



Gujarat University, Ahmedabad 380 009, Gujarat, India.

M.Sc. MICROBIOLOGY 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 microbiology focuses in-depth the study of microorganisms by imparting classical and modern knowledge and skillsets to the students which makes them competent to thrive in research and industries pertaining to pharmaceuticals, bioprocess technology, environmental protection, in the domains of intellectual property rights and bioethics.

- **PO1** Imparting theoretical and experimental skills in microbiology.
- **PO2** Enabling young minds to grasp effective communicational skills in the domain of microbiology with scientific writing and communication.
- **PO3** This programme, with dissertation projects, imparts competent skills to thrive in research institutions and industries.
- **PO4** Sensitizes students to pursue scientific advancements in microbiology while embracing ethics and environmental safety.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

- **PSO1** The knowledge of microbes including prokaryotes, eukaryotes and archaea is provided in depth with their diversity, health benefits and hazards with their industrial and environmental use.
- **PSO2** The programme emphasizes for development of potential recombinant microorganisms under ethical guidelines to produce industrial products at commercial level.
- **PSO3** Significant portion of this programme is dedicated to food, agriculture and environmental microbiology along with focus on monitoring control of various products and process in synchrony with the guidelines of government, international norms and of control agencies.
- **PSO4** In depth knowledge and skillsets are addressed with respect to bioethics, environmental safety, biosafety and intellectual property rights in the domain of microbial technology.
- **PSO5** The programme also involves activities for all round development of students and to develop an urge of research dissertation work with interactive seminars, assignments, group discussions along with ethical and biosafety training.

M.Sc. MICROBIOLOGY SYLLABUS
SEMESTER 1 & 2

Paper no.	Title	No. of Hours per Week				Course Credits
		Lecture	Others	Practicals	Total	
Semester 1						
MIC 401	Diversity of Prokaryotic and Eukaryotic Microorganisms	3	1	-	4	4
MIC 402	Microbial Biochemistry and Enzymology	3	1	-	4	4
MIC 403	Microbial Genetics and Biostatistics	3	1	-	4	4
MIC 404 E	Microbial Physiology and Immunology	3	1	-	4	4
MIC 405 PR	Lab 1	-	-	12	12	4
MIC 406 PR	Lab 2	-	-	12	12	4
Total		12	4	24	40	24
Semester 2						
MIC 407	Fermentation technology	3	1	-	4	4
MIC 408	Gene regulation and recombinant DNA technology	3	1	-	4	4
MIC 409	Techniques in synthetic microbiology and Bioinformatics	3	1	-	4	4
MIC 410 E	Advances in Microbial Technology	3	1	-	4	4
MIC 11 PR	Lab 3	-	-	12	12	4
MIC 412 PR	Lab4	-	-	12	12	4
Total		12	4	24	40	24

SEMESTER 1

MIC 401: Diversity of Prokaryotic and Eukaryotic Microorganisms

COURSE CODE: MIC 401

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

- **CO1** Imparting knowledge of microbial diversity including important microbes impacting health, environment and industries.
- **CO2** Identifying importance of microbial diversity and Bacterial systematics.
- **CO3** Understanding and distinguishing various genera of Yeasts, molds and extremophiles.
- **CO4** Knowing the Ecological importance and economic uses of microbes as a whole.

Unit 1: Principles of microbial diversity

- History of microbial diversity, concepts of the tree of life
- Principles of Microbial Diversity and taxonomy: Morphological, Biochemical, Chemical and Numerical
- Methods of studying microbial diversity: Classical and Molecular approaches, Microbial phylogeny
- Concept of Metagenomics and methods of assessment non-cultivable microbial diversity

Unit 2: Bacterial Systematics

- Green phototrophic bacteria/cyanobacteria,
- Proteobacteria: α , β , γ , δ , ϵ
- Gram-positive bacteria, High G+C bacteria, actinomycetes, Spirochetes & Bacteroids, Deinococci, Chlamydiae, Planctomycetes
- Bacterial phyla and non-cultivable species

Unit 3: Diversity of yeast and molds

- Structure, Reproduction, classification of molds and yeast, life cycle of important examples
- Fungal cell factories: pharmaceuticals and enzymes
- Fungal diseases in plants and animals
- Mycotoxins and their significance
- Environmental Importance of Fungal associations: Mycorrhizal fungi and lichens

Unit 4: Diversity of Archaea

- Systematics occurrence, diversity, and classification of archaea
- Characteristics features of different groups of archaea
- Alkaliphiles: alkaline environments, genera of alkali-tolerant and alkaliphilic microorganisms, homeostasis of the pH, adaptation mechanisms, biotechnological applications
- Acidophiles: diversity of acidic environments, phylogenetic relationship, energy metabolism, cellular and molecular adaptation mechanisms, biotechnological applications
- Thermophiles: distribution, physiological, biochemical, and molecular adaptations to life at high temperature, biotechnological applications
- Halophiles: occurrence and ecosystem, cell architecture, biochemical and molecular strategies to life at high salinity, biotechnological applications

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>

MIC 402: Microbial Biochemistry and Enzymology

COURSE CODE: MIC 402

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

- **CO1** Conveying understanding of biomolecules, microbial metabolism and enzymes.
- **CO2** Identifying biological importance of biomolecules-carbohydrates, lipids, proteins and enzymes.
- **CO3** Appreciating the knowledge of biological metabolism of carbohydrates, lipids, amino acids and nucleotides.
- **CO4** Imparting the knowledge on working of enzyme 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>
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- 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

MIC 403: Microbial Genetics and Biostatistics

COURSE CODE: MIC 403

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

- **CO1** Classical concepts of molecular biology and microbial genetics is imparted along with emphasis on modern advancements.
- **CO2** Promulgating the information on Fungal and bacteriophage genetics.
- **CO3** Implementing the learning on in-age concepts of on molecular biology and genetic engineering.
- **CO4** Familiarizing the concept of biological data management and its analysis using statistics.

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 biometrics 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

MIC 404: Microbial Physiology and Immunology

COURSE CODE: MIC 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 in 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 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

MIC 405: Practicals

COURSE CODE: MIC 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** Acquiring skills in isolating and cultivation of various microbes.
 - **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.
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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

MIC 406: Practicals

COURSE CODE: MIC 406

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

- **CO1** Acquiring expertise in experimentation pertaining to microbial physiology, 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
MIC 407: Fermentation technology

COURSE CODE: MIC 407

NO. OF CREDITS: 04

COURSE OUTCOMES (COs)

- **CO1** Defining basic principles of fermentation technology.
- **CO2** Use of microbes in industry of fermentation, pharmaceutical, food and environment are inculcated to the students in depth.
- **CO3** Processes in the fermentation industries are explained in depth.
- **CO4** Economics and ethics of environmental safety is explained in length to students.

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

MIC 408: Gene regulation and Recombinant DNA technology

COURSE CODE: MIC 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	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

MIC 409: Techniques in synthetic microbiology and Bioinformatics

COURSE CODE: MIC 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, Transcriptomics

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

MIC 410: Advances in Microbial Technology

COURSE CODE: MIC 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** In-age knowledge pertaining for the use of microbes in developing chemicals alternatives of glues, gums and plastics is imparted.

Unit 1: Microbial fermentative products

- Organic Acid : Citric Acid, Acetic acid
- Organic Solvent : Acetone-butanol
- Beverage: Beer
- Enzyme : Protease
- Polysaccharide : Xanthan gum
- Biosurfactants
- Biopolymer : Polyhydroxyalkanoates (PHA)

Unit 2: Production of Therapeutic agents

- Antibiotic: Streptomycin
- Amino acid: Glutamic acid
- Vitamin: Riboflavin (B₂)
- Anticancer agents
- Vaccines
- Monoclonal antibodies: Hybridoma technology

Unit 3: Dairy Microbiology

- Fermented foods and their microbiology
- Starter cultures, significance, and production
- Steps in Cheese production
- Evaluation and role of Probiotics
- Nutraceuticals

Unit 4: Biomass production and applications

- Fungal biomass- baker's yeast and single cell oil
- Mushroom cultivation
- Use of Algal biomass.

- Microbial production for food and feed
- Carotenoid pigments- B carotene, lycopene

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-20 Production of fatty acids and amino acids

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

Paper-11 Module-01 & 02 Nutraceuticals

MIC 411: Practical

COURSE CODE: MIC 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

MIC 412: Practical

COURSE CODE: MIC 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