

| <b>Microbiology B. Sc. II Semester-III (CBCS)</b>   |  |                        |
|---|--|------------------------|
| <b>Course Code - USMBT05</b>  | <b>Paper-I</b>   | <b>Marks: 50</b>       |
| <b>Credits: 2</b>   |  | <b>Total Hours :48</b> |
| <b>MICROBIAL PHYSIOLOGY AND METABOLISM</b>  |  |                        |
| <b>Objective:</b> To make the students to understand the fundamentals of bacterial physiology and Metabolic pathways. |  |                        |
| <b>Unit No.</b>   | <b>Content</b>   | <b>Hrs</b>             |
| <b>1</b>  | <b>Growth</b>  | <b>12</b>              |
|   | a) Concept of Growth; b) Bacterial Growth Curve and its phases<br>c) Reproduction-Binary fission d) Generation time, mathematical expression, Growth rate constant e) Diauxic Growth f) Synchronous Growth (methods) g) Continuous Culture (methods)<br><b>h) Measurement of Bacterial Growth:</b> Breed's method, Hemocytometer, Coulter counter, Plate count, Membrane filter count.<br>i) Physical conditions required for growth i) Oxygen requirement ii) pH iii) Temperature iv) Miscellaneous.  |                        |
| <b>2</b>  | <b>Enzymes</b>   | <b>12</b>              |
|   | a) Introduction and terminologies used in Enzymology, Characteristics of Enzymes, Nomenclature and Classification Based on IUB system and EC.<br>b) Enzymes and catalysts i. Activation energy ii. Mechanism of enzyme action c) The active site, Allosteric Site, Allosteric modulators d) Enzyme-Substrate Interactions (E. Fischer Hypothesis & Daniel Koshland's Model)<br>e) <b>Enzyme kinetics:</b> i. Michaelis-Menten equation ii. Line Weaver-Burk Plot<br><b>f) Enzyme Inhibition:</b> Competitive, Uncompetitive and non-competitive<br><b>g) Factors affecting Enzyme activity:</b> pH, temperature and substrate concentration. |                        |
| <b>3</b>  | <b>Microbial Metabolism</b>  | <b>12</b>              |
|   | a) Definition of Metabolism, Anabolism, Catabolism and Amphibolism.<br>b) EMP pathway (detail)<br>c) HMP pathway (outline)<br>d) ED Pathway (outline)<br>e) PK pathway (outline)<br>f) TCA cycle (detail)<br>g) Metabolic mill (outline), Anaplerotic reactions: Definition and examples<br>h) $\beta$ -oxidation of fatty acid, Urea Cycle  |                        |
|   | <b>Energy Metabolism</b>   | <b>12</b>              |
| <b>4</b>  | a) Phosphorylation: Substrate level, definition and examples, Oxidative Phosphorylation and electron transport chain - general features, cytochromes, NADH and Succinate dehydrogenase, Chemoistic coupling hypothesis.<br>b) Cyclic and non cyclic phosphorylation in detail<br>c) General concept of Respiration and Fermentation: Alcohol, lactic acid, acetone butanol and mixed acid fermentation.<br>d) High energy rich compounds   |                        |

| <b>Microbiology B. Sc. II Semester-III (CBCS)</b>  |  |                        |
|--|--|------------------------|
| <b>Course Code -USMBT06</b>  | <b>Paper-II</b>  | <b>Marks: 50</b>       |
| <b>Credits: 2</b>  |  | <b>Total Hours :48</b> |
| <b>FOOD, SOIL MICROBIOLOGY AND MICROBIAL ECOLOGY</b>   |  |                        |
| <b>Objective:</b> To make the students to understand the fundamentals of Food, Soil and Microbial ecology. |  |                        |
| <b>Unit No.</b>  | <b>Content</b>   | <b>Hrs</b>             |
| <b>1</b>   | <b>Food Microbiology</b>   | <b>12</b>              |
|  | a) Definition and types of food, Sources of contamination in food<br>b) Microbial examinations of food, Significance of microorganisms in food<br>c) Spoilage and its types (Different types of spoilages with suitable examples)<br>d) Preservation of food ( Physical, chemical and biological methods)<br>e) Food borne diseases, food infections and food poisoning (Botulism, <i>Staphylococcal</i> intoxication and <i>Salmonellosis</i> )<br>f) Concept of HACCP  |                        |
| <b>2</b>   | <b>Soil Microbiology</b>   | <b>12</b>              |
|  | a) Definition and composition of soil, types of soil<br>b) Humus Formation (Nature and Characteristics)<br>c) Compost, aerobic and anaerobic methods of composting<br>d) <b>Elemental transformations:</b> Carbon cycle; Nitrogen cycle; Sulphur cycle; Phosphorus cycle   |                        |
| <b>3</b>   | <b>Microbial Association and Nitrogen Fixation</b>   | <b>12</b>              |
|  | a) Positive and Negative Microbial associations with examples, mutualism, Symbiosis, Syntrophism, Synergism, Commensalism, Parasitism, Competition, Antibiosis.<br>b) <b>Biological Nitrogen fixation</b> , Nitrogen fixing bacteria, Symbiotic and non symbiotic nitrogen fixation, Process of nodulation in legume, Nitrogenase complex, Mechanism of nitrogen fixation (symbiotic and non symbiotic), <i>Nif</i> gene and r DNA technology in N <sub>2</sub> Fixation.<br>c) Mycorrhizae (types and application)<br>d) Biofertilizers and Biopesticides |                        |
| <b>4</b>   | <b>Environmental Biotechnology</b>   | <b>12</b>              |
|  | a) Microbial leaching - Bioleaching of Copper and Uranium.<br>b) Microbial Enhanced Oil Recovery (MEOR).<br>c) Bioremediation, Acid mine drainage, Desulfurization of coal<br>d) Biogas plant, Construction and working mechanism<br>e) Biodegradation of (a) Cellulose (b) Pesticides (Xenobiotics)   |                        |

**Practical B. Sc. II**  
**Semester III**  
**{Based on Paper I & II}**

**Course code – USMBP03**

**Total Hours: 48**

**CREDITS: 2**

**Marks: 30**

1. \*Demonstration of enzymes activity: Catalase, Lecithinase (Lipase), Amylase, Caseinase (protease), Urease, Gelatinase
2. \*Isolation and study of *Rhizobium* from root nodules.
3. \*Isolation and study of *Azotobacter* from soil
4. Demonstration of Synergism.
5. Demonstration of Antibiosis
6. Demonstration of Syntrophism.
7. Isolation and Study of Rhizospheric microflora.
8. \*Demonstration of: Ammonification, Nitrification, Nitrate Reduction.
9. Microbiological examination of food by SPC, YMPC.
10. Demonstration of cellulose degradation.
11. Study of Phosphate solubilization by *Mycorhizae*.
12. \*Production of amylase enzyme and its assay
13. Preparation of *Rhizobium* Biofertilizer.
14. Study of bacterial growth curve.
15. Study of effect of P<sup>H</sup> , temperature on enzyme activity
16. Detection of food Adulteration

**Note:** i) Minimum 4 major and 4 minor experiments are compulsory  
ii) Underlined experiments are considered to be major experiments  
iii) Experiments with asterisks are compulsory  
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two Consecutive days

**Distribution of marks for practical examination:**

|                                |          |
|--------------------------------|----------|
| One major experiment .....     | 10 Marks |
| Two minor experiments 5 × 2=10 | marks    |
| Viva-Voce                      | 05 marks |
| Practical Record               | 05 Marks |

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**Total ..... 30 marks**

## **Books Recommended for Theory& Practical of B.Sc. II Year SEM III**

1. Soil Microbiology by Martin A. Alexander, John Wiley & Sons
2. Food Microbiology by William C. Frazier, McGraw Hill.
3. Food Microbiology- Martin R.Adams and Maurice O. Moss, RSC Publishing
4. Introductory Food Microbiology by H. A .Modi, Ekta publication
5. Soil Microbiology by N.S. Subbarao, Oxford & IBH Publishing Co.
6. A Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Craford, ASM Press
7. Soil Microbiology by S.A. Waksman,Chapman & Hall
8. Soil Microbiology & Biochemistry by E.A. Paul, Elsevier Academic Press
9. Soil microorganism and plant growth- N.S. Subbarao, Oxford and IBH Pub. co. Delhi
10. Principles of Microbial Ecology by T.D. Brock, Prentice Hall Inc
11. Nature and properties of soil- N.C.Brady, Pearson Education
12. Agricultural Microbiology, G. Rangaswamy and D.J.Bhagyaraj,Prentice Hall of India
13. The Enzymes by P.D.Boyer, Academic Press
14. Lehninger, 2010, Principles of Biochemistry, 5th edn., by Nelson & Cox, W.H. Freeman and Co.NYork.
15. Molecular and Cellular enzymology by J.Y. Khan & G. Herve
9. Text Book of Microbial Taxonomy, Ecology and Diversity by P.H.Kumbhare and V.U.Thool Rajani Prakashan, Nagpur.
10. Text Book of Enzymology and Metabolism by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
11. Text Book of Industrial and Food Microbiology by P.H.Kumbhare and V.U.Thool, Rajani Prakashan, Nagpur.
21. Bacterial Cell to Cell Communication by D.R. Demuth
22. Modern Food Microbiology by James M. Jay.
23. Bacterial Metabolism by Gottschalk
24. Chemical Microbiology by Rose
25. Fundamentals of Food Microbiology by A. Bhunia
26. Secondary Metabolites in Soil Ecology by Ajit Verma
27. Molecular Mechanism of Plant and Microbe Coexistence by C. Nautiyal.
28. Bacterial Metabolism by Doelle
29. Fundamental Food Microbiology by Bibek Ray & Arun Bhutia, CRC Press
30. Elementary Microbiology by H.A. Modi
31. General Microbiology by Powar & Daginawala, Himalaya Publication
32. Textbook of Microbiology by R.C.Dubey & D.K. Maheshwari
33. Biochemistry by J.L.Jain
34. Environmental Biotechnology, InduShekhar Thakur- IK International Pvt. Ltd. New Delhi
35. Experiments in Microbiology, Plant pathology and Biotechnology, K .R. Aneja
36. Cappucino J and Sherman N.(2010) Microbiology, A Laboratory Manual. 9th edition, Pearson Education Limited.
37. Standard methods of Biochemical analysis by Thimaiah
38. Practical Biochemistry by Plummer

| <b>Microbiology B. Sc. II Semester-IV (CBCS)</b>  |   |                    |
|---|---|--------------------|
| <b>Course Code - USMBT07</b>  |   | <b>Paper-I</b>     |
| <b>Credits: 2</b>   |   | <b>Marks: 50</b>   |
| <b>:48</b>  |   | <b>Total Hours</b> |
| <b>INDUSTRIAL MICROBIOLOGY</b>  |   |                    |
| <b>Objective:</b> To make the students to understand the fundamentals of Industrial processes and mechanisms for the product formation. |   |                    |
| Unit No.  | Content   | Hrs                |
| <b>1</b>  | <p><b>Basics of Industrial Microbiology</b></p> <p>Definition, Scope and Development of Industrial Microbiology, Bioreactor / Fermentor (Definition, Characteristics of Ideal, General design and Different parts of typical Fermentor), Application of Computer in fermentation process, Antifoaming agents.</p> <p><b>Types of Fermentor:</b> Laboratory Fermentor, Batch and Continuous Fermentor with diagram, Single stage and Multiple stage continuous fermentor (in brief).</p> <p><b>Fermentations:</b> Definition and Types- Batch and Continuous (comparison), Aerobic and Anaerobic, Solid and Liquid state, Surface and Submerged culture, Single, Dual / Multiple culture.</p>                  | <b>12</b>          |
| <b>2</b>  | <p><b>Fermentation Media and Microbes in Industrial Microbiology</b></p> <p>A) Commonly used raw materials for the fermentation process with composition: Saccharine materials (Cane and beet molasses, fruit juices, cheese whey), Starchy materials (cereals and root tubers), Cellulosic materials (Sulphite waste liquor, wood molasses, agricultural waste- rice straw), Nitrogenous materials (corn steep liquor), Vegetable oils.</p> <p>B) Industrially important microorganisms &amp; their products (List)<br/>Screening of industrially important microorganisms: Primary and Secondary screening, Strain improvement, Inoculum build up, Scale up of fermentation process, Tolerance studies.</p> | <b>12</b>          |
| <b>3</b>  | <p><b>Upstream and Downstream Processing</b></p> <p><b>Upstream process :</b> Definition and different stages in brief<br/><b>Downstream process -</b> Recovery &amp; Purification of fermentation products(brief )<br/>. Cell mass removal by precipitation, filtration &amp; centrifugation<br/>. Cell disruption by physical &amp; chemical methods<br/>. Solvent recovery process<br/>. Chromatographic separation and industrial product recovery<br/>. Drying &amp; crystallization, Quality testing of end product.<br/>. Packaging and marketing of product</p>   | <b>12</b>          |
| <b>4</b>  | <p><b>Production of Important Fermentation products</b></p> <p>Industrial production, Fermentation media , Microbes involved, Biochemistry, fermentation conditions, Product recovery operations and Uses of.</p> <ul style="list-style-type: none"> <li>• Beverages (Production of Wine, concept of Beer and its types)</li> <li>• Organic acid (Citric acid)</li> <li>• Antibiotics(Penicillin)</li> <li>• Amino acids(Lysine)</li> <li>• Enzymes (Amylase)</li> <li>• Biomass – Baker’s Yeast</li> <li>• Fermented food – Idli</li> </ul>  | <b>12</b>          |

| <b>Microbiology B. Sc. II Semester-IV (CBCS)</b>   |   |                    |
|--|---|--------------------|
| <b>Course Code -USMBT08</b>  | <b>Paper-II</b>   | <b>Marks:</b>      |
| <b>50</b>  |   |                    |
| <b>Credits: 2</b>  |   | <b>Total Hours</b> |
| <b>:48</b>   |   |                    |
| <b>MICROBIAL GENETICS AND MOLECULAR BIIOLOGY</b>   |   |                    |
| <b>Objective:</b> To make the students to understand the fundamentals of Microbial genetics and concept of DNA, RNA and Protein Synthesis. |   |                    |
| <b>Unit No.</b>  | <b>Content</b>  | <b>Hrs</b>         |
| <b>1</b>   | <b>Gene Regulation and Gene Action</b><br><b>Concept of Gene-</b> Intron, Exon, Recon, Muton, Cistron-Mono and Polycistron, Structural organization of DNA in cell (Nucleosome Model).<br><b>Types of Genes</b> - Split gene, Overlapping genes and Pseudo genes, Central dogma of gene action (Brief).<br><b>Regulation of Gene Expression</b> - Repression, Induction, Positive and Negative Control.<br><b>Operon Model</b> - Lac operon and trp operon in E.coli<br>Role of SiRNAs and MiRNAs in regulation.  | <b>12</b>          |
| <b>2</b>   | <b>Mutation and Replication</b><br>Spontaneous and Induced Mutation, Frequency of Mutation.<br><b>Types of Mutation</b> - Point mutation (Base substitution), Frameshift mutation, Nonsense mutation, Missense mutation, Silent mutation, Suppressor mutation (Intragenic and Extragenic), Transition and Transversion.<br><b>Mutagens</b> - Physical and Chemical agents<br><b>Detection of Mutation</b> - Replica plating technique and Ame's Test<br><b>Enzymes in DNA replication</b> - DNA helicases, RNA primase, SSB, DNA polymerase and DNA ligase. Mechanism of DNA replication (detail), Modes of replication, DNA damage and repair (NER, BER) | <b>12</b>          |
| <b>3</b>   | <b>RNA synthesis, Processing and Translation</b><br><b>Transcription</b> - RNA polymerase, sigma factor, pribnow box, mechanism of transcription (detail), reverses transcription.<br><b>Post transcriptional modification</b> - m-RNA processing, Splicing mechanism - alternate and spliceosome.<br>Genetic codes and its different characteristics.<br><b>Translation</b> - General features, enzymes and factors involved, mechanism of protein synthesis in bacteria (detail).   | <b>12</b>          |
| <b>4</b>   | <b>Genetic Recombination</b><br><b>Transformation</b> - Competence, Artificially induced competence, Mechanism of bacterial transformation, Griffith Experiment.<br><b>Transposable Genetic Elements</b> - Insertion sequence and transposon<br><b>Transduction</b> - U tube experiment, Generalized and specialized transduction, abortive and complete transduction.<br><b>Conjugation</b> - F factor, F+ cells, F- cells, Hfr cells, F prime cells, Mechanism of conjugation, Sexduction.  | <b>12</b>          |

**Practical's B.Sc. II  
(Semester IV)  
{Practical's based on Paper -I & II}**

**Course Code – USMBP04**

**Total Hours: 48**

**CREDITS: 2**

**Marks: 30**

1. Primary screening of antibiotic producers, amylase producers, and organic acid producers.
2. Preparation of fermented food – Idli.
3. \*Production of Penicillin by Fermentation and its Bioassay.
4. \*Production of Wine by Fermentation and its estimation by Titration.
5. \*Production of Ethanol by Fermentation and its estimation by Titration.
6. Production of Citric acid by Surface/submerged fermentation and its estimation by titration.
7. Extraction and Purification of RNA from Yeast.
8. Replica Plate method.
9. \*Isolation of bacterial plasmid DNA
10. \*Extraction of genomic DNA from E. coli and isolation by Agarose gel electrophoresis
11. \*Digestion of DNA using restriction enzyme and analysis by agarose gel electrophoresis
12. \*Ligation of restricted DNA fragment
13. Demonstration of Transformation
14. Demonstration of Conjugation

**Note:** i) Minimum 4 major and 4 minor experiments are compulsory  
ii) Underlined experiments are considered to be major experiments  
iii) Experiments with asterisks are compulsory  
iv) Duration of practical examination will be 8 hours i.e. 4 hours each for two Consecutive days

**Distribution of marks for practical examination:**

|                                      |          |
|--------------------------------------|----------|
| One major experiment .....           | 10 marks |
| Two minor experiments $5 \times 2 =$ | 10 marks |
| Viva-Voce                            | 5 marks  |
| Practical Record                     | 5 marks  |

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**Total .....**                      **30 marks**

## **Books Recommended for Theory& Practical of B.Sc. II SEM –IV**

1. Essentials of Molecular Biology by D. Freidfelder
2. Molecular Biology of the Gene(5th edition) : By James D Watson
3. Microbial Genetics by D. Freidfelder
4. Microbial Technology by Vol. I & II by A.H. Pepler.
5. Microbial Technology of TCA by A. B. Solunke, V.S. Hamde, P.S. Wakte
6. Principles of Genetics by R.H. Tamarin.
7. Lodish , et. Molecular cell biology ,WH Freeman;2003
8. Molecular Biology and Genetic engineering by Narayanan.
9. Genes XI, Author- B. Lewin.
10. Genome by T.A.Brown
11. Measuring Microbiome by Vijay Wadhai & Hariom Powar, Lambert Academic Publishing, Germany
12. Fundamentals of Bacterial Genetics by Nancy Trum and J. Trumphy.
13. Industrial Microbiology by A.H. Patel
14. Industrial Microbiology by Prescott & Dunn.
15. Industrial Microbiology, Author- G. Reed.
16. Principles of Fermentation Technology- Standbary, Whitaker and Hall.
17. Biotechnology, A textbook of industrial Microbiology by Creuger and Creuger, Sinaeur associates.
18. Modern Industrial Microbiology & Biotechnology by Nduka Okafoe.
19. The Book of Citric Acid by A.B. Solunke
20. Industrial Microbiology: An Introduction by Michael J. Waites, Neil Morgan, John S. Rockey and Gary Higton, Blackwell Science Ltd
21. Text Book of, Microbial Genetics by P.H.Kumbhare & V.U.Thool Rajani Prakashan, Nagpur
22. Biotechnology by P. Prave
23. Industrial Microbiology by Casida.
24. DNA Chromatography by Doughlas
25. Ion Chromatography by J. Weiss
26. Encyclopedia of Bioprocessing Technology by M.C. Flickinger & S.W. Drew.
27. Microbiology for Analytical Chemists by R.K. Dar
28. Practical Fermentation Technology by Brian McNeil, Linda M. Harvey, John Wiley & Sons Ltd.