

|| ~~North Maharashtra University~~ ||

NORTH MAHARASHTRA UNIVERSITY,
Jalgaon - 425 001

*Syllabus for T.Y. B.Sc.
(Microbiology)*

As per UGC guidelines
(W.e.f. June 2004)

Instruction

Two tutorials and two seminars
shall be conducted per paper,
excluding the regular teaching schedule.

North Maharashtra University, Jalgaon
Syllabus for T. Y. B. Sc. (Microbiology)
w.e.f. July 2004.

Course Structure

1. There will be six theory papers and three practical courses of 100 marks each.
2. The titles of the courses will be as follows –

A. Theory courses (100 marks each)

- | | |
|-------------------------|----------------------------------------|
| i) Microbiology paper | V Microbial Genetics |
| ii) Microbiology paper | VI Microbial Technology |
| iii) Microbiology paper | VII Microbial Metabolism & Enzymology |
| iv) Microbiology paper | VIII Medical Microbiology |
| v) Microbiology paper | IX Immunology |
| vi) Microbiology paper | X Applied & Environmental Microbiology |

B. Practical courses (100 marks each)

- | | |
|------------------------------------|----------------------------------------|
| i) Microbiology practical course | III Medical Microbiology |
| ii) Microbiology practical course | IV Microbial Biotechnology |
| iii) Microbiology practical course | V Applied & Environmental Microbiology |

3. Each theory course will be covered in four periods per week. Each practical will be covered in four periods per week per batch.
4. A visit to Fermentation Industry, Blood Bank, Research Institution and Dairy or Agricultural College is compulsory. Students are required to prepare TOUR REPORT at the time of practical examination

Paper V MICROBIAL GENETICS

UNIT 1.0 Extrachromosomal DNA

10

- 1.1 Comparative account of DNA and extrachromosomal DNA.
- 1.2 Plasmid.
 - 1.2.1. Types and their significance.

- 1.2.1.1 Conjugal Plasmid
- 1.2.1.2. R plasmid
- 1.2.1.3. Col plasmid.
- 1.2.1.4. Degradative plasmid.
- 1.2.1.5. Other plasmids-pBR322, Ti, Ri Virulence determinants
- 1.2.2 Amplification and curing
- 1.3 Kappa particles.
- 1.4. Petite mutants.

UNIT 2.0 Gene transfer process and recombination

35

- 2.1. Gene transfer mechanisms in bacteria
 - 2.1.1 Transformation
 - 2.1.1a. In Gram positive bacteria
 - 2.1.1b. In Gram negative bacteria (*Haemophilus influenzae*)
 - 2.1.1c. Artificial transformation.
 - 2.1.2. Conjugation
 - 2.1.2a. In Gram negative bacteria
 - 2.1.2b In Gram positive bacteria
 - 2.1.2c. Hfr, F plasmid and F⁺ donor
 - 2.1.3. Transduction
 - 2.1.3a. Generalized transduction
 - 2.1.3b Specialized transduction
 - 2.1.3c Abortive transduction
 - 2.1.4. Mapping
 - 2.1.4.1. Cotransformation
 - 2.1.4.2. Cotransduction
 - 2.1.4.3. Deletion mapping
 - 2.1.4.4. Mapping by interrupted mating experiment.
- 2.2 Genetic Recombination
 - 2.2.1. Types of recombination
 - 2.2.1.1. General recombination
 - 2.2.1.2. Site specific recombination
 - 2.2.1.3 Recombination of non-homologous DNA (Transposition & Illegitimate)
 - 2.2.2. Molecular basis of recombination
 - 2.2.2.1. Copy choice model
 - 2.2.2.2. Breakage and union model (Holliday's model)
 - 2.2.3. Transposons
 - 2.2.3.1. Types of transposons

- 2.2.3.1a. IS elements
- 2.2.3.1b. Composite transposon
- 2.2.3.1c. Tn3 transposons
- 2.2.3.1d. Transposable bacteriophage
- 2.2.3.2. Characteristics of transposons
- 2.2.3.3. Mechanism of transposition (J. Shapiro model)

UNIT 3.0. Gene Regulation **10**

- 3.1. Modes of regulation
- 3.2. Regulation of operon by inducible-constitutive system and repression
- 3.3. The model of lactose operon
 - 3.3.1. Positive regulation
 - 3.3.2. Negative regulation
- 3.4. Tryptophan operon
- 3.5. Isolation of mutants
 - 3.5.1. Constitutive mutants
 - 3.5.2. Permease defective mutants
 - 3.5.3. Lac Z mutant

UNIT 4.0. DNA Damage and Repair Mechanisms **15**

- 4.1. Photoreactivation
- 4.2. Dark repair
- 4.3. Excision repair
- 4.4. Recombination repair
- 4.5. SOS repair

UNIT 5.0. Techniques in Genetics **15**

- 5.1. rDNA technology- Concepts and applications
- 5.2. Blotting techniques
 - 5.2.1. Northern blotting
 - 5.2.2. Southern blotting
 - 5.2.3. Western blotting
 - 5.2.4. Dot and Slot blots
- 5.3. Construction of gene libraries

UNIT 6.0. Eucaryotic Genetics

- 6.1. Eucaryotic chromosome structure
- 6.2. Chemical composition of chromosome
- 6.3. Lampbrush chromosome
- 6.4. Polytene chromosome
- 6.5. Polyploidy
- 6.6. Tetrad analysis
- 6.7. Transfection
- 6.8. Protoplast fusion with applications

Recommended Books

1. Benjamin, L., (2000), *Genes VIII*, Oxford University Press Inc., New York.
2. Dale, J. W., (1994), *Molecular Genetics of Bacteria*, John Wiley and Sons Inc., New York.
3. Freifelder, D., (1993), *Microbial Genetics*, Jones And Bartlett Publishers, Inc.
4. Gardner (1994), *Principles of Genetics*, 8th Ed., John Wiley and Sons Inc., New York.
5. Glazer, A. N., (1995), *Microbial Biotechnology*, Academic Press, London.
6. Jogdand, S. N., (1997), *Gene Biotechnology*, Himalaya Publishing House, Mumbai
7. Lewin, B., (1994) *Genes V*, Oxford University Press, Oxford.
8. Malacinski, G. M. and Freifelder, D., (1998) *Essentials of Molecular Biology*, Jones and Bartlett Publishers, Inc.
9. Strickberger, M. W., (1995), *Genetics*, Prentice Hall of India, Pvt. Ltd., New Delhi
10. Sundara Rajan, (2000), *Genetics*, Anmol Publications Pvt. Ltd., New Delhi.
11. El-Mansi, E. M. T and Bryce, C.F.A (2002) *Fermentation Microbiology and Biotechnology*, Taylor and Francis Ltd., London

Paper VI. MICROBIAL TECHNOLOGY

UNIT 1.0. Types of Fermentation	10
1.1. Single fermentation	
1.2. Batch fermentation	
1.3. Continuous fermentation	
1.4. Dual or multiple fermentation	
1.5. Surface fermentation	
1.6. Submerged fermentation	
1.7. Solid-state fermentation.	
UNIT 2.0. Strain Improvement	12
2.1. Criteria of ideal strains for fermentation	
2.2. Methods of strain improvement	
2.2.1. Programme for primary metabolites	
2.2.1a. Modification of permeability	
2.2.1b. Isolation of mutants not producing any inhibitors or repressors	
2.2.1c. Isolation of mutants not recognizing the presence of inhibitors or repressors	
2.2.2. Programme for secondary metabolites	
2.2.2a. Isolation of resistant mutants	
2.2.2b. Isolation of revertant mutants.	
UNIT 3.0. Development of Inocula For Industrial Fermentations	10
3.1. Development of inocula for yeast, bacterial and fungal processes	
3.2. Criteria of inocula transfer	
3.3. Inoculum transfer with examples.	
UNIT 4.0. Design and Types of Fermenters	10
4.1. Tower fermenter	
4.2. Cylindrico-conical fermenter	
4.3. Air-lift fermenter	
4.4. Stirred tank reactors	
4.5. Biosensors	
4.5.1. Thermal biosensors	
4.5.2. Optical biosensors.	

UNIT 5.0. Scale-up and Process Economics	10
5.1. 'Scale-up' window	
5.2. Scale-down processes	
5.3. Introduction to process economics	
5.3.1. Starting point	
5.3.2. Cost estimates	
5.3.3. Process design	
5.3.4. Design exercise	
5.3.5. Capital cost estimates	
5.3.6. Operating cost estimates	
UNIT 6.0. Quality Control Processes in Fermentation Industry	08
6.1. Carcinogenicity testing	
6.2. Sterility testing	
6.3. Toxicity testing	
6.4. Pyrogen testing	
UNIT 7.0. Bioinsecticides	10
7.1. Introduction	
7.2. Bacteria, microbes other than bacteria, biomass production.	
7.3. Bacterial insecticides	
7.4. Viral insecticides	
7.5. Formulation	
7.6. Advantages and disadvantages.	
UNIT 8.0. Fermentations	30
Large-scale production of the following with respect to organisms involved, inoculum preparation, fermentation media, fermentation process, flow chart, biochemical mechanism, recovery, packaging and storage.	
8.1. Organic acids: Citric acid	
8.2. Organic solvents: Acetone and Butanol	
8.3. Amino acids: L- Lysine and L- Glutamic acid	
8.4. Alcoholic beverages: Beer, Wine and its types	
8.5. Antibiotics: Streptomycin	
8.6. Enzyme: Amylases	
8.7. Vitamin: B ₁₂ .	

Recommended Books

1. Stanbury, P. F., Whitaker, A., Hall, S. J., (1997), Principles of fermentation Technology, Aditya Book Pvt. Ltd., New Delhi.
2. Bu'lock, J. and Kristiansen, B., (1987), Basic Biotechnology, Academic Press, London.
3. Rehm, H. J. and Reed, G., (1983), Biotechnology vol.III, Verlag Chemie, Florida
4. Vyas, S. P. and Dixit, V. K., (1998), Pharmaceutical Biotechnology, CBS Publisher, New Delhi.
5. Casida, L. E., (1991), Industrial Microbiology, Wiley Eastern, New Delhi.
6. Peppler, H. J., Perlman, D., (1979), Microbial Technology, vol I & II, Academic Press.
7. Prescott, S. C. And Dunn, C. G., (1987), Industrial Microbiology, 3rd Ed., McGraw Hill, New York.
8. Rattledge, C. and Kristiansen, B., (2001), Basic Biotechnology, Cambridge University Press.
9. Patel, A. H., (1984), Industrial Microbiology, MacMillan India Ltd., New Delhi.
10. Doelle, H. W., Mitchell, D. V. and Roiz, C. E., (1992), Solid Substrate Cultivation, Elsevier Science Publishers Ltd., England.

Paper VII MICROBIAL METABOLISM AND ENZYMOLOGY

UNIT 1.0. Basics of Metabolism	10
1.1. Concept of amphibolism	
1.2. Central role of acetyl-CoA	
1.3. Bioenergetics	
1.4.a. Laws of thermodynamics	
1.4. b. Concept of free energy, entropy and enthalpy	
1.4. c. High energy compounds	
1.4. d. Theories of ATP formation	
1.4. e. Electron Transport Chain	
UNIT 2.0. Degradation of Macromolecules	12
2.1. Polysaccharides: Starch and glycogen	
2.2. Beta oxidation of fatty acids	
2.3. Overview of catabolism of proteins	
2.3.1. Transamination	
2.3.2. Oxidative deamination	
2.3.3. Non oxidative deamination	

UNIT 3.0. Biosynthesis: Concept of polymerization of macromolecules

- 3.1. Polysaccharides: Starch, Glycogen and Peptidoglycan
- 3.2. Protein synthesis
- 3.3. Fatty acids
- 3.4. Nucleic acids

UNIT 4.0. Photosynthesis and bioenergetics

- 4.1. Photosynthesis
- 4.1a. Photosynthetic apparatus
- 4.1b. Cyclic and non cyclic photophosphorylation
- 4.1c. Calvin cycle
- 4.1d. Comparative account of bacterial and plant photosynthesis

UNIT 5.0. Enzyme active sites and coenzymes

- 5.1. Commonly occurring amino acids at the active site
- 5.2. Methods of determination of amino acids at the active site
- 5.3. Role of cofactor in metabolism
- 5.4. Structure and biochemical functions of the following:
 - 5.4a. Nicotinic acid
 - 5.4b. Riboflavin
 - 5.4c. Thiamine
 - 5.4d. Biotin
 - 5.4e. Coenzyme A
 - 5.4f. Folic acid

UNIT 6.0 Enzyme regulation and inhibition

- 6.1. Covalent modification
- 6.2. Proteolytic modification
- 6.3. Allosteric enzymes
- 6.4. Isoenzymes: LDH
- 6.5. Enzyme inhibition
 - 6.5.1. Irreversible
 - 6.5.2. Reversible
 - 6.5.2a. Competitive
 - 6.5.2b. Uncompetitive
 - 6.5.2c. Noncompetitive
 - 6.5.2d. Mixed inhibition
 - 6.5.2e. Partial inhibition
 - 6.5.2f. Substrate inhibition

UNIT 7.0. Enzyme technology	03
7.1. Immobilized enzymes and whole cells	
7.2. Concept of immobilization	
7.3. Methods of immobilization	
7.4. Applications	
UNIT 8.0. Purification of enzymes	15
8.1. Principles of enzyme purification	
8.2. Methods of purification	
8.3. Molecular size	
8.4. Solubility difference	
8.5. Electric charge	
8.6. Adsorption	
8.7. Criteria of purity	
8.8. Characterization of enzyme: Optimum pH, Temperature & Molecular weight.	
8.9. Enzyme assays	
8.9.1. Principles of enzyme assay	
8.9.2. Techniques with suitable example	
8.9.2a. Spectrophotometry	
8.9.2b. Fluorescence spectroscopy	
8.9.2c. Polarometry	
8.9.2d. Electrode method	
8.9.2e. Manometry	
8.9.2f. Radiochemical assay.	
UNIT 9.0. Bioinformatics	05
9.1. Definitions	
9.2. Importance in Life Sciences	
9.3. Applications	
9.4. Biological databases.	

Recommended Books

1. Cohn and Stumph, (1976), Outline of Biochemistry, 4th Ed., John Wiley and Sons, New York.
2. Dixon, M. and Webb, E., (1979), Enzymes, 3rd Ed., Academic Press, New York.

3. Lehninger, A. L., (1982), Principles of Biochemistry, Butterworth Publishers, New York.
4. Moat, A., Foster, J., (1988), Microbial Physiology, 2nd Ed., Wiley Interscience Publications, New York.
5. Palmer, T., (1985), Understanding Enzymes. 2nd Ed., Ellis Horwood Ltd., Chichester
6. Price, N. C., Stevens, L., (1989), Fundamentals of Enzymology, 2nd Ed., Oxford Sci. Publ., Oxford.
7. Rose, A. H., (1983), Chemical Microbiology, 3rd Ed., Butterworth Publishers.
8. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R., (1990), General Microbiology, 5th Ed., MacMillan Edu. Ltd., London
9. Stryer, L., (1988), Biochemistry, W. H. Freeman and Co., New York.

Paper VIII MEDICAL MICROBIOLOGY

UNIT 1.0. Introduction to Medical Microbiology 06

- 1.1. Stages of infectious diseases
 - 1.1.1. Portal of entry of pathogen.
 - 1.1.2. Virulence factors: invasiveness and toxigenicity
 - 1.1.3. Signs, symptoms and syndrome
 - 1.1.4. Epidemiology
 - 1.1.5. Pattern of disease: Chronic, acute etc
 - 1.1.6. Incubation period
 - 1.1.7. Transmissibility: Mode of transmission.
 - 1.1.8. Laboratory diagnosis.
 - 1.1.9. Prophylaxis.
 - 1.1.10. Treatment

Unit 2.0. to 8.0. with respect to anatomy, physiology, portal of entry, virulence, epidemiology, laboratory diagnosis, prophylaxis, treatment.

UNIT 2.0. Skin and ophthalmic system

- 2.1. Leprosy
- 2.2. Dermatophytoses
- 2.3. Wound infection (caused by *S. aureus*)

UNIT 3.0. Respiratory system	10
3.1. Tuberculosis	
3.2. Diphtheria	
3.4. SARS	
UNIT 4.0. Gastrointestinal tract	14
4.1. Typhoid	
4.2. Cholera	
4.3. Amoebic dysentery	
4.4. Shigellosis	
UNIT 5.0. Genito-urinary tract	10
5.1. Syphilis	
5.2. Gonorrhoea	
5.3. Urinary tract infection caused by <i>Proteus</i>	
UNIT 6.0. Central nervous system	14
6.1. Tetanus	
6.2. Rabies	
6.3. Poliomyelitis	
6.4. Meningitis	
UNIT 7.0. Liver	04
7.1. Hepatitis	
UNIT 8.0. Immune system	06
8.1. AIDS	
UNIT 9.0. Circulatory system	02
9.1. Malaria	
UNIT 10.0. Veterinary disease	04
10.1. FMD	
10.2. Rinderpest	
UNIT 11.0. Antimicrobial agents	20
11.1. Criteria for evaluation of chemotherapeutic agents	
11.2. Spectrum of activity	
11.3. Action	

- 11.3.1 Inhibition of cell wall synthesis (Penicillins and cephalosporins)
- 11.3.2 Inhibition of protein synthesis (Tetracyclines and chloramphenicol)
- 11.3.3 Inhibition of nucleic acid synthesis (Sulphonamides and Diaminopyrimidines)
- 11.4 Antifungal agents: Polyenes and Griseofulvin
- 11.5. Antiviral agents: Amantadine and Zidovudine
- 11.6. Antiparasitic drugs: Quinine and Metronidazole
- 11.7 Mechanism of drug resistance.

Recommended Books

1. Anantnarayan, P., Paniker, C. K. J., (1990), Textbook of Microbiology, Orient Longman, Madras
2. Atlas, R. M., (1995), Microorganisms in our world, Mosby Year Book Inc.
3. Davis, B. D., Dulbecco, R., Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore.
4. Dey, N. C. and Dey, T. K., Medical Bacteriology and Microbiology, 16th Ed., Allied Agency, Calcutta.
5. Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C Brown Publ., England
6. Tortora, G. J., Funke, B. R. and Case, C. L., (1994), Microbiology, 5th Ed., Benjamin Cummings Inc., California
7. Zinsser, H. (1938), Microbiology, 19th Ed., Joklik, W. K., Willett, H. P., Amos, D. B., Wilfert, C. M., Prentice Hall International, Inc.

Paper IX IMMUNOLOGY

UNIT 1.0. Cells and organs involved in immune system	10
1.1. Blood cells: Morphology, formation function	
1.2. Lymphoid organs: Structure, function of	
1.2.1. Thymus	
1.2.2. Bone marrow	
1.2.3. Spleen	
1.2.4. Lymph node.	
UNIT 2.0. Concept of Antigen and Antibody	15
2.1. Antigen	
2.1.1. Concept of antigen	
2.1.2. Types of antigen	
2.1.3. Factors affecting antigenicity	

- 2.1.4. Antigen specificity (Hapten)
- 2.1.5. Carriers
- 2.1.6. Epitopes
- 2.2. Antibody
 - 2.2.1. Structure and classification of antibody
 - 2.2.2. Burnet's clonal selection theory: Theory of antibody formation
 - 2.2.3. Genetic basis of antibody formation (organization of heavy & light chain genes).
 - 2.2.4. Monoclonal antibodies: Production and applications.

UNIT 3.0. Immunological Techniques (Antigen-Antibody reaction)	08
3.1. Agglutination	
3.2. Precipitation	
3.3. Radio-Immuno Assay (RIA)	
3.4. Enzyme Linked Immuno Sorbent Assay (ELISA)	
3.5. Immunofluorescence	
3.6. Electrophoretic and gel diffusion technique.	

UNIT 4.0. Protective Mechanisms	25
4.1. Primary and secondary immune response	
4.1.1. Cell interaction in immune response	
4.1.2. Antigen processing and presentation	
4.2. B- cell activation	
4.2.1. Proliferation	
4.2.2. Differentiation	
4.2.3. Memory cells	
4.2.4. Plasma cells	
4.3. T cells	
4.3.1. Effector T cell activation	
4.3.2. Cell Mediated Immunity	
4.3.3. Role of lymphokines.	
4.4. Other protective mechanisms	
4.4.1. Inflammation	
4.4.2. Complement: Classical and Alternative cascade	
4.4.3. Interferon: Introduction, Mechanism and Significance.	
4.4.4. Tumor Necrosis Factor (TNF)	

UNIT 5.0. Hypersensitivity and autoimmune disorders	12
5.1. Hypersensitivity. Types and mechanism in detail (Type I to V)	
5.2. Autoimmune diseases. concept	
5.2.1. Anaemia	
5.2.2. Rheumatoid arthritis	
5.2.3. Diabetes	
UNIT 6.0. Tissue transplantation	10
6.1. Major histocompatibility complex: Structure and role of HLA.	
6.2. Transplantation: Types of graft, Graft rejection.	
6.3. Immunosuppression and immunotolerance.	
UNIT 7.0. Immunoprophylaxis	12
7.1. Vaccines: Types with one example	
7.2. Immune sera, Antitoxin sera: types, production with one example.	
7.3. Quality control of vaccines and sera.	
7.4. Immunization schedule in India.	
UNIT 8.0. Blood grouping: ABO and Rh	08
8.1. Biochemistry of blood group substances	
8.2. ABO and Rh inheritance.	
8.3. Clinical importance (HDN).	

Recommended Books

1. Ananthnarayan, P., Paniker, C. K. J., (1990), Textbook of Microbiology, Orient Longman, Madras.
2. Banker, D. D., (1980), Modern Practice in Immunization, 3rd Ed., Popular Prakashan Pvt. Ltd., Bombay.
3. Coleman, R. M., Lombard, M. F., Sicard, R. E., (1989), Fundamental Immunology, 2nd Ed., W. C. Brown Publishers, USA.
4. Glazier, A. M., Nikaido, H., (1995), Microbial Biotechnology, W. H. Freeman and Co., New York.
5. Kimball, J. W., (1990), Introduction to Immunology, MacMillan Publishing Company, New York.
6. Kuby, J. W. H., (1994), Immunology, Freeman and Company, New York.
7. Roitt, E. M., (1988), Essential Immunology, ELBS, Blackwell Sci. Publ., Oxford.

8. Vyas, S. P. and Dixit, V. K., (1998), *Pharmaceutical Biotechnology*, CBS Publisher, New Delhi.
9. Weir, D. M., (1991), *Immunology*, Livingstone, ELBS and Churchill.

Paper X APPLIED AND ENVIRONMENTAL MICROBIOLOGY

UNIT 1.0. Soil microbiology	12
1.1. Types of soil and soil microbes	
1.2. Composition of different types of soil.	
1.3. Rhizosphere	
1.4. Biogeochemical cycles: C, N, S, P.	
1.5. Bioremediation of soil	
1.5.1. Pesticide degradation	
1.5.2. Xenobiotics	
1.6. Degradation of Cellulose, Hemicellulose, Lignin and Pectin.	
UNIT 2.0. Geomicrobiology	12
2.1. Scope	
2.2. Microbial leaching and beneficiation of ore	
2.3. Laboratory Process	
2.4. <i>In situ</i> leaching	
2.5. Pyrite ore and manganese leaching.	
UNIT 3.0. Plant pathology	15
3.1. Classification of plant disease based on symptoms	
3.2. General methods of plant disease control	
3.3. Study of plant diseases with respect to,	
3.3.1. Wilt of cotton	
3.3.2. Citrus canker	
3.3.3. Downy Mildew of grapes	
3.3.4. Whip smut of sugarcane	
3.3.5. Tikka disease of groundnut.	
UNIT 4.0. Milk microbiology	16
4.1. Milk: Definition, Composition and Types.	
4.1.1. Microbiological examination of milk	
4.1.2. Test for mastitis; MBRT and Resazurin	
4.1.3. Dye reduction test	

- 4.1.4. Brucella ring test
- 4.2. Pasteurization
 - 4.2.1. Principle
 - 4.2.2. Types
 - 4.2.3. Efficiency
- 4.3. Spoilage of milk
 - 4.3.1. Succession of microorganisms in milk
 - 4.3.2. Colour and flavour defects
 - 4.3.3. Sweet curdling, stormy fermentation, ropiness.
- 4.4. Fermented milk
 - 4.4.1. Acidophilus milk
 - 4.4.2. Yoghurt

UNIT 5.0. Food microbiology

26

- 5.1. Cheese: General production
- 5.2. Study of following cheese types with respect to production, process changes during ripening and defects.
 - 5.2.1. Cheddar cheese
 - 5.2.2. Cottage cheese
 - 5.2.3. Swiss cheese
- 5.3. Food fermentations
 - 5.3.1. Bread
 - 5.3.2. Idli
 - 5.3.3. Sauerkraut
- 5.4. Food preservation
 - 5.4.1. Principles and methods
- 5.5. Microbial food poisoning
 - 5.5.1. Food poisoning of the following microorganisms with respect to toxins, their effect, properties of toxins and treatment.
 - 5.5.1a. *Staphylococcus aureus*
 - 5.5.1b. *Bacillus cereus*
 - 5.5.1c. *Clostridium botulinum*
 - 5.6. Food infection: sources and prevention
 - 5.6.1. *Salmonella*
 - 5.6.2. *Vibrio parahaemolyticus*
 - 5.7. Aflatoxins: structure, detection, mode of action and detoxification.

UNIT 6.0. Waste Treatment

14

- 6.1. Types of wastes: Characterization of solid and liquid wastes.
- 6.2. Solid waste management: Composting.
- 6.3. Liquid waste management: Aerobic and Anaerobic methods.

UNIT 7.0. Air pollution

05

- 7.1. Sources and classification of air pollutants.
- 7.2. Effects of air pollution on human health
- 7.3. Green House Effects
- 7.4. Acid rain

Recommended Books

1. Adams, M. R., Moss, M. O., (1995), Food Microbiology, New Age International, New Delhi.
2. Barwart, G. J., (1987), Basic Food Microbiology, CBS Publ., New Delhi.
3. Bilgrami, K. S., Dube, H. G., (1994), Text book of Modern Plant pathology, Vikas Publ., New Delhi.
4. Frazier, W. C., Westhoff, D. C., (1988), Food Microbiology, Tata McGraw Hill, New Delhi.
5. Kuderia, V. P., (1998), Water Pollution, Pragati Pralkashan, Meerut.
6. Martin Alexander, Introduction to Soil Microbiology, 2nd Ed., Wiley Eastern Ltd.
7. Mitchell, R. (1974), Introduction to Environmental Microbiology, Prentice Hall, New Jersey.
8. Pathak, V. N., Khatri, N.K., Pathak, M., (1996), Fundamentals of Plant Pathology, Agro-botanical Publ., Bikaner.
9. Powar, C. B., Dagainwalla, H. F., (1990), General Microbiology, vol. I & II, Himalaya Publishing House, Mumbai.
10. Rao, M. N. and Rao, H. V. N., (1989), Air Pollution, Tata McGraw Hill Publ., Company, Ltd., New Delhi.
11. Salle, A. J., (1990), Fundamentals of Microbiology, Tata McGraw Hill, New Delhi.
12. Winton, A. L., Winton, K. B., (1998), Milk and Milk Products, Agro-botanical Publ., Bikaner.

**PRACTICAL COURSE - III
MEDICAL MICROBIOLOGY**

- 1.0 Isolation and identification of pathogens from following samples:
 - 1.1. Urine sample: *Proteus*
 - 1.2. Stool sample: *Salmonella, E. coli*
 - 1.3. Pus sample: *Staphylococcus, Pseudomonas*.
- 2.0 Demonstration of growth of pathogens on following selective media:
 - 2.1. Mannitol Salt agar.
 - 2.2. Wilson and Blair's medium.
 - 2.3. *Salmonella-Shigella* agar.
 - 2.4. Eosin Methylene Blue agar.
 - 2.5. Cystine Lactose Electrolyte Deficient (C.L.E.D.) with bromothymol blue and Andrade's indicator.
 - 2.6. Triple Sugar Iron (TSI) agar
 - 2.7. Cetrimide agar
- 3.0 Determination of Minimum Inhibitory Concentration of antibiotic (MIC).
- 4.0 Antibiotic sensitivity test
- 5.0 Widal test (Qualitative and Quantitative)
- 6.0 Occult blood test.
- 7.0 Cultivation of *Candida* by slide culture technique
- 8.0. Demonstration of permanent slides. *Plasmodium, Entamoeba histolytica*.
- 9.0. Visit to blood bank.

**PRACTICAL COURSE IV
MICROBIAL BIOTECHNOLOGY**

1. Laboratory scale production of ethanol, estimation, recovery and yield calculation.
2. Laboratory scale production of citric acid, estimation and recovery and yield calculation.
3. Biological assays of Penicillin
 - 3.1 Streptomycin
 - 3.2 Vitamin B₁₂.
4. Detection of tolerance to dyes using gradient plate technique.
5. U.V survival curve.
6. Separation of proteins / DNA by electrophoresis

7. Sterility testing for injectables.
8. Paper chromatography: sugar and amino acids.
9. Thin Layer Chromatography: sugar and amino acids.
10. Determination of specific activity of invertase.
11. Study of spontaneous mutation by Fluctuation test.
12. Isolation of bacteriophage.
13. Visit to Industry or Research Organization.

PRACTICAL COURSE V APPLIED AND ENVIRONMENTAL MICROBIOLOGY

- 1.0. Isolation and identification of agriculturally significant microorganisms from the following samples:
 - 1.1. Root nodules: *Rhizobium*
 - 1.2. Infected citrus fruit or leaf: *Xanthomonas*
 - 1.3. Ground nut leaf (Tikka disease) *Cercospora*
 - 1.4. Soil: *Azotobacter*.
- 2.0. BOD and COD tests.
- 3.0. Tests for milk and dairy products.
 - 3.1. MBRT test.
 - 3.2. Phosphatase test.
 - 3.3. Estimation of fat: Gerber's method.
 - 3.4. Total count: Neubauer's chamber.
- 4.0. Isolation and characterization of food fermenting organisms from Idli batter.
- 5.0. Preparation and application of biofertilizer.
- 6.0. Detection of anaerobic bacteria.
- 7.0. Introduction to internet : Websites related to microbiology.
- 8.0. Visit to dairy or agricultural college.

Recommended Books

1. Anuja, K. R. (1996) Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, 2nd Ed., Wishwa Prakashan, New Delhi (New Age International, Pvt. Ltd.).
2. Harley, J.P. and Prescott, L. M. (1996) Laboratory Exercises in Microbiology, 3rd Ed., WCB / McGraw Hill Inc.
3. Jayaraman, J. (1981) Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.

4. Mackie and McCartney (1989) Practical Medical Microbiology, 13rd Ed , Collee, J. E., Duguid, J. P., Fraser, A. G., Marmion, B. P., Churchill Livingstone International Student Ed.
5. Plummer, D. T (1992) An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi.

Examination Structure
Microbiology paper V to X
(Each of 3 hours duration)

1. There will be SIX questions in each of these theory courses. Question 1, 2, 4 and 5 will carry 16 marks and question 3 and 6 will carry 18 marks with sufficient internal options. The weightage of marks for numerical problems will be 10-20% in paper X and the weightage of marks to various topics in the syllabus will be given strictly according to the number of lectures assigned to the respective topics in the syllabus.
2. The total marks including options for each paper will not exceed 150
3. Each practical paper will have three Major Experiments (20 marks each) and two Minor Experiments (10 marks each). 10 marks will be reserved for Viva-Voce and 10 marks for spotting (5 spots per course having 2 marks per spot).