Gujarat University, Ahmedabad 380 009, Gujarat, India.
M.Sc. BIOTECHNOLOGY SYLLABUS
From June 2022

- There shall be four theory papers each of four hours (3+1) duration and two practicals each of eight hours' duration.

- Each theory paper shall carry hundred marks and each practical shall carry hundred marks.

- 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.

- Each theory paper is divided into four units. Each unit will have equal weightage while setting question paper. Question or its sub question including the options will be set from the same unit.

- There shall be one microbiological study tour / field work during fourth or any semester of P.G. study. It will pertain to different microbiological / environmental industries / research institute / various ecosystems even outside Gujarat State. The microbiological tour is highly essential for studying microbiological process and technology.

- Assignments and group discussions / industrial training accomplished with the bound copy of report are necessary for evaluation.

- At-least two seminars should be delivered during fourth semester.

- Practical batch will be consisting of maximum 10 students.

- Student can select any one paper from the three elective papers given in semester III.

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	Practi-cals	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-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 5th 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 3rd 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=MNhNzp1RQlU+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)

- **CO1** Conveying vital concepts of molecular biology and modes of gene exchange in prokaryotes.

- **CO2** Conveying the information on fungal and bacteriophage genetics.

- **CO3** Discussing the extensive concepts of molecular biology and genetic engineering.

- **CO4** 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 3rd 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+vtlwaZoj+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)

- **CO1** 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.

- **CO2** Imparting the in-depth knowledge of microbial growth and physiology.

- **CO3** Understanding the interplay of various components on Immune system during infection.

- **CO4** 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 5th 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 3rd 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=MNhNzp1RQlU+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 Km, Vmax 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)

- **CO1** Familiarizing students with industrially important microbes.
- **CO2** Imbibing the concepts of bioprocesses involving microbes at an industrial scale.
- **CO3** Biotechnological roles of microbes in dairy and food industry is imparted.
- **CO4** 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, 2nd 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)

- **CO1** Genetic manipulation in microbes is conveyed with their use under ethical wisdom.
- **CO2** various components and techniques used for genetic manipulation in microbes are taught.
- **CO3** 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	Gloover & 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=MNhNzp1RQlU+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, Transcraptomic

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 3rd Edition	Jeremy Ramsden
4.	Bioinformatics and Functional Genomics 3rd 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=MNhNzp1RQlU+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)

- **CO1** In-depth knowledge on the development of microbially derived products such as antibiotics, organic acids, therapeutic agents, enzymes, vitamins.

- **CO2** Role of microbes at industrial scale for developing beverages food and are taught to the students with special emphasis on entrepreneurship.

- **CO3** 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 (B_2)
- 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)

- **CO1** Use of computational tools in retrieving and analyzing biological data from the domains of genomics and proteomics is learnt by students.

- **CO2** 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)

- **CO1** Skills that are essential for industrial production microbial production of food, beverages, enzymes are learnt and imparted.

- **CO2** Various industrial microbial products like enzymes, alcohol, antibiotics, organic acids are produced by students during this course.

- **CO3** 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