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

Microbiology B. Sc. II Semester-III (CBCS)		
Course Code –USMBT06	**Paper-II**	**Marks: 50**
Credits: 2		**Total Hours :48**
FOOD, SOIL MICROBIOLOGY AND MICROBIAL ECOLOGY		
Objective: To make the students to understand the fundamentals of Food, Soil and Microbial Ecology.		
Unit No.	**Content**	**Hrs**
1	**Food Microbiology** a) Definition and types of food, Sources of contamination in food b) Microbial examinations of food c)Spoilage and its types (Different types of spoilages with suitable examples) d) Preservation of food (Physical, chemical and biological methods) e) Food borne diseases, food infections and food poisoning (Botulism, *Staphylococcal* intoxication and Salmonellosis) f) Concept of HACCP	**12**
2	**Soil Microbiology** a) Composition of soil, Types of soil b) Humus Formation (Nature and Characteristics) c) Compost : Aerobic and anaerobic methods of composting d) **Elemental transformations:** Carbon cycle; Nitrogen cycle; Phosphorous cycle	**12**
3	**Microbial Association and Nitrogen Fixation** a)Positive and Negative Microbial associations with examples Symbiosis, Syntrophism, Synergism, Commensalism, Parasitism, Competition, Antibiosis. b) **Biological Nitrogen fixation -** Nitrogen fixing bacteria, Symbiotic and non-symbiotic nitrogen fixation(in detail), Process of nodulation in legume, Nitrogenase complex, Nif gene. c) Biofertilizers and Biopesticides	**12**
4	**Environmental Biotechnology** a) Microbial leaching - Bioleaching of Copper and Uranium. b) Microbial enhanced oil recovery (MEOR). c) Bioremediation, Acid mine drainage, Desulfurization of coal d) Biogas plant, construction and working mechanism e) Biodegradation of Pesticides (Xenobiotic)	**12**

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 of *Rhizobium* from root nodules.
3. *Isolation 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^H , 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

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

Total ……. 30 marks

Microbiology B. Sc. II Semester-IV (CBCS)

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

1. Soil Microbiology by Alexander
2. Food Microbiology by Frazier.
3. Soil Microbiology by Subbarao
4. A Manual of Environmental Microbiology by Christon.
5. Soil Microbiology by S.A. Waksman
6. Microbial Ecology by T.D. Brock
7. Enzymology by Boyer
8. 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.
12 Soil Microbiology & Biochemistry by E.A. Paul
13. Bacterial Cell to Cell Communication by D.R. Demuth
14. Modern Food Microbiology by James M. Jay.
15. Bacterial Metabolism by Gottschalk
16. Chemical Microbiology by Rose
17. Fundamentals of Food Microbiology by A. Bhunia
18. Secondary Metabolites in Soil Ecology by Ajit Verma
19. Molecular Mechanism of Plant and Microbe Coexistence by C. Nautiyal.
20. Bacterial Metabolism by Doelle

Course Code – USMBT07	Paper-I	Marks: 50
Credits: 2		Total Hours :48

INDUSTRIAL MICROBIOLOGY

Objective: To make the students to understand the fundamentals of Industrial processes and mechanisms for the product formation.

Unit No.	Content	Hrs
1	**Basics of Industrial Microbiology** Definition, Scope and Development of Industrial Microbiology, Bioreactor / Fermentor (Definition, Characteristics of Ideal, General design and Different parts of typical Fermenter). Antifoaming agents. **Fermentations**: Definition and Types- Batch and Continuous (comparison), Solid and Liquid state, Surface culture and Submerged culture, Single, Dual / Multiple culture. **Types of Fermentor**: Continuous Stirred Tank Fermenter, Bubble Column reactors, Air Lift Fermenter Tower fermenter, Fluidized Bed Fermenter, Packed bed reactors (In Brief)	12
2	**Fermentation Media and Microbes in Industrial Microbiology** 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), Nitrogenous materials (Corn steep liquor, Soybean meal, Pharmamedia, Distillers soluble), Precursers B). Industrially important microorganisms & their products (List) C) **Upstream Process:** Primary and Secondary screening, Strain improvement, Inoculum build up, Scale up of fermentation process, Tolerance studies.	12
3	**Downstream Processing** **Downstream process** . Cell mass removal by precipitation, filtration & centrifugation . Cell disruption by physical & chemical methods . Solvent recovery process . Chromatographic separation and industrial product recovery . Drying & crystallization. Quality testing of end product. . Packaging and marketing of product	12
4	**Production of Important Fermentation products**	12
	Industrial production, Fermentation media, Microbes involved, Biochemistry, fermentation conditions, Product recovery operations and Uses of.. • Biomass – Baker's Yeast • Beverages –Wine (Production of Wine) • Antibiotics(Penicillin) • Organic acid (Citric acid) • Amino acids(Lysine) • Enzymes (Amylase)	

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

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. Detection of Auxotrophic mutants.
8. *Replica Plate method.
9. *Isolation of bacterial DNA, Plasmid DNA and Agarose Gel Electrophoresis
10. Digestion of DNA using Restriction Endonucleases and Agarose Gel Electrophoresis
11. *Detection of UV mutagenesis
12. Demonstration of Transformation
13. 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

Distribution of marks for practical examination:

One major experiment …….	10 marks
Two minor experiments 5 × 2 =	10 marks
Viva-Voce	5 marks
Practical Record	5 marks
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 by J.D. Watson.
3. Microbial Genetics by D. Freidfelder
4. Microbial Technology Vol. I & II by A.H. Peppler.
5. Microbial Technology of TCA by A. B. Solunke, V.S. Hamde, P.S. Wakte
6. Principles of Genetics by R.H. Tamarin.
7. Measuring Microbiome by V. S. Wadhai & H. Powar, Lambert Pub. Germany
8. Molecular Biology and Genetic engineering by Narayanan.
9. Fundamentals of Bacterial Genetics by Nancy Trum and J. Trumphy.
10. Industrial Microbiology by A.H. Patel
11. Industrial Microbiology by Prescott & Dunn.
12. Modern Industrial Microbiology & Biotechnology by Nduka Okafoe.
13. The Book of Citric Acid by A.B. Solunke
14. Industrial Microbiology: An Introduction by Wastes, Morgan, Rockey and Highten.
15. Text Book of, Microbial Genetics by P.H.Kumbhare & V.U.Thool Rajani Prakashan, Nagpur
16. Biotechnology by P. Prave
17. Industrial Microbiology by Casida.
18. DNA Chromatography by Doughlas
19. Ion Chromatography by J. Weiss
20. Encyclopedia of Bioprocessing Technology by M.C. Flickinger & S.W. Drew.