SYLLABI

FOR

M.Sc. Microbial Biotechnology
(Semester System)

EXAMINATION 2016-2017

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# SYLLABUS – 2016-17

## 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>
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<td><strong>Course No.</strong> Marks</td>
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<td>2.</td>
<td>Immunology and Immunotechnology</td>
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<td>3.</td>
<td>Genetics and Recombinant DNA Technology</td>
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<td><strong>Total Marks = 750</strong></td>
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### M.Sc. 1st year (2nd Semester)

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<td>Industrial Microbiology-1 (Health, Food, Enzymes)</td>
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<td>Bioinformatics &amp; Biostatistics</td>
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<td>Intellectual Property Rights (IPR), Bioethics &amp; Entrepreneurship</td>
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### M.Sc. 2nd year (3rd Semester)

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<td>Industrial Microbiology-II (Environment, Biofuels, Chemicals, Biomass, Protocols)</td>
<td>MBT-302 T</td>
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<td>Bioinstruments and their Applications</td>
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Total Credits= 28

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

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<td>Seminar &amp; Tutorials</td>
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Total Credits= 18

#### Consolidation of Marks and Credits

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Department of Microbial Biotechnology (DMBT)

Syllabus
for
M.Sc. MICROBIAL BIOTECHNOLOGY
2016-2017

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-I (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: Seminars and Tutorials
2. MBT-402: Dissertation.
MBT-101: Microbial Biodiversity and Physiology

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

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
3. Structures and functions of *Escherichia, Staphylococci & Saccharomyces*.
4. Control of microbes by the use of physical and chemical agents.

Unit – II
5. Biodiversity of
(a) Archaea
(b) Bacteria
(c) Fungi
(d) Algae
(e) Viruses
6. Microbial ecology: Biogeochemical cycling, Microbes in marine & freshwater environments, Microbes in terrestrial environment, Microbial interactions

Unit – III
7. Nutritional requirements of microbes
10. Mechanisms involved in transport of nutrients in microbes

Unit - IV
11. Unique pathways of microbial metabolism: ED, PK pathways; Respiration; Fermentations; Amphibolic pathways; Anaplerotic reactions.
12. Bacterial cell wall biosynthesis
13. Photoautotrophy, Chemolithotrophy, Methylotrophy, Calvin cycle
Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practicals - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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:

MBT-102: Immunology and Immunotechnology

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

Objective: To expose 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. Immune cells and immune organs, adaptive and innate 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, complement system, haptens, adjuvants.

Unit-II

6. Antigen presenting cells (APCs): Dendritic cell (DC), importance of DCs in adaptive immune response, role of B cells and macrophages as APCs, non-professional APCs, cell biology of antigen processing and presentation.
8. Immune Homeostasis: Homeostasis, migration, tissue redistribution of lymphocytes, site specific immune response.
9. Chemokine, cytokine and cell signaling: Their roles in activation and differentiation of cells of immune system, importance in response to pathogens.
10. Nuclear receptors for macrophage and T cell plasticity, nuclear receptors and antigen processing and presentation, nuclear receptors and immune cell effector repertoire.

Unit-III

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

Unit-IV

15. Tolerance and autoimmunity, allergy and hypersensitivity-mediated diseases.
16. Immune response to infectious diseases: Responses to different class of pathogens such as intracellular bacteria, viruses and extracellular and intracellular parasites.
17. Vaccines and their types: killed and live, sub unit, recombinant, multivalent, DNA, edible vaccines. Microbe-resistant transgenic plants
18. Antibodies as immunotherapeutic, cytokine therapy

Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

1. Animal handling and routes of immunization
2. Drawing blood from animals
3. TLC and DLC for blood samples.
4. Determination of cell number (viable/non-viable).
5. Ficoll density gradient, separation of cell types.
6. Immunoassays

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 linkage, 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
6. Physical and chemical mutagens
7. Types of mutations
8. DNA Repair mechanisms

Unit – III

9. Host restriction/modification, 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, Combinatorial library
Practicals:

**Total Marks:** 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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

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)
9. Electron transport chain, Oxidative phosphorylation

Unit – IV

10 Enzymes: General distinctive features, nomenclature and industrial applications
11. Enzyme kinetics
12. Allosteric enzymes
13. Feed back inhibition and Feedback repression mechanisms
14. Multienzyme complexes: advantage and examples
15. Biocatalysis-Definition, chirality, advantages/disadvantages of biocatalysis over chemical catalysis, different types of biocatalysis
Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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
6. Substrate specificity and efficiency of enzymatic catalysis
7. Kinetics of enzyme catalyzed reactions
8. Effect of pH and temperature on enzyme activity
9. Enzyme immobilization

Suggested readings:

MBT-105: Bioprocess Engineering

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.

Unit – IV
6. Fermentations and Fermentative processes like Submerged, Solid state, Batch, Fed Batch, Continuous system etc.
7. Hygiene and safety in fermentation laboratory/processes.

Practicals

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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
Suggested readings:


Objective: To expose the students to (i) various types of diseases caused by microbial pathogens (ii) pathogenic mechanisms of microbes (iii) antimicrobial chemotherapy (iv) epidemiology of important diseases

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 (Pathogenesis, Chemotherapy)

1. Overview of a) Normal microflora of humans and its importance, b) Specific and Non-specific defense mechanisms.
2. Pathogenesis of microorganisms: Host parasite relationships, pathogenesis of bacterial diseases, pathogenesis of viral diseases, toxigenesis, host defense against microbial invasion, microbial mechanism for escaping host defenses.
3. Antimicrobial chemotherapy: Characteristics of anti microbial drugs, determination of anti microbial activity, anti-bacterial drugs, anti-viral drugs, anti-fungal drugs, anti-protozoan drugs.

Unit – II (Bacterial infections)

5. Air-borne bacterial diseases (TB, Diphtheria, Pertussis, Streptococcal, etc.)
6. Food/Water – borne bacterial diseases (Botulism, Gastroenteritis, Cholera, Salmonellosis, Shigellosis, Traveller’s diarrhea ; Sepsis and septic shock)
7. Direct - contact diseases (Gas gangrene, GBS, Conjunctivitis, Leprosy, Peptic ulcer, Staphylococcal, STB, Tetanus, Trachoma)
8. Arthropod - borne bacterial diseases (Typhus, Lyme, Plague, Q fever etc.); Zoonotic diseases (Anthrax, Brucellosis); Dental infections (Dental plaque, Dental Decay, Periodontal diseases.

Unit – III (Viral infections)

9. Air-borne viral diseases (Chicken pox, Small pox, Measles, Mumps, Influenza)
10. Direct - contact diseases (AIDS, Sores, Common cold, CMV, Genital herpes, Leukemia, Infectious monoucleosis, Hepatitis, Warts)
11. Food/Water – borne viral diseases (Gastroenteritis, Hepatitis, polio)
12. Zoonotic viral diseases; (Rabies, VHF); Arthropod - borne diseases (Encephalitis, RVF, Yellow fever); Prion diseases.
Unit – IV (Other infections, Epidemiology)


14. Brief introduction to discomforts caused by Algae

15. Epidemiological terminology, Morbidity rate, Mortality rate, Prevalence rate; Recognition of infectious diseases in a population; Recognition of an epidemic; infectious disease cycle; Virulence and the mode of transmission

16. Emerging and reemerging infectious diseases/pathogens; Control of epidemics; Global travel and health considerations; Nosocomial infections.

Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

1. Collection, handling and storage of clinical samples
2. Culture identification of bacteria (E.coli, Salmonella, Shigella, Staphylococcus, Streptococcus)
3. Culture identification of fungi (Candida, Aspergillus)
4. Identification of pathogens by PCR technology
5. Antibiotic sensitivity of clinical pathogens

Suggested Readings:

**MBT-202: Molecular Biology**

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

**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, C value paradox, DNA protein interaction, DNA super coiling.
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, 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
Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

1. Tm value of DNA
2. Spectrophotometric analysis of DNA
3. Protein purification by Gel exclusion chromatography
4. Protein purification by Ion-Exchange chromatography
5. Protein purification by Affinity chromatography
7. Separation of proteins on denaturing gels.

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

**Unit - II**

4. 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, Probiotics, Traditional fermented foods, Food additives: Vitamins, Bioflavors

**Unit – III**

5. 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: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

1. Screening of microbes for production of industrially important enzymes.
3. Wine fermentation
4. Purification of antimicrobial metabolites from a microbe.

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, 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.
13. Protein Structure: Classification, Structure Analysis, Secondary structure predictions, Comparative modeling.
Unit – IV (Genome analysis)

15. Next Gen Sequencing. Assembling of genomes from short reads
17. Description of major gene prediction methods

Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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:

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.

Unit - II
6. Copyright and Patents; International Treaties and Conventions; Business Software Patents
8. 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
10. The Cartagena protocol on biosafety
11. Social and ethical implication of biological weapons

Unit - IV
13. Functions of entrepreneurship, Entrepreneurship with the motive of economic growth, theory of social change, family structure, migration and enterprise.
Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practical - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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.

Suggested readings:

MBT-301: Advances in Microbial Biotechnology (Genomics, Proteomics & Metabolomics)

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

**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. 2D gel profiling of various microbes
15. Microbial pathogenesis at the proteome level
16. Structural proteomics and computational analysis
17. Proteomics of Archaea
18. Proteome research for novel drug targets
19. Techniques for Proteome research (2 – D gel, MALDI – ToF, Protein purification work station)
20. High throughput proteomic screening for novel enzymes

**Unit – IV**

21. Techniques for metabolic engineering
22. Gene manipulation of useful microbes
23. Production of valuable products by metabolic engineering
25. Strain improvement by metabolic engineering
26. Applications of metabolic engineering

Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practicals - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

1. Isolation of RNA.
2. Characterization of different types of RNA molecules
3. Construction of cDNA
4. Demonstration of 2-D gel electrophoresis
5. Demonstration of MALDI – ToF
6. Demonstration of DNA/Protein Microarray system
7. Practicals on Microbial Genomics/Proteomics/Metabolomics using computational tools
8. 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
Practicals:

Total Marks: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practicals - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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:

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: 50 Int. Asses.-10. Based on the performance of the students during the practical Exam. – 40 (Practicals - 20, Synopsis – 05, Notebook – 05, Viva voce – 10)

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:

Objective: To expose the students to (i) the various methods used in microbial identification & (ii) applications of nanotechnology for applications 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. Identification of bacteria using classical and molecular tools including BIOLOGS, FAME, DNA sequences. Importance of bioinformatics in the identification and construction of dendrogram
2. Identification of fungi and viruses using classical and molecular techniques
3. Microscopic techniques
4. Radioisotopes in diagnostics

Unit - II

5. PCR based diagnostic techniques. RFLP, Pulse field gel electrophoresis.
6. High throughput techniques – Micro arrays, Flow Cytometry
7. Bioreporter genes
8. DNA probes

Unit – III

9. Basic components of a sensor
10. Types of sensors and their applications.
11. Biosensors in industrial applications
12. Biosensors in research
13. Biosensor in diagnostics
14. Futuristic biosensors

Unit – IV

15. Understanding Nanobiotechnology and its importance to society.
16. Impact of Nanotechnology on biological systems especially microbiology.
17. Microbial nanoparticle production
18. Nanoparticles for biological applications
19. Luminiscent quantum dots for biological labeling
Practicals:

1. Bacterial culture identification using BIOLOGS, FAME and DNA sequences (demonstration)
2. Identification of fungi – Candida, Aspergillus, Penicillium, Saccharomyces, and Pichia
3. Rapid diagnosis of bacterial infections
4. Practical on biosensors

Suggested readings:

MBT-305: Tutorials

Objective: To make students aware of the recent advances made in different relevant fields.

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. Exception to the classical bacterial definition

Unit - III
7. Diversity of antimicrobial peptides
8. Role of integrons in microbial drug resistance
9. Non-Rhizobium PRPRs and their role in crop productivily

Unit - IV
10. Radiations in diagnostics
11. Phosphorescence, Florescence and Luminescence
12. Application of non-aqueous enzymology

Suggested Readings:
8. Journal: Biotechnology Advances; Current opinion in Microbiology, Nature Biotechnology; Analytical chemistry; Critical reviews in Biotechnology; Critical reviews in Microbiology.
**MBT-401: Seminars and Tutorials**

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**

Total Marks: 350

**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.