Department of Microbial Biotechnology (DMBT)

Panjab University
Chandigarh


M.Sc. Microbial Biotechnology

## M.Sc. 1st year (1st Semester)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course/Paper</th>
<th>Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Course No.</td>
<td>Theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marks</td>
<td>Practical</td>
</tr>
<tr>
<td>1.</td>
<td>Microbial Biodiversity and Physiology</td>
<td>MBT-101T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-101 P</td>
</tr>
<tr>
<td>2.</td>
<td>Immunology and Immunotechnology</td>
<td>MBT-102T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-102 P</td>
</tr>
<tr>
<td>3.</td>
<td>Genetics and Recombinant DNA Technology</td>
<td>MBT-103 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-103 P</td>
</tr>
<tr>
<td>4.</td>
<td>Microbial Biochemistry and Enzymology</td>
<td>MBT-104 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-104 P</td>
</tr>
<tr>
<td>5.</td>
<td>Bioprocess Engineering</td>
<td>MBT-105 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-105 P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credits= **20**

Total Marks = **500**

## M.Sc. 1st year (2nd Semester)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course/Paper</th>
<th>Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Course No.</td>
<td>Theory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Marks</td>
<td>Practical</td>
</tr>
<tr>
<td>1.</td>
<td>Medical Microbiology</td>
<td>MBT-201 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-201 P</td>
</tr>
<tr>
<td>2.</td>
<td>Molecular Biology</td>
<td>MBT-202 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-202 P</td>
</tr>
<tr>
<td>3.</td>
<td>Industrial Microbiology-1 (Health, Food, Enzymes)</td>
<td>MBT-203 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-203 P</td>
</tr>
<tr>
<td>4.</td>
<td>Bioinformatics &amp; Biostatistics</td>
<td>MBT-204 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-204 P</td>
</tr>
<tr>
<td>5.</td>
<td>Intellectual Property Rights (IPR), Bioethics &amp; Entrepreneurship</td>
<td>MBT-205 T</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MBT-205 P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Total Credits= **20**

Total Marks = **500**
### M.Sc. 2nd year (3rd Semester)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Course/Paper</th>
<th>Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Theory</strong></td>
<td><strong>Practical</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Course No.</td>
<td>Marks</td>
</tr>
<tr>
<td>1.</td>
<td>Advances in Microbial Biotechnology (Genomics, Proteomics, Metabolomics)</td>
<td>MBT-301 T</td>
<td>75</td>
</tr>
<tr>
<td>2.</td>
<td>Industrial Microbiology-II (Environment, Biofuels, Chemicals, Biomass, Protocols)</td>
<td>MBT-302 T</td>
<td>75</td>
</tr>
<tr>
<td>3.</td>
<td>Bioinstruments and their Applications</td>
<td>MBT-303 T</td>
<td>75</td>
</tr>
<tr>
<td>4.</td>
<td>Microbial Identification, Diagnostics &amp; Nanobiotechnology</td>
<td>MBT-304 T</td>
<td>75</td>
</tr>
<tr>
<td>5.</td>
<td>Tutorials</td>
<td>MBT-305 T</td>
<td>75</td>
</tr>
</tbody>
</table>

Total Credits= 20  
Total Marks = 500

### M.Sc. 2nd year (4th Semester)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course/Paper</th>
<th>Code</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Theory</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Course No.</td>
<td>Marks</td>
</tr>
<tr>
<td>1.</td>
<td>Seminar &amp; Journal Club</td>
<td>MBT-401 T</td>
<td>100</td>
</tr>
<tr>
<td>2.</td>
<td>Dissertation and Viva</td>
<td>MBT-402 T</td>
<td>300+100</td>
</tr>
</tbody>
</table>

Total Credits= 20  
Total Marks = 500

### Consolidation of Marks and Credits

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Class</th>
<th>Total Marks</th>
<th>Total No. of Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>M.Sc. 1st Yr</td>
<td>1000</td>
<td>40</td>
</tr>
<tr>
<td>2.</td>
<td>M.Sc. 2nd Yr</td>
<td>1000</td>
<td>40</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>2000</td>
<td>80</td>
</tr>
</tbody>
</table>
Department of Microbial Biotechnology (DMBT)

Syllabus
for
M.Sc. MICROBIAL BIOTECHNOLOGY

Semester I

1. MBT-101: Microbial Biodiversity and Physiology
2. MBT-102: Immunology and Immunotechnology
3. MBT-103: Genetics and Recombinant DNA Technology
4. MBT-104: Microbial Biochemistry and Enzymology
5. MBT-105: Bioprocess Engineering

Semester II

1. MBT-201: Medical Microbiology
2. MBT-202: Molecular Biology
3. MBT-203: Industrial Microbiology-1 (Health, Food, Enzymes)
4. MBT-204: Bioinformatics and Biostatistics
5. MBT-205: Intellectual Property Rights (IPR) Bioethics & Entrepreneurship

Semester III

1. MBT-301: Advances in Microbial Biotechnology (Genomics, Proteomics, Metabolomics)
2. MBT-302: Industrial Microbiology-II (Environment, Biofuels, Chemicals, Biomass, Protocols)
3. MBT-303: Bioinstruments and their Applications
4. MBT-304: Microbial Identification, Diagnostics & Nanobiotechnology
5. MBT-305: Tutorials

Semester IV

1. MBT-401: Seminar and Journal Club
2. MBT-402: Dissertation and Viva
Objective: To expose the students to (i) the diversity of microbes, (ii) growth & nutrient requirements (iii) unique metabolic pathways.

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit -I
1. Relevance of microbiology as a field of Biotechnology.
2. Historical milestones in Microbiology and Biotechnology
4. Control of microbes by the use of physical and chemical agents.
5. Basic principles of evolution
6. Principles of protein stability

Unit – II
7. Biodiversity of
   (a) Archaea
   (b) Bacteria
   (c) Fungi
   (d) Algae
   (e) Viruses
   (f) Extremophiles

Unit – III
8. Nutritional requirements of microbes
11. Mechanisms involved in transport of nutrients in microbes
12. Microbial interactions

Unit - IV
13. Brief introduction to common metabolic pathways.
14. Unique pathways of microbial metabolism: ED, PK pathways; Respiration; Fermentations; Amphibolic pathways; Anaplerotic reactions.
15. Bacterial cell wall biosynthesis
16. Integration of biochemical processes in the context of cells, tissues, and whole organisms
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical -20)

1. Use of basic instruments in Microbiology (Light microscope, pH meter, Autoclave, Laminar flow chamber, Centrifuge, Spectrophotometer).
2. Staining of bacteria, yeast and fungi.
3. Purification of mixed cultures by streaking technique
4. Determination of viable count
5. Correlation of viable counting and optical density of cultures
6. Isolation of microbes from environment
7. Bacteriophage screening
8. Preparation of complex and synthetic medium.
9. Sterilization of liquid and solid items.
10. Storage of microbes

Suggested readings:

Objective: To introduce the students to (i) the basics of immune system (ii) the response of humans to foreign bodies (iii) the techniques involved in immunoassays (iv) vaccines

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit-I
1. Overview of the human immune response: adaptive and innate immunity; immune cells and immune organs
2. B cell biology: Development, selection, B cells as central players of humoral immunity
3. T cell biology: Development, thymic education, TCR rearrangement, basic functions of cells during immune response, T cells subsets
4. Immunoglobulins: Structure and functions of Immunoglobulins, Immunoglobulin rearrangement, molecular genetics of BCR generation
5. Antigens, haptens and adjuvants

Unit-II
6. Major Histocompatibility Complex (MHC): Structure, function and immunogenetics of MHC, MHC-TCR interactions, cell biology of antigen processing and presentation
7. Chemokine, cytokine and cell signaling: Their roles in activation and differentiation of cells of immune system, importance in response to pathogens
8. Immunological tolerance and autoimmunity
9. Hypersensitivity-mediated diseases

Unit-III
10. Antigen-antibody reactions, interaction, cross reactions, precipitation and agglutination
11. Radioimmunoassay, ELISA, Western blotting
12. Hybridomas and Monoclonal antibodies
13. Recent advances in immunological tools for diagnosis of diseases

Unit-IV
14. Immune response to infectious diseases: Responses to different classes of pathogens such as intracellular bacteria, viruses and extracellular and intracellular parasites
15. Vaccines and their types: killed and live, sub unit, recombinant, multivalent, DNA, edible vaccines
17. Antibodies as immunotherapeutics
18. Cytokine therapy
Practicals:

Total Marks: 25

Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Total Leukocyte Count (TLC) and Differential Leukocyte count (DLC) of blood samples
2. Isolation of peripheral blood mononuclear cells from blood samples
3. Determination of cell viability
4. Immunoassays
5. Animal handling
6. Routes of immunization
7. Drawing blood from animals

Suggested readings:

Objective: To expose the students to (i) genetics of microbes (ii) permanent changes in the genetic material (iii) techniques involved in the cloning of genetic elements

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit-I
1. Mendelian principles, concept of allele, multiple alleles, pseudoallele, co-dominance, incomplete dominance, gene interaction, pleiotropy, linkage, crossing over, sex-linked, sex-limited and sex-influenced characters.
2. Significance of genetic recombination
3. Homologous genetic recombination (Transformation, Transduction, Conjugation) and heterologous genetic recombination (IS, Tn, Mu phage)
4. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids

Unit - II
5. Mutations: Fluctuation test, Replica plating, Mutagenicity testing
6. Physical and chemical mutagens
7. Types of mutations
8. DNA Repair mechanisms

Unit – III
9. Host restriction/modification systems, Enzymes involved in gene cloning
10. Natural Plasmids and their types, Role of plasmids in transfer of genes
11. Plasmids as gene cloning vectors, Commercial vectors
12. Strategies involved in cloning of gene(s)
13. Construction of genomic, cDNA and meta-genomic libraries

Unit – IV
14. DNA sequencing
15. PCR and its applications and modifications
16. Phage display technology and its applications.
17. Yeast two-hybrid system and variants; Combinatorial library generation and use
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Isolation of chromosomal DNA
2. Isolation of plasmid
3. Preparation of competent cells
4. Transformation and Electroporation
5. Restriction digestion (complete and partial) of DNA
6. Cloning and expression of a gene in E.coli
7. Amplification of DNA by PCR

Suggested readings:

MBT-104: Microbial Biochemistry and Enzymology

Total Marks: 75 (Exam-60 + Int. Asses.-15)

**Objective:** To expose the students to (i) macromolecular interactions (ii) structure and functions of biomolecules (iii) enzymes: their functions, regulation and industrial applications

**Exam Pattern:** Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

**Unit - I**
1. Buffers and physiological buffers.
2. Thermodynamics and Principles of thermodynamics, free energy, enthalpy and entropy.
3. Macromolecular interactions: van-der waal’s, hydrogen bonding, ionic, hydrophobic, covalent etc.
4. Structure and functions of Carbohydrates, Proteins, Lipids, Nucleotides(DNA, RNA) and Vitamins.
5. Conformation of proteins (secondary, tertiary and quaternary structure; domains; motifs and folds; Ramachandran plot).

**Unit – II**
6. Metabolism of Carbohydrates (Glycolysis, TCA, HMP, Gluconeogenesis).
7. Metabolism of Lipids (Fatty acid metabolism, Phospholipid metabolism, Cholesterol biosynthesis).

**Unit – III**
8. Metabolism of protein (Digestion of proteins, General reactions of amino acids, Fate of carbon skeletons of amino acids, Regulation of amino acid biosynthesis).

**Unit – IV**
10. Enzymes: General distinctive features, nomenclature and industrial applications.
11. Enzyme kinetics, Factors affecting enzymatic activity
12. Allosteric enzymes, Different types of inhibitors/ modulators
13. Feed back inhibition and Feedback repression mechanisms.
15. Biocatalysis: Definition, chirality, advantages/disadvantages of biocatalysis over chemical catalysis, different types of biocatalysis.
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Qualitative and quantitative assay of Sugars.
2. Qualitative and quantitative assay of Proteins.
3. Qualitative and quantitative assay of Lipids.
4. Qualitative and quantitative assay of Nucleic acids.
5. Assay of enzymes.
8. Effect of pH and temperature on enzyme activity.

Suggested readings:

Objective: To expose the students to the (i) bioreactor and its types (ii) production of bioactive molecules/cells in a bioreactor (iii) purification of bioactive molecules (iv) fermentation processes

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit – I

2. Operation of bio-reactors.

Unit – II

3. Mass and Heat Transfer in Bioreactors: Aeration and Agitation in Bioreactors, Concept of mass transfer correlation and scale up.

Unit – III

5. Down Stream Process (DSP): Cell disruptions, Flocculation, Filtration, Ultra filtration, Centrifugation, Ultracentrifugation, Chromatographic methods, two phase aqueous separations, solvent – solvent extraction, centrifugation, pre treatment, crystallization etc.
6. Characterization of protein structure and function

Unit – IV

7. Fermentations and Fermentative processes like Submerged, Solid state, Batch, Fed Batch, Continuous system etc.
8. Hygiene and safety in fermentation laboratory/processes.
Practicals

Total Marks: 25

Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Components and Operation of a Bioreactor
2. Batch fermentation in conical flask
3. Production of the enzyme/s in shake flask
4. Solid state fermentation
5. Fermentation strategies for proteins/polysaccharides
6. Purification strategies (simulation)

Suggested readings:

MBT-201: Medical Microbiology

Total Marks: 75 (Exam-60 + Int. Asses.-15)

Objective: To introduce the students to (i) Major infections in clinical settings (ii) Recent trends and topics in microbial pathogenesis (iii) Antimicrobial chemotherapy (iv) Drug resistance

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit – I
1. Human microbiome in health and disease
2. Revisiting the basic concepts of infectious diseases: host parasite relationship; molecular Koch postulates; modes of transmission; virulence and pathogenicity; pathogenesis of infectious diseases; microbial mechanisms for escaping the host defenses; measures of disease occurrence and outcome
3. Microbial toxins (exotoxins and endotoxins) and their cellular targets
4. Quorum sensing and microbial pathogenicity

Unit – II
5. *Staphylococcus* species as a pathogenetic enigma
6. Molecular pathogenesis of infections caused by intracellular bacteria, with an emphasis of *Salmonella*, *Shigella*, *Listeria monocytogenes* and *Rickettsia*
7. Immunopathology, with an emphasis on *Mycobacterium tuberculosis*
8. Virulence mechanisms of other bacterial pathogens including streptococci, *Corynebacterium diphtheriae*, *Bordetella pertussis*, *Bacillus anthracis*, *Vibrio cholerae*, pathogenic *E. coli*, *Clostridium botulinum*, *Clostridium tetani*, *Clostridium perfringens*, *Helicobacter pylori*, *Yersinia pestis*, *Brucella abortus*, *Treponema pallidum*, *Borrelia burgdorferi*

Unit – III
9. Overview of viral pathogens, including Herpesviridae, Orthomyxoviridae, Paramyxoviridae, Flaviviridae, Hepatitis viruses, Rabies virus, Rhinovirus, Norwalk virus, Papilloma virus, Polio virus; Prion diseases
10. Viruses that changed the world: HIV and Ebola
11. Common fungal infections
12. Pathophysiology of malaria, amoebiasis and giardiasis

Unit – IV
13. Antimicrobial drugs and their cellular targets
14. Antimicrobial susceptibility testing in clinical laboratories
15. Mechanisms of drug resistance in microbes
16. Microbial biofilms and their clinical implications
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Culture identification of representative Gram-positive bacterial pathogens: *Staphylococcus, Streptococcus*
2. Culture identification of representative Gram-negative bacteria: *E. coli, Salmonella, Shigella, Proteus, Klebsiella, Pseudomonas*
3. Culture identification of fungal pathogens (*Candida, Aspergillus*)
4. Antimicrobial susceptibility testing of pathogenic bacteria
5. Collection, handling and storage of clinical samples

Suggested Readings:

**Objective:** To expose the students to the mechanism of (i) DNA replication (ii) DNA transcription (iii) protein synthesis (iv) regulation of gene expression (v) signal transduction

**Exam Pattern:** Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

**Unit – I**

1. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cOT and ROT curves/analysis, C-value paradox, DNA protein interaction
2. Unit of DNA replication, enzymes involved in replication, origin and replication fork, fidelity of replication.
3. Replication of bacterial chromosome, chromosome structure and organization of genes on chromosome, operon context.
4. Replication of eukaryotic chromosomes, cell division and cell cycle

**Unit-II**

5. RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, RNA capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, non coding RNA, RNA transport.

**Unit – III**

7. Control of gene expression at transcription and translation level

**Unit – IV**

10. Gene silencing strategies and applications
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Spectrophotometric analysis of DNA
2. Isolation of RNA
3. Characterization of different types of RNA molecules
4. Construction of cDNA
5. Separation of *Escherichia coli* soluble proteins on non-denaturing gels.
6. Separation of *Escherichia coli* total proteins on denaturing gels.
7. Cell Proliferation/Cytotoxicity assays

Suggested readings:

Objective: To expose the students to (i) Industrially important metabolites produced by microbes especially in the areas of health, food and enzymes (ii) immobilization of enzymes/cells

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit - I
1. Primary and Secondary metabolites of industrial importance.
2. Techniques involved in screening/detection of industrially important metabolites from microbes.
3. Pyruvate as the hub molecule
4. Microbial therapies and diagnostics

Unit - II
5. Biosynthesis and fermentation process involved in
   (a) Health & Pharma- Antibiotics (Penicillin, Streptomycin,), Alkaloids (ergot, lysergic acid), Biotransformations (Steroids, chirals), Therapeutic proteins (Interferons, Insulin).
   (b) Food and Beverages- Beer, Wine, Whisky, Vinegar
   (c) Traditional fermented foods; Food additives: Vitamins, Bioflavors

Unit – III
6. Microbial Enzymes - Pharma related enzymes, Detergent enzymes, Processing of starch and related carbohydrates, Fruit juice production, Textile & leather manufacture, Treatment of wood pulp, Organic synthesis, Diagnostics

Unit – IV
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Screening of microbes for production of industrially important enzymes.
3. Wine fermentation
4. Purification of antimicrobial metabolites from a microbe.
5. Enzyme immobilization
6. Design of fermentation processes for the production of fuels, chemicals and foodstuffs

Suggested readings:

Objective: To expose the students to (i) basic understanding of computers (ii) computational tools developed for understanding of genetic material and proteins

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit – I (Biostatistics)

1. Basic definitions and applications. Data collection and representation. Measure of central tendencies (Mean, Median and Mode) and dispersal; measure of variability (standard deviation, standard error, range, mean deviation, coefficient of variation); probability distributions (Binomial, Poisson and Normal), sampling distribution
2. Difference between parametric and non-parametric statistics, confidence interval, errors, levels of significance
3. Regression and correlation, t-test, analysis of variance, chi-square test
4. Basic introduction to Multivariate statistics

Unit – II (Biological databases)

5. Brief on programming languages commonly used in Biological Sciences
6. Database- introduction, Primary, Secondary and Tertiary databases; Type and kind of databases; Literature search (PUBMED and MEDLINE).
7. Nucleic acid (GenBank, EMBL etc.); Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc. Motifs and Pattern Databases- PROSITE, Pfam, iPfam etc.
8. Protein databases (SWISS PROT, UNIPROT etc.); Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc; Motifs and Pattern Databases- PROSITE, Pfam, etc.
9. Sequence retrieval (SRS, Entrez) and Data submission.

Unit – III (Sequence analysis)

10. Sequence alignment- introduction and concepts, Local and Global alignment concepts.
11. Similarity and Percent identity score (open, extended gap penalty). Multiple sequence alignment (MSA) - introduction and concepts. Types of multiple sequence alignment techniques. Description of major softwares (MSA, CLUSTAL variants (X, W2, OMEGA), PILEUP, T-Coffee, PROS, CONS).
12. Database Scanning and Sequence similarity searches. Algorithm of FASTA. Description of BLAST algorithm. Various BLAST programs (BLASTP, BLASTN, BLASTX, PHI-BLAST, PSI-BLAST etc).
13. Protein Structure: Classification, Structure Analysis, Secondary structure predictions, Comparative/Homology modeling, Modeling using Swiss Model Server.
Unit – IV (Genome analysis)

15. NextGen Sequencing (NGS); Assembling of genomes from short reads
16. Concept of Metagenomics; Types of repeats and repeat finding techniques; Structure of genes; Prediction of gene in prokaryotic and eukaryotic genomes (GENESCAN, GeneMark, GeneSeqer etc.); Promoter prediction in \textit{E. coli} and in eukaryotes
17. Description of major gene prediction methods

Practicals:

Total Marks: 25 \textit{Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)}

1. Sequence (DNA & Protein) alignments
2. Genome sequence studies
3. Designing ideal primers for amplification of genetic material
4. Deciphering 3-D structure of proteins
5. Designing inhibitors of enzymes

Suggested readings:

MBT-205: Intellectual Property Rights (IPR), Bioethics and Entrepreneurship

Total Marks: 75 (Exam-60 + Int. Asses.-15)

Objective: To expose the students to (i) understanding of patents (ii) filing of patents (iii) ethical and social issues in biotechnology

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit - I

1. Introduction: General Introduction
2. Patent Claims, the legal decision-making process
4. Basic requirements of patentability, patentable subject matter, novelty and the Public Domain; Non-obviousness, Foreign Patents
5. Special issues in Biotechnology Patents: Disclosure Requirements, Ethical issues, Plant Biotechnology- UPOV and plant breeder’s rights, Case studies/ experiences from developing and developed countries, IPR issues in the Indian context.
6. Contract law, IP reform, Policy implications of IP

Unit - II

7. Copyright and Patents; International Treaties and Conventions; Business Software Patents
9. IT Act, 2000 : Aims and Objectives; Overview of the Act; Jurisdiction; Role of Certifying Authority; Regulators under IT Act; Cyber Crime-offences and Contraventions; Grey Areas on IT Act.

Unit - III

11. The Cartagena protocol on biosafety
12. Social and ethical implication of biological weapons
13. Intersection of Biotechnology with globalization, trade, poverty, food security, and environmental sustainability

Unit - IV

15. Functions of entrepreneurship, Entrepreneurship with the motive of economic growth, theory of social change, family structure, migration and enterprise.
16. Barriers to entrepreneurship, community and entrepreneurship.
17. Funding challenges for an entrepreneur, Business planning and investment pitch, Identify and evaluate business opportunities, Risk assessment and management Opportunities for entrepreneurship in emerging markets

Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Searching of Indian Patent databases
2. Drafting and filing of Indian Patent application.
3. Searching of International Patent databases
4. Drafting and filing of International Patent application.
5. How to formulate well-structured research questions, recognize appropriate research methods, and assess research reports

Suggested readings:

Objective: To expose the students to recent trends in the field of Microbial Genomics, Proteomics & Metabolomics.

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit – I

1. Introduction to Microbial genomes
2. Genome sequencing of different microbes and their importance
3. Techniques for genome research (chromosome walking, RFLP etc.)
4. Application of microbial genomic variability for utilizing in human welfare (applications)
5. Phylogenetic relationships between various genera of microbes

Unit – II

6. Sequences as Biological Information - Cells obey the Laws of Chemistry and Physics
7. Evolution by Genome Expansion and Reduction
8. Metagenomics
9. Methods to Compare Genomes
10. Archaeal Genomics
11. Microbial Genome Annotation
12. Genomics for pathogenic microbes – Search for better vaccines

Unit – III

13. Introduction to microbial proteomics
14. Techniques for Proteome research (2 – D gel electrophoresis, DIGE, PROTOMAP, COFRADIC, MALDI-ToF, Protein purification work station)
15. Gel free Mass Spectrometry based microbial proteomics - methodology and application
16. Microbial pathogenesis at the proteome level
17. Proteome research for novel drug targets
18. Structural proteomics and computational analysis
19. Proteomics of Archaea
20. High throughput proteomic screening for novel enzymes

Unit – IV

21. Techniques for metabolic engineering
22. Genetic and epigenetic manipulation of useful microbes
23. Strain improvement methods and strategies - Classical vs metabolic engineering, developing/ emerging/ novel
24. Production and yield enhancement of valuable products (fuels, amino acids, drugs etc) by metabolic engineering

Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. RAPD/RFLP/16S rRNA-sequencing of bacterial isolates (e.g., Escherichia coli isolates) and phylogenetic tree construction
2. Isolation of metagenomic DNA from soil or water source
3. Demonstration of 2-D gel electrophoresis
4. Demonstration of MALDI – ToF
5. Demonstration of DNA/Protein Microarray system
6. Practicals on Microbial Genomics/Proteomics/Metabolomics using computational tools
7. Comparison of genomes. Genome projects and sequence archive databases.

Suggested readings:

Objective: To expose the students to (i) the benefits of microbes/their products in cleaning the environment (ii) large scale production of useful microbial biomass (iii) production of biofuels and chemicals (iv) useful protocols

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise of objective type/short notes covering the complete syllabus.

Unit – I (Environment)

1. Waste water and effluent treatment,
2. Biodegradation of Xenobiotics, Bioremediation, Biomining
3. Biodegradable plastics
4. Bioinsecticides
5. Microbes as N and P Biofertilizers

Unit – II (Biomass)

6. Manufacture of Baker’s yeast
7. Single cell protein production especially Spirulina
8. Mushroom cultivation especially Agaricus bisporus
9. Probiotics, Prebiotics, Synbiotics

Unit – III (Biofuels & Chemicals)

10. Biofuel production especially Ethanol, Butanol, Methane, Hydrogen, Electricity, Biodiesel
11. Organic acids especially Amino acids (glutamic acid, lysine), Citric acid, Acetic acid, Lactic acid
12. Microbial exopolysaccharides

Unit – IV (Protocols)

13. Good Lab Practices guidelines
14. Good Manufacturing Processes guidelines
15. Guidelines for use of recombinant microbes
16. Important Biotech companies of India and the World
17. Equipment validation, Analytical method validation, Process validation
Practicals:

Total Marks: 25  Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Estimation of BOD levels of a water sample
2. Isolation of P-solubilizers from the soil
3. Estimation of P-solubilizing activity of P-solubilizer
4. Isolation of Lactobacilli from milk/ curd
5. Production of bacteriocin by probiotics
6. Effect of temperature on the preparation of curd from milk
7. Effect of type of milk on the preparation of curd from milk

Suggested readings:

MBT-303: Bioinstruments and their Applications

Objective: To expose the students to the variety of instruments used in the study of Microbial Biotechnology.

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit - I

1. Microscopy: Light microscope, Field Microscope, Fluorescent microscope, Phase contrast microscope, AFM, SCM, TEM, SEM, STM.
2. Spectrophotometer: UV and Visible
3. Mass spectroscopy, Infrared and Raman spectroscopy. CD spectroscopy, NMR, ESR.

Unit - II

4. Centrifugation: Theory and its applications to biological systems, centrifuges, rotors-fixed angle/swing out, concept of vertical, buoyant density centrifugation.

Unit – III

6. Chromatography: GC, Paper Chromatography, TLC, HPLC, FPLC,
8. Radioisotope techniques: radiotracers GM Counter, Proportional and Scintillation counters, autoradiography

Unit – IV

9. Protein purification workstation
10. GCMS, LCMS
11. MALDI-ToF

Practicals:

Total Marks: 25 Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Operation of Microscopes: TEM, and SEM.
2. Running TLC; Rf value using TLC
3. Operation of Centrifuges (microfuge and high speed centrifuge and ultracentrifuge).
4. Operation of GC, HPLC
5. Operation of MS, LCMS, NMR.
Suggested Readings:

MBT-304: Microbial Identification, Diagnostics and Nanobiotechnology

Total Marks: 75 (Exam-60 + Int. Asses.-15)

Objective: To introduce the students to (i) the various methods used in microbial identification & (ii) applications of nanotechnology in biotechnology.

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit - I

1. Principles of microbial diagnostics: conventional and molecular approaches
2. Microscopic examination: applications of light microscopy, fluorescent microscopy and electron microscopy in microbial identification
3. Serological diagnosis of infectious diseases
4. Automated detection systems: BACTEC, VITEK, FAME and Biolog

Unit - II

5. Nucleic-acid based detection: fluorescent in situ hybridization; line probe assay; PCR and its various types; transcription mediated amplification (TMA); nucleic acid sequence based amplification (NASBA); branched DNA (bDNA); Qβ replicase; hybrid capture
6. Epidemiological molecular typing: pulsed field gel electrophoresis, RFLP, RAPD and MLST
7. Flow cytometry and fluorescence-activated cell sorting
8. Microarray: types and applications

Unit - III

9. Basic components of a sensor
10. Types of biosensors and their applications
11. Biosensors in research and diagnostics
12. Lateral flow assays
13. Lab on a Chip technology

Unit - IV

14. Understanding Nanobiotechnology and its importance to society
15. Microbial nanoparticle production
16. Nanoparticles for biological applications
17. Luminiscent quantum dots for biological labeling
Practicals:

Total Marks: 25

Int. Asses.-05. Based on the performance of the students during the practical Exam. – 20 (Practical - 20)

1. Case studies in infectious disease diagnostics: clinical-case discussions and hands on
2. Chromogenic media for microbial identification
3. Microbial identification using VITEK, BACTEC, BIOLOGS and FAME (demonstration)
4. Microbial identification and typing by molecular methods
5. Practical on biosensors
6. Microbial synthesis of nanoparticles

Suggested readings:

MBT-305: Tutorials
Total Marks: 75 (Exam-60 + Int. Asses.-15)

Objective: (i) To overcome the academic deficiencies of students and to expose the students to those parts of Microbial Biotechnology which have not been covered in the syllabus (ii) Invited lectures from experts.

Exam Pattern: Five questions to be attempted from a total of nine questions, which will be divided into five units. Each unit will comprise of two questions and students would be required to attempt one question from each unit. The last unit will comprise objective type/short notes covering the complete syllabus.

Unit – I

1. Quantitative PCR: Theory, Practice, Problems and Solutions.
2. Myths and misconception about diseases e.g., Tuberculosis, Leprosy, Rabies, Anthrax, Brucellosis.
3. Giant viruses and Virophages: Characteristics and evolutionary implications.

Unit - II

4. Biosafety, biosecurity and dual use research of concern.
5. Biomedical waste management.
6. Exceptions to the classical bacterial definition.

Unit - III

7. Diversity of antimicrobial peptides.
8. Role of integrons in microbial drug resistance.
9. Non-Rhizobium PGPRs and their role in crop productivity.

Unit - IV

10. Radiations in diagnostics.
11. Phosphorescence, Fluorescence and Luminescence.
12. Applications of non-aqueous enzymology.

Practicals:

Total Marks: 25 Int. Asses.-05, Project Report-20

The practical is intended to apprise the students of the research methodology including techniques and prepare for dissertation/research work. The overall assessment of the project report will be based on the quality of final project report (review/overview of literature and general methodology update of the assigned field) submitted.

Suggested Readings:


8. Journals: Biotechnology Advances; Current opinion in Microbiology; Nature Biotechnology; Analytical chemistry; Critical reviews in Biotechnology; Critical reviews in Microbiology

MBT-401: Seminar and Journal Club

Total Marks: 100 (Exam-80 + Int. Asses.-20)

**Objective:** *This course will help the students to know the type of research going on in various countries. It will also help the students in preparing, delivering and defending a ‘talk’.*

The Internal assessment will be made from the attendance and the interaction of the student during the seminars and tutorials.

Students will be asked to deliver a talk on current issues pertaining to Microbiology, Biotechnology and other important topics. Some guest lectures will be arranged.

MBT-402: Dissertation and Viva

Total Marks: 400 (Dissertation: 300 + Viva: 100)

**Objective:** *To prepare the students as how to carry out independent research work*

Each student will be given an independent research project. The evaluation will be based on the presentations, knowledge of the topic of research, quality of the compiled Dissertation.

******