_La , rheological and fluid-flow properties
- Fundamentals of scale up

Unit 4 Downstream processing & Fermentation economics

- Methods of cell separation and product recovery: Filtration, Centrifugation, Membrane processes, Extraction, Chromatography
- Methods of cell disruption: Mechanical and non-mechanical
- Fermentation economics: Expenses for industrial organism, strain improvement, media sterilization, heating, cooling, aeration, agitation, Batch process cycle time and continuous culture

- Fermentation economics: Cost of fermenter plant and other equipment, product recovery and effluent treatment, Cost due to recovery, waste usages and recycling

REFERENCE

No.	Name	Author
1.	Principles of Fermentation Technology	P F Stanbury, A Whitaker, S J Hall
2.	Industrial Microbiology: An Introduction	M J Waites, N L Morgan, J S Rockey
3.	Bioprocess Engineering	P.K. Ghosh
4.	Fermentation Microbiology and Biotechnology	EL-Mansi & C.F.A.Bryce eds
5.	Manual of Industrial Microbiology and Biotechnology	Demain & Davies, 2 nd ed.

WEBLINKS

e-PGPathshala:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==>

- Paper-06 Module-16 Fermentation technology overview
- Paper-06 Module-17 Downstream processing
- Paper-06 Module-18 Bioreactors

BT 408: Concepts in Genetic Engineering

COURSE CODE: BT 408

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Genetic manipulation in microbes is conveyed with their use under ethical wisdom.
- **C02** various components and techniques used for genetic manipulation in microbes are taught.
- **C03** Tools such as to identify and analyze Molecular markers are explained to students.

Unit 1: Gene expression and regulation

- Transcriptional and translational control
- Lac, arabinose and tryptophan operon circuits
- Regulation of lytic and lysogenic cycle of λ phage

Unit 2: Enzymes in r-DNA Technology and DNA sequencing

- Extraction, purification, analysis and size fractionation of nucleic acid
- Enzymes involved in genetic engineering
- c-DNA formation and c-DNA library and genomic library
- Cohesive and blunt end ligation
- CRISPER-Cas9

Unit 3: Vectors and Probes

- Cloning and expression vectors
- Methods of introduction of r-DNA into host cell
- Expression and characterization of cloned genes
- Oligonucleotide probes and labelling of probes

Unit 4: Molecular markers and techniques

- Blotting and hybridization techniques
- DNA sequencing
- DNA fingerprinting
- Molecular markers- RFLP and RAPD
- Microarray technique

REFERENCE

No.	Name	Author
1.	Genetic engineering	Rastogi & Pathak, Oxford
2.	Biotechnology and genomics	P. K. Gupta, Rastogi Publication
3.	Biotechnology	U. Satyanarayana
4.	Molecular biology and genetic engineering	P. K. Gupta
5.	Molecular biology of gene	J.D.Watson
6.	Genetics as a tool in Microbiology	Glover & Hopwood
7.	Genetics of Bacteria	Scaife et.al
8.	Molecular Genetics of Bacteria	Snyder & Champnes
9.	Molecular Biotechnology	Primrose
10.	Gene cloning and manipulation	Christopher Howe
11.	Molecular Biology and Biotechnology	Robert A., Meyers Eds.
12.	Principle of Gene Manipulation, An Introduction to Genetic Engineering	R. W. Old & S.B. Primrose
13.	Essential of Molecular Biology	George M. Malacinski
14.	Recombinant DNA Principles and Methodology	James J Greene & Venigalla B. Rao
15.	Molecular Bio methods Handbook	Rapley & Walker
16.	Cell and Molecular Microbiology	Garald Karp
17.	Biotechnology An Introduction	Susan R. Barnum
18.	Recombinant DNA Methodology II	Ray Wu
19.	Molecular biology and genetic engineering	P. K. Gupta

WEBLINKS

e-PGPathshala:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQIU+6LM40KjY1Q==>

- Paper-15 Module-07 Bacterial transcription
- Paper-15 Module-12 Post transcriptional modification
- Paper-15 Module-15 Prokaryotic translation
- Paper-15 Module-08 Operons
- Paper-15 Module-18 Vectors and Restriction enzymes
- Paper-15 Module-20 DNA Cloning
- Paper-15 Module-24 Macromolecule Blotting and Probing
- Paper-15 Module-25 DNA sequencing
- Paper-15 Module-26 Microarray technique

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-04 Module-02 DNA modifying enzyme
- Paper-04 Module-18, 19 & 20 Vectors

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=eCJfy23Kjy3c0vICLa6VYg==>

- Paper-13 Module-15 & 17 DNA markers
- Paper-13 Module-19 & 20 Blotting

BT 409: Synthetic and Systems biology

COURSE CODE: BT 409

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **CO1** Specialized computational tools needed to retrieve and analyze data of microbes, their genes and proteins are taught to improve the skillsets of the students.
- **CO2** Knowledge on modern development in biological sciences and in microbiology making use of Nanotechnology is imparted.
- **CO3** Principles, working and applications of sophisticated instruments used in microbiology and biotechnology is taught.
- **CO4** Use of computers to retrieve data from biological databases and their analysis is learnt by students.

Unit 1: Bio-nanotechnology

- Introduction to concept and principles of nanotechnology
- Nanomaterial in nanotechnology: Nanoparticles, Quantum Dots, Nanotubes, Nanowires
- Development of nanotechnology-Timelines and Progress
- Techniques and methodology used to study nanoparticles
- Biosensors, Molecular recognition devices, Lab on Chip- concepts and applications
- Biological Nanoparticles- Plant and Microbial
- Application of nanoparticles in molecular biology, industry, agriculture and environment

Unit 2: Advances in Instrumentation

Principle, working and applications of:

- Atomic absorption Spectrophotometer (AAS)
- Fourier Transformation Infrared Spectroscopy (FTIR), Matrix Assisted LASER Desorption/Ionization Time of Flight (MALDI-ToF), Mass spectrophotometer (MS)
- High Performance Liquid Chromatography (HPLC), Gas chromatography (GC)
- Nuclear Magnetic Resonance (NMR)

Unit 3: Bioinformatics-I

- Introduction to bioinformatics
- Introduction to computers and bioinformatics
- Biological databases
- Pairwise sequence alignment: Global sequence alignment vs local sequence alignment
- Phylogeny
- Application of bioinformatics in Proteomics, Genomics, Transcriptomic

Unit 4: Bioinformatics-II

- Dot plot, scoring matrices, FASTA and BLAST algorithms
- Protein Profiles, motifs and feature identification
- Homology modelling and HMM algorithm
- Bioinformatic drug discovery pipeline

REFERENCE

No.	Name	Author
1.	Bio nanotechnology: Principles and Applications	Anil Kumar
2.	Essential Bioinformatics, Cambridge	Jin xiong
3.	Bioinformatics: An Introduction 3 rd Edition	Jeremy Ramsden
4.	Bioinformatics and Functional Genomics 3 rd Edition	Jonathan Pevsner

WEBLINKS

e-PGPathshala:

1. Bio-nanotechnology:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-11 Module-13 Nanotechnology based delivery systems for biotechnological applications
- Paper-11 Module-35 Food Nanotechnology: an introduction
- Paper-11 Module-16 Carbon based nanomaterials
- Paper-11 Module-11 Nanotechnology, Nanomedicine and Nanomaterials: Applications in biotechnology
- Paper-11 Module-14 Dendrimers
- Paper-11 Module-15 Quantum dots
- Paper-11 Module-16 Carbon nanotubes
- Paper-11 Module-24 Environment remediation using Nanotechnology
- Paper-11 Module-28 Risks associated with nanotechnology
- Paper-11 Module-31 Medical Nanobiotechnology applications
- Paper-11 Module-38 Nutraceuticals in nanotechnology

2. Instrumentation:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=1+p0z2ZbAGSfsyfLITzgZQ==>

- Paper-01 Module-28 Atomic absorption spectroscopy
- Paper-10 Module-24 to 26 FTIR
- Paper-06 Module-30 to 35 Mass spectrometry
- Paper-03 Module-09 to 14 HPLC
- Paper-03 Module-04 to 08 Gas chromatography

3. Bioinformatics:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=MNhNzp1RQIU+6LM40KjY1Q==>

- Paper-13 Module-01 Overview of Bioinformatics
- Paper-13 Module-02 & 03 Database
- Paper-13 Module-06, 07 & 19 Sequence Alignment
- Paper-13 Module-09 BLAST

BT 410: Microbial and Animal Cell culture products

COURSE CODE: BT 410

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** In-depth knowledge on the development of microbially derived products such as antibiotics, organic acids, therapeutic agents, enzymes, vitamins.
- **C02** Role of microbes at industrial scale for developing beverages food and are taught to the students with special emphasis on entrepreneurship.
- **C03** This course infers the knowledge on ethical use of eukaryotic animal cell lines for therapeutic used.

Unit 1: Microbial fermentative products and therapeutic agents

- Beverage: Beer
- Organic Acid : Citric Acid, Acetic acid
- Biopolymer: EPS and Polyhydroxyalkanoates (PHA)
- Antibiotic: Streptomycin
- Vitamin: Riboflavin (B₂)
- Vaccines
- Monoclonal antibodies: Hybridoma technology

Unit 2: Food Biotechnology

- Fermented foods and Starter cultures
- Cheese production technology
- Evaluation and role of Probiotics
- Fungal biomass- baker's yeast
- Mushroom cultivation
- Carotenoid pigments- B carotene, lycopene

Unit 3: Introduction to Animal Cell Culture

- Historical background, Definitions, Advantages and Limitations of Animal Cell Culture
- Laboratory design, Layout and Equipment of Cell Culture lab
- Basics of Primary culture, subculture, cell line, cell strain, cell clone
- Basic media and techniques of mammalian cell culture
- Biosafety, Bioethics and Validation in Animal cell culture

Unit 4: Applications of Animal cell culture

- Production of humanized and chimeric monoclonal antibodies, cytokines for treatment of various diseases including cancer
- Applications of recombinant proteins/enzymes and Fusion Biologics
- Production of recombinant hormones and its use in IVF Technology
- Production of recombinant coagulation factors for the treatment of haemophilia A and B

REFERENCE

NO.	Name	Author
1.	Principles of Fermentation Technology	P F Stanbury, A Whitaker, S J Hall
2.	Topics in Enzyme & Fermentation Biotechnology	Volumes by Wisemen
3.	Preservation and Sterilisation Methods in Microbiology	Norris & Ribbons
4.	Biology of Industrial Microorganisms	A.L. Duncun
5.	Bioprocess Engineering	P.K. Ghosh
6.	Handbook of dairy microbiology	Getachew osei
7.	Food and Dairy microbiology	Getachew osei

WEBLINKS

e-PGPathshala:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=NuAs6SreCGryddEfs4kkBA==>

- Paper-06 Module-21 Production of Vitamin B12, Riboflavin and Xanthan gum
- Paper-06 Module-22 Technologies for production of alcoholic beverages
- Paper-06 Module-23, 24 & 25 Fermentation of food and Milk
- Paper-06 Module-36 Microbial biomass
- Paper-06 Module-37 Production of Single cell protein
- Paper-06 Module-38 Production of yeast and fungal biomass

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-09 Module-01 History, scope and future perspective of animal biotechnology
- Paper-09 Module-05 Introduction and history of cell culture
- Paper-09 Module-02 & 04 Laboratory requirement and instrumentation in animal cell biotechnology
- Paper-09 Module-03 Media and reagents in animal cell biotechnology
- Paper-09 Module-39 Biosafety issues in animal cell biotechnology
- Paper-09 Module-40 Ethical issues for animal cell culture

BT 411: Practical

COURSE CODE: BT 411

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Use of computational tools in retrieving and analyzing biological data from the domains of genomics and proteomics is learnt by students.
 - **C02** Skills for the techniques used in genetic manipulation is imparted.
1. Bioinformatics:
 - Data base exploration
 - BLAST
 - Sequence alignment: Multiple and Pair-wise
 - Phylogenetic tree construction
 - Sequence submission
 2. Isolation, quantification and determination of purity: DNA, RNA and Plasmid
 3. Amplification of DNA by thermocycler
 4. RE digestion of plasmid
 5. Induction of mutants by physical and/or chemical mutagens and its characterization:
 - Auxotrophic mutants,
 - Pigment variants
 - lac⁻ mutants
 - Antibiotic resistant mutants
 6. Determination of oxygen transfer rate (OTR)
 7. Determination of MIC and MBC of antibiotics

BT 412: Practical

COURSE CODE: BT 412

NO. OF CREDITS: 04

COURSE OUTCOMES (COS)

- **C01** Skills that are essential for industrial production microbial production of food, beverages, enzymes are learnt and imparted.
 - **C02** Various industrial microbial products like enzymes, alcohol, antibiotics, organic acids are produced by students during this course.
 - **C03** Students get through with the procedures to develop commercially important fermentation derived products.
1. Fungal spore/Yeast cells count
 2. Isolation, screening and optimization of conditions for production:
 - Solid state fermentation: enzymes, alcohol
 - Submerged fermentation: enzymes, exopolysaccharide, alcohol, organic acids and antibiotics
 3. Ammonium sulphate precipitation method for enzyme purification
 4. Electrophoretic separation of proteins by PAGE: SDS and NATIVE
 5. Estimation, recovery and purification of fermentation products- Antibiotics, Organic acids, Alcohol, Exopolysaccharide
 6. Rheological study of culture broth by Brookfield viscometer
 7. Influence of different parameters on immobilisation of cells and enzymes
 8. Scale up study

**M.Sc. BIOTECHNOLOGY SYLLABUS
SEMESTER 3 & 4**

Paper no.	Title	No. of Hours per Week				Course Credits
		Lecture	Others	Practicals	Total	
Semester 3						
BT 501	Plant Biotechnology	3	1	-	4	4
BT 502	Environment Microbiology	3	1	-	4	4
BT 503	Green and Blue Biotechnology	3	1	-	4	4
BT 504 E	Animal Tissue Culture and Pharmaceutical Biotechnology	3	1	-	4	4
BT 505 PR	Lab 1	-	-	12	12	4
BT 506 PR	Lab 2	-	-	12	12	4
Total		12	4	24	40	24
Semester 4						
BT 507	MIC 507 PT: Project / Dissertation Work theory	-	-	-	16	16
BT 508	Conference report writing and Study tour			6	6	4
BT 509	Review Paper Presentation and assignments	-	-	6	6	4
Total		-	-	12	28	24

SEMESTER 3

BT 501: Plant Biotechnology

COURSE CODE: BT 501

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 To demonstrate the skills and competence in performing various types of plant tissue culture such as callus culture, cell suspension culture, organ culture and protoplast culture.

CO2 To explore the current and potential applications of plant bioreactors in various fields such as medicine, agriculture and industry.

CO3 Knowledge on developing transgenic crops using molecular biology is imparted.

CO4 Skills and knowledge for the use of Plant Tissue Culture (PTC) technology is inculcated.

Unit 1: Plant Tissue Culture- Techniques and Methodology

- Introduction to plant tissue culture and its techniques
- Plant tissue culture media and composition
- Plant tissue culture laboratory design and layout
- Callus and suspension cultures, cloning and regeneration
- Micropropagation and applications of plant tissue culture

Unit 2: Plant Tissue Culture- Application and its uses

- Production of haploid plants
- Germplasm conservation, cryopreservation and seed bank
- Protoplast isolation and regeneration
- Transgenic plants and its application

Unit 3: Plant as Bioreactor

- Types of Plant reactor
- Secondary metabolites: production and extraction
- Molecular marker aided breeding, assistant selection and its DNA based application
- Plant based production of enzymes, biopolymers and Plantibiotics, Plantibodies

Unit 4: Molecular Biology approaches for crop improvement

- Genetic Engineering: Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery;
- Direct gene transfer - PEG-mediated, electroporation, particle bombardment
- Molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

- Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications;
- Introduction to mapping of genes/QTLs; Marker-assisted selection - strategies for introducing genes of biotic and abiotic stress resistance in plants

REFERENCE

1.	Plant Biotechnology and Genetics: Principles, Techniques, and Applications	C. Neal Stewart Jr.
2.	Plant Tissue Culture: Theory and Practice	S.S. Bhojwani and M.K. Razdan
3.	Plant Cell Culture Protocols	M. Loyola-Vargas and Felipe Vázquez-Flota
4.	Introduction to Plant Biotechnology	H.S. Chawla

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- Paper- 04: Module-33 Plant Transformation vectors Ti-,Ri-plasmid
- Paper- 12: Module-02 Set up Tissue Culture laboratory
- Paper- 12: Module-04 Medium constituents (macro and micro elements, hormones, other growth regulators) and preparation
- Paper- 12: Module-05 Cell and Tissue culture
- Paper- 12: Module-06 Micropropagation1
- Paper- 12: Module-07 Micropropagation shoot multiplication
- Paper- 12: Module-13 In Vitro Production of Haploids-Part 1 (Anther Culture)
- Paper- 12: Module-17 Somatic Hybridization, culture and fusion: selection of hybrid cells and regeneration of hybrid plants
- Paper- 12: Module-18 Production of secondary metabolites
- Paper- 12: Module-19 In situ conservation and cryopreservation
- Paper- 12: Module-20 Production of Virus free plant
- Paper- 12: Module-31 Detection, characterization and expression of transformants (Genetic markers, reporter genes, transgene stability and gene silencing)
- Paper- 12: Module-37 Metabolic engineering and industrial products (plant secondary metabolites, alkaloids, industrial enzymes, therapeutic proteins, antibodies, edible vaccines)

BT 502: Environment Microbiology

COURSE CODE: BT 502

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 The course emphasizes on environmental problems and monitoring.

CO2 The students are learnt about the environmental laws and policies in India.

CO3 Strategies such as bioremediation, biodegradation and biodeterioration is taught involving microbes for developing sustainable environment is learnt.

Unit 1: Environmental problems and monitoring

- Environmental monitoring: environmental impacts and their assessments
- Bio-indicators (Keystone species), biomarkers,
- Biosensors, toxicity testing, and DNA based technologies.
- Conservation strategies, Environmental laws, and policies in India

Unit 2: Waste treatment

- Classification and characterization of waste
- Principles and mechanisms of waste treatment
- Biological methods of liquid waste treatment
- Biological methods for solid waste management

Unit 3: Biodegradation

- Principles of biodegradation and mechanism of detoxification
- Role of key enzymes, Monooxygenases, Dioxygenases, Cytochrome P440s in the biodegradation of compounds
- Biodegradation of detergents and lignin
- Biodegradation, bio-decoloration and bio-detoxification of dyes
- Biodegradation and detoxification of Pesticide and Hydrocarbons with suitable examples

Unit4: Biodeterioration

- Principles and mechanisms of biodeterioration
- Methodology to assess biodeterioration
- Prevention and control of biodeterioration
- Biodeterioration of selected materials of economic value

REFERENCE

No.	Name	Author
1.	Environmental Monitoring	G. Bruce Wiersma
2.	Environmental Monitoring Handbook	Frank R. Burden et al.
3.	Environmental Monitoring and Characterization	Janick F. Artiola et al.
4.	Waste Treatment in the Process Industries	Lawrence K. Wang et al.
5.	Biological Wastewater Treatment	C.P. Leslie Grady Jr. et al.
6.	Waste Treatment and Disposal	Paul T. Williams
7.	Biodegradation and Bioremediation	Martin Alexander
8.	Biodegradation: Natural and Synthetic Materials	S.J.L. Roffey
9.	Biodegradation of Organic Pollutants in Natural Waters	E.M. Perdue
10.	Biodeterioration of Stone Surfaces: Lichens and Biofilms as Weathering Agents of Rocks and Cultural Heritage	Larry St.Clair and Mark Seaward
11.	Biodeterioration Research 4: Mycotoxins, Wood Decay, Plant Stress, Biocorrosion, and General Biodeterioration	Gerald C. Llewellyn et al.
12.	Biodeterioration 7: Proceedings of the Seventh International Biodeterioration Symposium	D.R. Houghton et al.
13.	Biodeterioration of Stone Surfaces: Lichens and Biofilms as Weathering Agents of Rocks and Cultural Heritage by	Larry St.Clair and Mark Seaward
14.	Environmental Microbiology, Second Edition	Ralph Mitchell, Ji-Dong Gu
15.	Manual of Environmental Microbiology, Fourth Edition	Marylynn V. Yates et al.
16.	Brock Biology of Microorganisms, Fifteenth Edition	Michael T. Madigan et al.
17.	Environmental Microbiology, Third Edition	Ian L. Pepper et al.

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<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-05 Module-05 Methodology of environmental management
- Paper-05 Module-06 waste water treatment
- Paper-05 Module-09 Bioremediation and Biodegradation
- Paper-05 Module-11 Bioremediation of Soil and Water Contaminated with Pesticides and Toxic Substances
- Paper-05 Module-12 Biodegradation of lignin and cellulose

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=0Xvq9yUM2ILDrj07FvlArQ==>

- Paper 15 Module 24 Biosensors: An introduction
- Paper 13 Module-02 Constitutional Provisions relating to Environment Protection in India

BT 503: Green and Blue Biotechnology

COURSE CODE: BT 503

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Infer the use of microbes in developing Biofuels.

CO2 Discuss the role of microbes in environmental sustainable strategies such as acid mine drainage formation and control, biogeohydrotechnology of sulphidic minerals and biobeneficiation.

CO3 Inculcate knowledge of marine microbes as treasure house of industrial, therapeutic, cosmetics, pharmaceuticals and nutraceuticals agents.

Unit 1: Fuel Biotechnology

- Types of energy resources and their uses
- Biotechnology for biogas, bioethanol, biodiesel and biohydrogen production
- Desirable and undesirable features of biofuels
- Energy crops
- MEOR
- Mode of utilization of biomass

Unit 2: Microbiology of Minerals

- Biogeohydrotechnology of sulphidic minerals
- Biobeneficiation
- Acid mine drainage formation and control
- Bioleaching methods and factors affecting bioleaching

Unit 3: Bioremediation

- Bioremediation principles
- Strategies and techniques of bioremediation: in situ and ex situ
- Bioremediation of metals
- Phytoremediation
- GMOs and their impact on bioremediations

Unit 4: Marine Biotechnology

- Introduction to Marine environments and marine biotechnology
- Marine microbial enzymes, antimicrobial peptides and exopolysaccharides
- Marine therapeutics, cosmetics, pharmaceuticals and nutraceuticals agents
- Microbial Bioprospecting in Marine Environments

REFERENCE

No.	Name	Author
1.	Environmental Microbiology, Second Edition	Ralph Mitchell, Ji-Dong Gu
2.	Manual of Environmental Microbiology, Fourth Edition	Marylynn V. Yates et al.
3.	Brock Biology of Microorganisms, Fifteenth Edition	Michael T. Madigan et al.
4.	Environmental Microbiology, Third Edition	Ian L. Pepper et al.
5.	Biotechnology: An Introduction, Second Editions	Susan R. Barnum
6.	Environmental Biotechnology: Principles and Applications	Bruce E. Rittmann and Perry L. McCarty
7.	Fungi in Fuel Biotechnology, edited	Gholamreza Salehi Jouzani et al.
8.	Industrial Biotechnology: Products and Processes	Christoph Wittmann and James C. Liao
9.	Geomicrobiology	Henry Lutz Ehrlich et al.
10.	Environmental Microbiology: From Genomes to Biogeochemistry	Eugene L. Madsen
11.	Bioremediation: Principles and Applications	Ronald L. Crawford et al.
12.	Environmental Biotechnology: Principles and Applications	Bruce E. Rittmann
13.	Marine Biotechnology I and II	Yves Le Gal et al

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<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=0Xvq9yUM2ILDrJ07FvlArQ==>

- Paper-15 Module-13 Role of microbes and plants in remediation - Phytoremediation
- Paper-15 Module-30 Biogas Production from Biomass and Its Applications
- Paper-15 Module-37 Bioremediation: Processes and Techniques
- Paper-15 Module-40 Bioremediation of heavy metals
- Paper-05 Module-10 Biofuel-gaseous biofuel (Biogas); Biohydrogen and biomethane
- Paper-15 Module-17 Microbial biohydrogen production
- Paper-15 Module-29 Biomineralization

BT 504 E1: Animal Tissue Culture and Pharmaceutical Biotechnology

COURSE CODE: BT 504 E1

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 This course infers the knowledge on ethical use of eukaryotic animal cell lines for therapeutic used.

CO2 The knowledge on economic management for fermentation industry is imparted.

CO3 In-depth knowledge on intellectual property rights for microbiological and biotechnological interventions is imparted.

CO4 Wisdom on Regulatory affairs, Biosafety and bioethics is inculcated.

Unit 1: Bio-entrepreneurship

- Introduction and Significance of the Bio-Entrepreneur
- Skill sets in Science-Business
- Forms of business organizations & Source of funds, investments
- The Biotechnology Sector, Start-up ecosystem and BT policy of Gujarat (2022-2027)

Unit 2: Intellectual Property rights

- Types of IPR
- Patent types and process, Inclusions, and exclusions in various IPRs Overview on Rules and sections of Indian Patent act 1970
- Benefits, problems, and management of IPR
- National and International harmonization of patent law
- Patents of biotechnological process and their protection
- Case Study of Diamond v. Chakrabarty on patenting engineered microbes

Unit 3: Regulatory affairs

- Introduction to pharmacopoeia, good microbiological techniques and good laboratory practice (GLP)
- Basic principles of quality control (QA) and quality assurance (QC)
- Guidelines for QA and QC: raw materials, sterilization, media, stock cultures and products
- Validation study and toxicity testing
- Role of culture collection centre, public health laboratories and regulatory agencies

Unit 4: Biosafety and bioethics

- Biosafety guidelines
- Risk and risk assessment
- Biosafety levels, laboratory biosecurity concepts
- Introduction to drug design
- Pre-clinical and clinical trials
- Basics of bioethics principles, international codes and guidelines in India Ethics in post-genomic era

REFERENCE

No.	Name	Author
1.	Animal Cell Culture: A Practical Approach	John Mastersv
2.	Animal Cell Culture and Technology	Michael Butler
3.	Introduction to Pharmaceutical Biotechnology, Volume 1-4	Saurabh Bhatia et al.
4.	Pharmaceutical Biotechnology: Fundamentals and Applications, Fifth Edition	Daan J.A. Crommelin et al.
5.	Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies	Craig Shimasaki
6.	Bioentrepreneurship and Transferring Technology Into Product Development	Swati Agarwal et al
7.	Intellectual Property Rights: Legal and Economic Challenges for Development	Mario Cimoli et al

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Unit 1: Bio-entrepreneurship

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- Paper-03 Module-01 Understanding Business and Entrepreneur
- Paper-03 Module-06 BUSINESS ECOSYSTEM: DIFFERENT FORMS OF ECOSYSTEMS

Unit 2: Intellectual Property rights

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>
- Paper-05 Module-36 Intellectual Properties
- Paper-05 Module-37 Implication of IPRS on commercialization of biotechnology products
- Paper-05 Module-38 Copyrights, Trademarks, Trade secrets, Patents, Geographical Indications

Unit 3: Regulatory affairs

- Paper-05 Module-25 General principles for the laboratory and biosafety

Unit 4: Biosafety and bioethics

- Paper-05 Module-26 National Biosafety Policies and Regulatory Framework
- Paper-05 Module-28 Biosafety and risk assessment issues and Risk management issues
- Paper-09 Module-39 Animal cell culture, Tissue culture, Biosafety level, Different level of Biosafety, Good Laboratory Practice
- Paper-09 Module-40 Ethical Issues in Animal Cell Culture
- Paper-10 Module-02 Biosafety and Biocontainment I
- Paper-10 Module-03 Biosafety and Biocontainment I

BT 504 E2: Recombinant DNA Technology

COURSE CODE: BT 504 E2

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

C01 Genetic manipulation of microbes for biotechnological innovations is conveyed with their use under ethical wisdom.

C02 Techniques used for genetic manipulation in microbes are taught.

C03 Tools to identify and analyze genes for their mapping are explained to students.

Unit 1: Fundamentals of rDNA Technology

- Core techniques and essential enzymes used in rDNA.
- Restriction digestion, ligation and transformation.

Unit 2: Cloning strategies-1

- Cloning vectors-plasmids, phages and cosmids.
- Cloning strategies. Cloning and selection individual genes, gene libraries: cDNA and genomic libraries.

Unit 3: Cloning strategies-2

- Specialised cloning stratifies. Expression vectors, Promoter probe vectors,
- vectors for library construction-artificial chromosomes.

Unit 4: Methods and Techniques in rDNA Technology

- PCR methods and application.
- DNA sequencing methods; dideoxy and chemical method.
- Sequence assembly. Automated sequencing. Genome sequencing and physical mapping of genes.

REFERENCE

No.	Name	Author
1.	Gene Cloning And DNA Analysis: An Introduction, Seventh Edition	T A Brown
2.	Principles Of Gene Manipulation And Genomics, Eighth Edition	Sandy B Primrose et al.
3.	Recombinant Gene Expression: Reviews And Protocols	Paulina Balbas et al.
4.	Recombinant DNA: Genes and Genomes - A Short Course	James D Watson et al.
5.	Molecular Biotechnology: Principles and Applications of Recombinant DNA	Bernard J Glick et al.
6.	Basic Concept of Recombinant DNA Technology	Somnath De
7.	Recombinant Dna Technology and Genetic Engineering	Rajagopal K

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<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-04 Module-02 DNA modifying enzyme (Nomenclature, Type I-IV)
- Paper-04 Module-03 Restriction Endonucleases, Isoschizomers
- Paper-04 Module-04 Classification of Restriction enzymes
- Paper-04 Module-05 DNA Topoisomerases Paper-04 Module-06 DNA Methyltransferases
- Paper-04 Module-07 DNA polymerases
- Paper-04 Module-011 Polymerase Chain Reaction (PCR)
- Paper-04 Module-15 Generalized cloning schemes and strategies
- Paper-04 Module-19 Insertion vectors, replacement vectors, cosmids, phasmids
- Paper-04 Module-32 Sanger's Di-deoxy Chain termination method (Use of M13 based ssDNA vectors to cycle sequencing)
- Paper-12 Module-24 Cloning Strategies

BT 504 E3: Biopharmaceuticals and Drug Development

COURSE CODE: BT 504 E3

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Therapeutic signaling factors and their industrial production is explained.

CO2 Strategies for development of vaccines and their improvement is conveyed to combat novel challenges is addressed.

CO3 Sensitization to pharmacopeia and ethical manufacturing practices are inculcated.

CO4 Approaches of Rational drug design with special emphasis on clinical trial is discussed at length.

Unit 1: Basics of Biopharmaceuticals

- Introduction to pharmaceuticals of animal, plant and microbial origin
- Hemotopietic growth factors and coagulation factors
- Interferons and cytokines for anti-infective and cancer therapy
- Insulin and growth hormones
- Vaccine: genetically improved vaccines, synthetic peptide based and nucleic acid vaccines

Unit 2: Products and therapies based on Biopharmaceuticals

- Recombinant thrombolytic agents: tissue type plasminogen activator, first and second generation of thrombolytic agents
- Concept and approaches for gene therapy, ex vivo and in vivo gene therapy
- Potential target diseases for gene therapy (inherited disorders and cancer)
- Antigene and antisense therapy

Unit 3: Xenotransplantation, Forensic Sciences and Toxicity Estimation

- Xenotransplantation in pharmaceutical biotechnology
- The role of biotechnology in forensic sciences
- Estimation of toxicity: LD50 and ED50
- Pre-clinical and clinical trails

Unit 4: Pharmaceutical Quality Assurance

- Introduction to pharmacopoeia, guide to good manufacturing practice
- Manufacturing facility
- Final product fills and analysis
- Validation study

REFERENCE

No.	Name	Author
1.	Biopharmaceutical Drug Design and Development	Susanna Wu-Pong et al.
2.	Development of Biopharmaceutical Drug-Device Products	Feroz Jameel et al
3.	Biopharmaceutics and Pharmacokinetics Considerations	Rakesh K. Tekade et al.

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<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=WR+tSjp4YS3g7BIFEffOcw==>

- Paper-06 Module-16 Good Manufacturing Practice

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

- Paper-10 Module-07 Fundamentals of Gene therapy
- Paper-10 Module-16 Cytokine therapy
- Paper-10 Module-19 Biotherapy of cancer
- Paper-10 Module-28 Recombinant Protein therapeutics
- Paper-10 Module-34 Vaccines and vaccinology-1
- Paper-10 Module-35 Vaccines and vaccinology-2

BT 505: Practicals

COURSE CODE: BT 505

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Use of microbes in Bioremediation of pollutants in practically learnt.

CO2 Skills in the domain of microbial assessment of water, soil and environment is implicated.

CO3 Developing acumen in Microbial assessment for the quality of fermented food.

1. Bioremediation of inorganic pollutants and phytoremediation of metals
2. Characterization of waste water:
 - a. Physical: odour, colour, turbidity, temperature, salinity
 - b. Chemical: acidity, alkalinity, sulphate, copper
3. Analysis of drinking water by MTT and MFT
 - a. Biological characterization: BOD & COD
4. Estimation of phosphatase activity of soil: acid and alkaline
5. Use of ex-plant to regenerate plant using Plant tissue culture
6. Propagation of tissue cultured plants
7. Initiation of callus and development
8. Isolation of bioactive compounds from callus
9. Initiation and development of haploid plants
10. Identification of bioactive compounds from plant extracts

BT 506: Practicals

COURSE CODE: BT 506

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Practical learning on environmental assessment for contamination of toxic metals and dyes with its biodegradation.

CO2 Skills are inculcated to develop bio fertilizers.

CO3 Environmental rehabilitating using microbes in inculcated.

1. Bio-oxidation and determination of oxidation rate: Fe, Cu, S
2. Bioleaching of Cu from sulphidic ore
3. Biocatalyst from marine microbes
4. Microbial load determination
5. Decolourization of dye
6. Biodeterioration of lignocellulosic waste and pharmaceutical products:
 - a. Determination of microbial load
 - b. Characterization of biodeteriorating microorganisms
7. Isolation of Plant growth promoting bacteria (PGPR)
 - a. Nitrogen fixers
 - b. IAA producers
 - c. Phytohormone (IAA and Gibberellic Acid) procedures
8. Antioxidant activity of pigment

SEMESTER 4

BT 507: Project / Dissertation Work theory

COURSE CODE: BT 507 PT

NO. OF CREDITS: 16

COURSE OUTCOMES (COs)

CO1 Enables the student to develop aptitude to carry out research independently.

CO2 Acquire skills to plan and execute experiments individually as well as in groups.

CO3 The student imbibes necessary skills to represent scientific data in form of scientific report.

CO4 The course intends to inculcate individual research methodology skill sets.

- The candidate is required to show article to faculty in/before interpreting his/her experimental work.
- Two typed/computerised bound copies of the dissertation shall be submitted to the University during the final M.Sc. at least fifteen days before the commencement of the final examination.
 - Thesis experimental work: conducting and reporting experiments in labs or other settings with quality, safety and ethics considerations
 - Thesis evaluation: assessing and comparing experimental work with existing literature and suggesting future research directions.
 - Presentation and viva-voce: presenting and defending dissertation to examiners who test research skills and knowledge.
- Students have to provide Project Proposal: A project proposal is a document that outlines the objectives, methods, expected outcomes of selected dissertation topic.
- Students have to give a seminar on Classical Research Paper Presentation: A research paper presentation-seminar is an oral presentation of a research paper to an audience of peers and experts. It is usually accompanied by slides or other visual aids and followed by a question-and-answer session. The purpose of a research paper presentation-seminar is to share the findings to demonstrate their concept understanding of the topic.
- Student has to either choose to study Concepts in Research Methodology or undergo Industrial Training of seven (07) days and submit a report.
 - Concepts in research methodology are the principles and techniques that guide the design and conduct of a research project. They include topics such as research paradigms, research questions, literature review, data collection methods, data analysis methods and ethical issues.
 - Industrial training with report is a practical learning experience in an industry-related setting that requires students to write a report on their activities, achievements and challenges. The purpose of industrial training with report is to expose students to real-world problems and solutions in their field of study and enhance their professional skills.

- **Students opting to study Concepts in Research Methodology must learn the following:**
 - Searching interest of research, Defining the research question, Approaches and Methodology, objectives, significance and techniques of research
 - Introduction to kinds of scientific documents: research paper, review paper, book reviews, theses, and project reports (for the scientific community and for funding agencies).
 - Ethics in research: Honesty and integrity, Misconducts: Falsification, fabrication, plagiarism. Best/ standard practices of research.
 - Redundant publication: duplication and overlapping of publications, selective reporting and misinterpretation of data. Conflict of interest, Violation of publication ethics: authorship and contributorship.
 - Introduction to spreadsheet applications, features
 - Generating charts / graph and other features, Tools – Microsoft Excel or similar.
 - Using formulae and functions, Data storage, Standard deviation, standard error
 - Web Search: Use of Publication search engines and libraries (PubMed, PubMed central, CrossRef, Google scholar).
 - Use of automated referencing softwares (Mendley, Zotero, EndNote, etc.)
 - Presentation tools: Introduction, features and functions, slide presentation
 - Key aspects of research presentations

BT 508: Conference report writing and Study tour

COURSE CODE: BT 508

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Students will be able to learn Conference report writing by collecting, evaluating information on that elaborates on a scientific topic using facts, charts, and graphs to support its arguments and findings.

CO2 Study tours will let student to reflect the educational value of a trip, including any objectives the student might have and unexpected learning experiences.

CO3 Students will learn to highlight the impact of the trip on the student's chosen discipline, and will serve to develop inspiration.

- Students have to (i) attend conference and write a report on it and (ii) participate in study tour and provide its report
- Conference report writing:
 - A summary of the main themes, topics and outcomes of a conference attended by the writer
 - A critical reflection on the relevance, quality and impact of the conference for the writer's research or professional development

- Study tour:
 - A visit to a place or an institution related to the field of study or interest of the participants
 - An opportunity to observe, learn and interact with experts, practitioners and peers in a different cultural and academic context

BT 509: Review Paper Presentation and assignments

COURSE CODE: BT 509

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

CO1 Enables the student to present a scientific topic of subject relevance thereby developing oral presentation and oratory skills.

CO2 The students are familiarized to the opportunities that lie in the commercial avenues pertaining to microbiology & biotechnology.

CO3 Sensitize students with the standard operational procedures employed in the industrial setup.

Students have to give a Presentation on Review Paper and submit two assignments of which one should be on Instrument or Technique, while the other assignment should be on either of Process or Product or Technology.

- Presentation on Review Paper:
 - A critical analysis and synthesis of the literature on a specific topic or research question.
 - A demonstration of the current state of knowledge, gaps and controversies in the field.
 - A communication of the main findings, implications and recommendations for future research.
- Assignment-1 on Instrument or Technique:
 - A description and evaluation of a tool or a method used for data collection or analysis in research project.
 - A comparison and contrast of the advantages and disadvantages of different instruments or techniques for a given purpose.
 - An application and demonstration of an instrument or a technique to a relevant research problem or question.
- Assignment-2 on Process or Product or Technology:
 - A description and explanation of a sequence of actions, an outcome or an innovation related to the field of study or interest.
 - A discussion and assessment of the benefits, challenges and impacts of the process, product or technology for society, environment and economy.

An identification and suggestion of potential improvements, alternatives or extensions for the process, product or technology.