Shivaji University, Kolhapur
Introduced from June 2006
Syllabus for M.Sc. T. & D (Microbiology)-Part I

Structure for M.Sc. Part - I & II (T. & D.) Course.

MIC T/D – 01: Morphology , Cytology and Taxonomy of microorganisms.
MIC T/D - 02 : Virology.
MIC T/D - 03: Microbial genetics.
MIC T/D - 04: Medical microbiology and immunology – I
MIC T/D - 05: Biochemical, Biophysical and Microbiological techniques.
MIC T/D - 06: Molecular biology and genetics.
MIC **T/D -**07 : Microbial physiology, Biochemistry and Metabolism.
MIC T/D -08 : Medical microbiology and immunology.- II

M.Sc. Part - II (T. & D.)

MIC T/D -09: Biostatistics, Bioinformatics and Scientific writing.
MIC T/D -10: Enzymology and enzyme technology
MIC T/D -11 : Microbial Technology.
MIC T/D -12 : Microbial Diversity and Extremophiles.
MIC T/D -13: Food and Dairy microbiology
MIC T/D -14: Fermentation technology
MIC T/D -15: Industrial waste management.
MIC T/D -16 : Biotechnology (Agricultural and Environmental)

MIC T/D – 01: Morphology , Cytology and Taxonomy of microorganisms.

1.) Surface properties of bacteria and significance
2.) General characteristics and outline classification of Rickettsias , Chlamydiae.
3.) Outline classification of algae , algal cell structure and reproduction , microalgae .
4.) Outline classification of fungi, structure of fungal cell- hyphae and nonmotile unicells, motile cells and spores.
5.) General characteristics of Lichens and Mycorrhizae.
6.) Bacterial nomenclature and classification:
    A) Principles of bacterial nomenclature
    B)Classification of prokaryotic organisms- an overview.
    B) Numerical taxonomy, chemotaxonomy, genetical and serological methods used in classification.

MIC T/D - 02: Virology

1) Bacterial viruses –

a)one step growth experiment, Single burst and premature lysis experiments.

b) Productive cycle of lambda and phi –X –174 virus.

c)Lysogeny – brief details on P2,P22, P1 and Mu 1 phages.

d) RNA phages.

e) Isolation and cultivation of bacteriophages .

2)Animal viruses ;

productive cycle of :

a) DNA viruses-Parvo, Adeno viruses.

b) RNA viruses – Reo, Rhabdo, Picorna, Influenza and Retroviruses.

c) Cultivation of viruses in embryonated eggs, experimental animals and cell lines, enumeration of viruses (Electron microscopic method , plaque method and end point method).

3)Plant viruses –

a) Classification

b) Transmission (vector and non vector).

c) Effects of viruses on plants.

d) Common viral diseases of plants – TMV.

4)Inhibition and inactivation of bacterial ,plant and animal viruses –photodynamic inactivation by physical and chemical agents, antiviral chemotherapeutic agents.

5)Interferon – definition , types , nomenclature and classification, induction of interferon. Molecular basis of antiviral state, antiviral effect of interferon, antiviral proteins,-

- double stranded RNA dependent and ds RNA independent pathways.

MIC T/D-03: Microbial genetics.

1)Classical genetics – origin of life, organic evolution, Darwinism and Mendelism.

2) Genentic material :

a) Evidences for nucleic acids as genetic material.

b) Watson and Cricks model of DNA structure ,alternative forms of DNA.

3)Organization of genetic material :

a) Viruses: Nature of gentic material unfolding and packaging of viral genetic material .

b) Bacteria : folded fibre model of *E. coli*.

c) Eucaryotes : Nucleus, nucleosomes, Euchromatin and heterochromatin, histones and non histone proteins, chromosomes banding and aberration, Giant chromosomes, satellite DNA .

4)Duplication of chromosomes and DNA :

a) DNA replication in *E.coli* - rules and enzymes involved, theta and rolling circle model.
b) Nucleic acid replication in viruses – basic model – rolling circle , theta and linear DNA replication.
c) Organelle DNA replication – chloroplasts and mitochondria
d) Chromosome duplication – Taylor`s experiment, Dupra`s folded fibre and alternative folded fibre models of metaphase chromosomes.

5)Plasmids : Nomenclature and classification, general properties and types; Detection and purification, amplification and rearrangements, replication and transfer processes, plasmids in Yeasts.

6)Mobile elements in prokaryotes and eucaryotes – Insertion sequences , transposons , transposable elements and their properties , detection and significance ,retroposons , J. shapires model of replicative transposition.

MIC T/D-04: Medical microbiology and immunology – I

1) Virulence – establishment, spreading , tissue damage and antiphagocytic factors, mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts, measurements of virulence.

2) Bacterial resistance to humoral defence mechanisms, coagulase reacting factor, lysozyme, lactoferrin and transferin.

3)Microbial toxins – characteristics, purification, mode of action and assay of following toxins- Diphtheria, Cholera, *Vibrio parahemolyticus*. Clostridia, staphylococcal and lipopoysaccharide endotoxins of Gram negative bacteria.

4)Host defence mechanisms – non specific defence mechanism, phagocytosis and antibody production and sensitization of T- cells.

5)Primary and secondary lymphoid organs ; Antigen presentation and MHC restriction , signal transduction in regulation of lymphocyte function.

6)Effect of sex hormones , nutrition and ageing on the immune response.

7)Antibodies – basic structure and types, generation of antibody diversity, evolution of antibodies , mechanism of elimination and persistence of foreign antigens in the tissue, Abzymes and immunotoxins .

8)Complement system – terminology , components , methods of detection and quantitation , classical and alternate complement pathways , regulation of complement pathways , biological consequences of compliment activation ,complement polymorphism , evolution of complement component.

MIC T/D 05: Biochemical, Biophysical and Microbiological Techniques

A. Biochemical techniques:

1.)Preparative techniques:

a.)chromatography – principles, materials and applications of

i.)column chromatography:-

Adsorption – hydroxylapatite, ion exchange, affinity chromatography.

Partition – normal phase, reverse phase, ion pair reverse phase,chiral , counter current,

molecular exclusion chromatography, High Performance Liquid chromatography(HPLC)

Gas Liquid chromatography(GLC)

ii.) Planar chromatography- paper, thin layer chromatography.

b.)Electrophoresis – General principles, Moving boundary and zonal electrophoresis, Electroendoosmosis.

i.)Protein electrophoresis- SDS-PAGE, native gels, gradient gels, IEF,2-D PAGE, cellulose acetate, continuous flow.

ii.)Nucleic acid electrophoresis- DNA sequencing gels, pulsed field gel electrophoresis(PFGE), RNA electrophoresis.

iii.) Electrophoresis of other molecules – polysaccharide and glycoproteins, lipoproteins etc.

c.) Centrifugation – Basic principles and types of centrifuges and rotors.

Principles and methods of differential, density gradient centrifugation, centrifugal elutriation, analytical centrifugation .

d.)Microfilm ultrafilteration – principles, materials used and applications .

Nanofilteration, reverse osmosis.

2.)Analytical techniques :

a.)Immunochemical techniques – general principles and applications of immunodiffusion, immunoelectrophoresis, radioimmunoassay, enzyme linked immunosorbent assay, fluorescence immunoassay, immunoblotting, immunohistochemistry.

b.) Radioisotopic techniques- nature of radioactivity, methods of detection and measurement, methods of application – tracer , autoradiography .

c.) Spectroscopy – general principles of electromagnetic radiation spectroscopy. Principles, instrumentation and applications UV – visible spectrophotometry, turbidimetry and nephelometry, fluorimetry, luminometry, atomic absorption and mass spectroscopy.

d.)Electrochemical techniques – electrochemical cells, potintiometry and voltametry . principles and applications of ion selective and gas sensing electrodes, pH, oxygen electrodes and redox couples.

e.) Principles, apparatus, functioning and applications of nanometry .

B.) BIOPHYSICAL TECHNIQUES :

i.)X-ray diffraction analysis and crystallography .

ii.)circular dichroism and optical rotory dispersion spectroscopy.

iii.) Infra red and Raman spectroscopy.

iv.)Electron spin and nuclear magnetic resonance spectroscopy.

C.) MICROBIOLOGICAL TECHNIQUES :

i.) Principles and methods of enrichment and isolation of bacteria, fungi, algae, protozoa and viruses.

ii.) Electron microscopy – basic principles and applications of transmission and scanning electron microscopy, methods of sectioning and staining of specimens for microscopy .

MIC T/D 06 : MOLECULAR BIOLOGY AND GENETICS

1.) Molecular aspects of gene regulation and expression :

a.) Genetic code- Deciphering of genetic code and important properties of genetic code

b.) Transcription in prokaryotes and eucaryotes – structures of rRNA, tRNA and mRNA, antisense RNA and its significance, post transcriptional processes.

c.)Translation in prokaryotes and eukaryotes – operon models- lactose, tryptophan and arabinose, Britten and Davidson`s model, post translational processing.

d.) Environmental factors in gene expression

2.) Proteins- cellular storage and secretions, protein sequencing and protein engineering.

3.)Terratogenesis – genetic disorders and differential gene activity, genetic counseling.

4.) Molecular biology of oncogenesis, neoplastic transformation, theories of oncogenesis

5.) Law of DNA constancy and redundancy, dosage compensation, genetic load, C-value paradox, Cot curves and DNA reassociation constant.

6.)Techniques – PCR, LCR, RELF, DNA foot printing and finger printing, chromosome walking blotting techniques, gene sequensing and mapping, DNA melting, gene targeting, cloning (animal ; Human genome project) nick translation, hybrid release and hybrid arrest translation, colony hybridization, drug targeting.

MIC T/D 07 : MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND METABOLISM

1.) Protein chemistry:

a.)Amino acids – classification, structural features and chemical reactions.

b.) Reverse turns, Ramchandran plot, helix coil transition.

2.) Carbohydrate chemistry ;

a.) Nomenclature, types and structures.

3.) Lipid chemistry :

a.) Fatty acids – types and nomenclature.

b.) Types of lipids and structural aspects

c.) Steroids, Terpenes and prostaglandins.

4.) Vitamins :

a.) Water and fat soluble.

b.) Structures and functions of vitamins.

5.)Chemistry of porphyrins, chlorophylls, cytochromes, hemoglobin, leg hemoglobin, bacteriorhodopsin.

6.) Electron transport chain :

concept, components involved, electron transport and oxidative phosphorylation, theories of ATP formation.

Bacterial Electron Transport Chain- photosynthetic and non photosynthetic, aerobic and anaerobic bacterial ETC.

Mitochondrial ETC : structure of mitochondria, mitochondrial ETC, shuttle systeme across membrane, Atkinson`s energy change.

7)Oxygen toxicity – study of catalase, peroxidase, super oxide dismutase, mechanism of O_2 toxicity.

7.)Microbial hormones and their significance.

MIC T/D 08 : MEDICAL MICROBIOLOGY AND IMMUNOLOGY- II

A.)Medical microbiology :

a.) Diseases caused; morphological, cultural, biochemical,antigenic characteristics; laboratory diagnosis, transmission, prevention and control of -

Helicobacter pylori, Leptospira icterohaemorrhagiae, Bordetella purtusis, Yellow fever virus, Japanese encephalitis virus, Dengue fever virus,

b.) AIDS and prevalence of Tuberculosis, Mycoplasma and Cryptococcus infection.

c.)Rapid methods of identification of infectious microorganisms : API for enterobacteria, ELISA, FAT, RIA, and western blot techniques.

d.) i.) Collection and transport of clinical specimens, preliminary processing of specimens (conjuctiva, throat swab, alimentary tract, urinogenital tract, ear, blood etc.)

ii.) Serological tests – Widal, test for brucellosis, ASO, cold heamagglutination test, Paul –Bunnel test, Weil- Felix test, streptococcus – MG test, tuberculin test, PCR based diagnostic tests.

B.) IMMUNOLOGY

1.) Major Histocompatibility Complex – inheritance and arrangement of MHC genes, Cellular distribution, structures and function of MHC antigens,Human HLA complex, Class I and class II molecules, HLA typing. 5

2.) Immunity to infection : 4

i.)Viral – antigenic drift and shift, Interferon, Interleukin, Humoral and cell mediated immunity.

ii.) Bacteria – Phagocytosis, role of complement and antibody, Role of CMI and activated macrophages, bacterial strategies to avoid cytophagosis.

3.) Tumor immunology – Cellular adaptations, tumor – host relationship, tumor specific antigen, immune response to tumor, immunosurveillance, natural immunity to tumors, immunodiagnosis of tumors- detection of tumor markers, alpha feto proteins, carcinoembryonic antigen, and assay, immune escape mechanism, immunotherapy. transplantation, graft versus host reaction.

4)Autoimmunity and autoimmune diseases – sprectrum of autoimmune diseases,genetic factors in autoimmune diseases, pathogenesis etiology and treatment of autoimmune diseases.

M.Sc. T/D -09

List of Reference books recommended.

1. A Biologist's guide to principles techniques of Practical biochemistry by K. Wilson and K. H. Goulding, Edwward Arnold publications.
2. Chromatographic methods by Brathwaite & White.
3. Analytical Chemistry by Robert B. Dilts, Van Nostrand Publications,
4. Introduction to practical biochemistry by D. Plummer, J. Wiley & Sons.
5. Hand book of experimental immunology Vol. I by P. M. Weir (editor) 1978. Black Well scientific publications.
6. Laboratory methods in biochemistry by J. Jayaraman.
7. Methods in Microbiology by Norris and Ribbons, Academic press.
8. Principles and techniques at practical Biochemistry – K. Wilson and J. Walker, Cambridge University Press.
9. Principles of PhysicalBiochemistry – Van Holde, et al., Prentice Hall.
10. Crystallography made crystal clear – G. Rhodes, Academic Press.
11. Introduction to Protein Structure – Branden and Tooze, Garland Publishing Co.
12. Basic Biochemistry 2nd Edition – Lehninger, A. L. (1984) Kalyani Publications, Ludhiyan, New Delhi.
13. Principles of Biochemistry 1st Indian Edition – Lehninger A. L. (1984) LBS Publishers and Distributors Pvt. Ltd., New Delhi.
14. Basic Bio-logical chemistry – Mehlar H. R. and E. H. Orders (1968) Harper and Row Publishers Inc, Newyork.
15. Biochemistry 2nd Edition, - Stryer L. (1981) W. H. Freeman & Company Publishers, San Franchiso.
16. Textbook of Biochemistry, 4th Edition – West E.S.W.R. Tood, H.S. Mason, J.T.V. Burgen (1966) Macmillan Company, New York.

17. Principles of Biochemistry 5th Edition – White A. P. Handler, Pand E. L. Smith 1973) McGrow Hill Koga Kusha Ltd., Tokyo.

18. Biochemistry – by Zubay

19. Bacterial cell structure by Rogers, ASM publications.

20. General Microbiology by stanier etal, 5th Edn.

21. Microbial Ultra structure by Fuller R.

22. Chemical Microbiology by Rose.

23. Microbial and Plant Protoplasts by Peberdy Etal.

24. Biology of Mycoplasma by Smith P. I.

25. Introduction to Fungi by Alexopolus.

26. Bergy's mannual of systemic bacterialogy Vol. 1, 2, 4 Williams, Wilkins & Baltimore, Academic Press.

27. A Mannul of Soil Fungi – Gilman J. C. (1967) Oxford & JBH Publications.

28. Bacterial & Bacteriophage Genetics by Edward A. Birge.

29. Principles of Bacteriology, Virology & Immunity 8th edition (Vol. 4) by Topley & Wilson's.

30. General Virology – Luria.

31. Introduction to Plant Virology – Bos I. (1983) Longman, London & New York..

32. Animal Virology – Fenner, F & White, D. O. (1976) Academic Press Inc., New York.

33. Chemistry of Viruses (2nd edition) – Knight C. A. (1975) Springer Verlag Inc. New York.

34. Virology – Dulbecco R. and Ginsberg H. S. (1980), Harper and Ravi Publishers Inc. New York.

35. Bacterial Physiology and Metabolism by R. J. Sokath.

36. Bacterial Metabolism by Doelle, Academic Press, London.

37. Biochemistry of Microbial growth – by Mandelstam.

38. Methods in Microbiology Vol. 3 A, Norris & Ribbons (eds) Academic Press.

39. Microbial Physiology – Dawes I. W., and Sutherland J. W, (1976) Halsted press, New York.

40. Metabolic Pathways 3rd edition – Greenberg D. M, (1976) Springer Verlag, New York.

41. Molecular Biology of gene – J. D. Watson (1980)

42. Gene expression by Levine Vol. 5, 6, 7 & 8 John Willey & Sons.

43. Recombinant DNA A short course by J. D. Watson, J. Tooze & D. T. Kurtz (1983).

44. Genetic Engineering by Chakravarty, CRC Publications (1981).

45. Molecular Cloning – Manitis Vol. 1, 2, 3 , Old Spring Harber.

46. Microbial Genetics – Freifelder.

47. Principles of Genetics – Gardner, E. J. (1991) John Willey & Sons Publication, New York.

48. A DNA replication – Kornberg A., Freeman Publications, San Fransisco.

49. Principles of Gene Manipulation and introduction to genetic engineering – Old R. R. W. Primrose, S.B. (1986) Black well scientific Ltd., Oxford.

50. Text book of Immunology – Barrette J. T., (1983).

51. Basic and Clinical Immunology – Fundenberg H. (1980), Large Medical Publications, Los Atlos, California.

52. Essential Immonology by Evan M. Roitt, 6th edition (1988) , BLBS/Black Well Scientific Publication.

53. Immunology by Roitt, Brostoff & Male 2nd Edition (1989) Churchill Livingstone/Gower Medical Publishing Co.

54. Immunology and Serology – Philip Carpenter.

55. Biology of Immune response – Abramoff & Lavice, Mac Graw Hill Publishing Co.

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Syllabus for M.Sc. T. & D (Microbiology)-Part II

MIC T/D - 09 : Biostatistics, Bioinformatics and scientific Writing

A) Biostatistics :

1. Introduction : definition of statistics, population and universe, the sample and population, statistical inference, parameter and statics.
2. Handling of bulky data : Constructing a histogram, interpretation of histogram, the normal distribution, the mean, the mode, median and standard deviation, representing the normal curve as a straight line, uncertainties in estimating a mean.,
3. Proportion data : Examples of proportion data : (MPN, sterility testing of medicines, animal toxicity, therapeutic trials of drugs and vaccines, animal toxicity, infection and immunisation studies, e.g.; LD50, ED50, PD50 statistical treatment of proportion data : Chi-sequare test, goodness of fit to normal distribution.
4. Count data : Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.) statistical treatment to count data : Poisson distribution standard error, confidence limits of cout.
5. Analysis of variance : Introduction, procedure, F and t test
6. Regression analysis: Introduction,Types,simple and multiple,linear and nonlinear.,
   Regression lines,regression equation X on Y and Y on X,corelation types
7. Statistical basis of biologcial assays : standard line interpolation assay, parallel line assay (4 points, 6 point assay), Slope ration assay.

B) Bioinfomatics :

14 1. Basics of Internet and e-mail :

a) Connecting to the Internet; Server and router, host and remote computer, Modem, ISP, gateway.

b) Network Communication Protocols - TCP/IP, FTP, Internet Explorer.

c) The World Wide Web - Website, webpage, homepage, URL, http, HTML, SMTP

e) Navigating the www:Search Engines - general purpose, portals and intelligent agents.

2. Computers and internet in bioinformatics, useful sites on www.
3. Databases :
    a) Definition and Nomenclature.
    b) Data Life Cycle – acquisition, modification, use, archiving, repurposing, ddisposal.
    c) Database Technology – architecture and management systems.
    d) Interfaces, softwares and programming languages.
    e) Examples of some Bioinformatics databases.
4. Use of Databases :
    a) Stricture databases – visualization of sltructural data, pattern matching, molecular modeling.
    b) Mapping dat6abases – genomic mapping, types fo maps.
    c) Phylogenetic analysis – an overview.
    d) Collaboration
5. Applications of Bioinformatics in the Pharmaceutical Indusstry;
    a) Drug discovery and development
    b) Pharmainformatics resources

MIC T/D - 10 Enzymology and Enzyme Technology

A. Specificity of Enzymes :

1. Basic concept, types of specificities - substrate and product, bond, group or relative, absolute - stereochemical and spatial.
2. Factors responsible for specificity -\
    a) Physical structure of enzymes - the monomeric and oligomeric enzymes.
    b) Concept of Active Site - Ogston's experiment, Lock and Key and Induced Fit hypotheses.
3. Kinetics of Enzyme activity -
    a) Introduction of Chemical kinetics
    b) Kinetics of Single substrate enzymes catalysed reactions - Wilhelmy's and Brown's work, Henri and Michaelis and Menten derivations, Briggs and Haldane modification.
    c) Significance of the M-M equation and K_m.
    d) Modifications of the M-M equation - Lineweaver - Burk, Eadie-Hofstee, Hanes and Eisenthal & Cornish - Bowden.
    e) Kinetics of multi-substrate reactions
    f) Sigmoidal kinetics - Hill and Adair equations for cooperativity.

B. Catalytic Power of Enzymes :

C. 1. Basic concept of catalysis - activation energy barrier and the transition state theory.

2. Catalytic mechanisms in Chemistry and in Enzymes - acid-base, covalent and electrochemical reactions.

3. Factors enhancing the catalytic efficiency of enzymes proximity and orientation, orbital steering, distortion and strain.

4. Functional groups involved in the catalytic mechanisms -
   a) Amino acids
   b) Cofactors - prosthetic groups, coenzymes, co-substrates.
   c) Metal ions in enzyme function - their role, metal activated and metallo enzymes, ternary complexes

C. Regulation of Enzyme Function :

1.models proposed to explain the mechanism of functioning (MWC and KNF), structural aspects of asparatate : carbamoyl transferase, role of allosteric enzymes inmetabolic regulation (feedback inhibition).

2. Enzymes in orgnaized systems and their role in control of function -
   a) Multienzyme systems - basic concepts, significance and types with examples, structural aspects of pyruvate dehydrogenase and fatty acid synthetase.
   b) Isoenzymes - basic concepts, types with examples and their significance to the cells and to the medical field.

D. EnzymeTechnology :

1. Enzymes in Medical Diagnosis - Lactate dehydrogenase, malate dehydrogenase, Fructose 6 biphosphatase, acid and alkaline phosphatase.,Glucose 6 phosphate dehydrogenase.
2. Enzyme therapy - cancer, Genetic diseases, clotting disorders, Neontal jaundice, surgery, toxicity, artificial cells, enzyme carriers, enzyme probe.
3. Industrial applications - catalysts in the manufacturing and other conversion processes, as analytical tools (enzyme electrode)

Books Recommended :

1. Enzyme Nomenclature - International Union of Biochemists (IUB), Academic Press.
2. Understanding Enzymes - Trevor Palmer, Ellis Horwood Publications.
3. Fundamentals of Enzymology - N.C. Price and L. Stevens, Oxford University Press.
4. Enzymes - P. Boyer, Academic Press.
5. The Enzymes - M. Dixon and E.C. Webb.
6. Advances in Enzymology - Series edited by N.O. Kaplan, Academic Press.
7. Enzyme Structure and Mechanism - A. Fersht, Freeman, USA.
8. Enzyme Biotechnology - Tripathi.

MIC- T/D 11 Microbial Technology

1. Fermentation equipment and its use :
   - i) Basic functions of a fermenter, body construction, aeration, agitation, theories of aeration, oxygen transfer kinetics, baffles.
   - ii) Fermentation broth rheology and power requirements, concepts of Newtonian and non-newtonian fluids, plastic fluids, effect of rheology on heat and oxygen transfer, Reynold's number, power number, aeration number and apparent viscosity.
   - iii) Design of other fermentation vessels: Airlift fermenter, tower fermenter, continuous fermenter, fed batch fermenter, waldhof type fermenter.
   - iv) sterilization of fermentation equipment,air,media,mechanical seal,steam glands

2. Growth and product formation : Concept of primary and secondary metabolites and their control, kinetics of growth and product formation (growth rate, yield coefficient, efficiency), economics.

3. Control of metabolic pathways- Environmental control and genetic control of metabolic pathways.

4. Patents- Introduction, composition of patent, background, patent practice and problems.

5. Computer applications in fermentation technology- General applications and specific applications.

6 Fermentation economics _ A case study,,market potential for product,and fermentation,product recovery cost ,Entrepreneurship, plan for industry, product selection process, site selection, finance, feasibility, excise and legal aspects..

References :

1. Industrial Microbiology by L.E. Casida, John Wiley and Sons INC.
2. Annual reports on fermentation processes vol. I and II, by D. Perlman. Academic press INC.
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
4. Food processing: Biotechnological applications by S.S. Marwaha and J.K. Arora (2000), Asiatech publishers INC.
5. Microbial technology vol. I and II by H.J. Peppler and D. Perlman. Academic Press INC.

MIC T/D – 12: MICROBIAL DIVERSITY AND EXTREMOPHILES

1. Anoxygenic photosynthetic microbes – general characteristics of purple bacteria and green bacteria.

2. Oxygenic photosynthetic bacteria –
a) General characteristics of Cyanobacteria – external and internal features, physiology and ecology. b) General characteristics of Prochlorales.

3. Oxidative transformation of metals –
a) Sulphur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation (habitat and ecological importance of organisms involved), siderophores.
b) Magnetotactic bacteria.

4. Microbial diversity in anoxic ecosystems –
   a) Methanogenic Archaeobacteria (general characteristics).
   b) Mechanisms of reduction of iron, sulphur, manganese, nitrate and oxygen.
   c) Bioleaching of precious metals from ores.
   d) Microbial transformation of carbon, phosphorus, sulphur, nitrogen and mercury.

5. Extremophiles – acidophilic, alkalophilic, thermophilic, barophilic, osmophilic and halophilic microorganisms.

BOOKS:

1. Extremophiles (2000) by B. N. Johri, Springer Verlag, New York.
2. Microbial diversity by (1999) D. Colwd, Academic Press.
3. Bergey's Manual of Systematic Bacteriology (1984), Vols. I and III, Williams and Wilkins, Baltimore Academic Press.
4. Microbial Life in Extreme Environments (1978), by D. S. Kushner, Academic Press Inc. New York.
5. Microbial Ecology (1979), by J. M. Lynch and N. J. Poole. Blackwell Scientific Publications, Oxford.
6. Brock Biology of Microorganisms (2000), 9th Edition, by M. T. Madigan, J. M. Martinko and Jack Parker.
7. Biochemistry, Bioengineering and Biotechnology Handbook (1991), by B. Atkinson et al. Macmillan.

MIC T/D – 13 : Food and Dairy Microbiology

1. Food as substrate for the microorganisms.
2. General princiiples underlying spoilage of foods and different methods of preservation of foods. . I
3. Milk and milk products – Definitions, composition, food and nutritive value of milk, properties of milk and its constituents.
4. Milk borne diseases, antimicrobial systems in milk, sources for contamination of milk.

5. History manufacture and microbiological defects of Butter, cheese, fermented milks, Khoa paneer, shrikand, chakka, creams, basundi, ice-cream defects.
6. Quality and safety assurance in food and dairy industry, sanitation and regulation in food and dairy industry Food and dairy arithmatic, standardization of products and costing.
7. Fermeated loods - Biotechnological approaches
   1) Cultured butter milk,
   2) Gilebi, Punjabi Warri, Dhokala, Pickles - Mango & Lime.
   3) Kefir, Kamiss, Yoghurt, Bulgarian sour milk
   4) Butter and cheese
8. a) Food adultreration and confamination of food with harmful microorganisms. Food laws and standards. Indian & International food saftey laws and standards
   b) BIS laboratory services, BIS product certification and licensing Quality systems certification by BIS.

References

1. Food science, Fifth Edition, Norman N. Potter 1996. CBS Publishers and Distributors.
2. The technology of food preservation. Fourth Edition. Norman W. Desrosier. CBI Publisher and Distributors. Delhi. 1987.
3. Milk & Milk Products - Fourth edition - clarence henry eckles, Tata McGraw Hill publishing company Limited, New Delhi, 1957

MIC T/D -14 Fermentation Technology

1 Production and applications of microbial polysaccharides- Xanthan gum, Dextran, Pullulan, Mannan, Curdlan and Alginate.

2. Typical fermentation processes- industrial production of :
   i) starter culture for food fermentations
   ii) Bacitracin.
   iii) Streptomycin.
   iv) Riboflavin.
   v) Dounurubicin and Lovastatin
   vi) Gibberellin.
   vii) Surfactants

3. Production of mushrooms- production steps, harvesting and preservation, and nutritive value.
4. Microbial production of nucleosides, nucleotides and pigments.
5. Microbial transformations of antibiotics and steroids.
6. Industrial production of distilled alcoholic beverages- Whisky and Brandy.

BOOKS:

1. Industrial Microbiology by L.E. Casida, John Wiley and Sons INC.
2. Annual reports on fermentation processes vol. I and II, by D. Perlman. Academic press INC.
3. Prescott and Dunn's Industrial Microbiology, 4th edition (1982) by Gerald Reed.
4. Food processing: Biotechnological applications by S.S. Marwaha and J.K. Arora (2000), Asiatech publishers INC.
5. Microbial technology vol. I and II by H.J. Peppler and D. Perlman. Academic Press INC.
6. Methods in Industrial Microbiology by B. Sikyta, Ellis Horwood Ltd. Chichester (1983).
7. Industrial Microbiology by A.H. Patel, MacMillan India Ltd.
8. Principals of fermentation technology by P. Stanbury and Allan Whitaker, Pergamon Press (1984).
9. Advances in Applied Microbiology Vols. 9 and 13, by W. W. Umbreit, Academic Press, New York.
10. Essays in Applied Microbiology by J. R. Norris and M. H. Richmond. John Wiley and Sons, Chicester, New Yor

MIC T/D 15 Industrial Waste Management

1. Types and Characterization of industrial wastes:

   Types of industrial wastes, General characteristics of different industrial wastes, pH, suspended solids, volatile solids, COD, BOD and organic carbon.

2. Effects of industrial wastes on aquatic life:

   Effects of industrial wastes of high BOD, effects of waste with toxicants.

3. Microbiology and biochemistry of waste water treatment:

   Introduction, biological treatment, impact of pollutants on bio-treatment, important microorganisms, bio-augmentation, packaged microorganisms use of genetically engineered microorganisms.

4. Waste disposal control and regulations :
   a) Water pollution control, Regulation and limits for disposal into lakes, rivers, oceans and land.
   b) Environmental Impact Assessment (EIA) Environmental Audit (EA).
   c) Water tracing : Need, Tracing problems, criteria for selection of tracer tracing method, significance.

5. Industrial waste treatment in- Dairies, Distilleries, paper and pulp industries, fertilizer industries, Pharmaceutical industries:

   Composition of waste, methods of treatment of wastes.

6. Microorganisms in Waste treatment technology : Source of organisms, enrichment and acclimatization, isolation, treatability tests, mass scale production, mixed cultures, preservation, Applications and future prospects.

Ref:

1. Industrial pollutional control Vol.I, E. Joe. Middlebrooks.
2. The treatment of industrial wastes. 2nd ed. Edmund B. Besselievre, and Max Schwartz.
3. Environmental biotechnology,(industrial pollution management) S.N. Jogdand,Himalaya Publishing house.
4. Water and water pollution hand book, vol.I,Leonard L. Ciaccio
5. Waste water treatment , M.N.Rao and A.K.Datta.
6. Industrial pollution, N. Irving Sax, Van Nostrand Reinhold Company.
7. Encyclopedia of Environmental science and technology, Vol.II, Ram Kumar.

MIC T/D 16 : Biotechnology –(Agricultural and Environmental)

1. Plant Cell Culture : Callus and supension culture, Meristem culture, regeneration and- rogenesis primary and secondary cultures, organ and protoplast culture, formulation of growth media, preparation of inoculum, sorting of cells, choice of growth vessels, storage of cell lines, Micro propagation, Allopheny, artificial seeds, soma clonal variation, protoplast fusion, gene transfer methods and transgenic plants.
   i) Somaclonal variation : applications and limitations, Exploitation for selecting superior phenotypes – disease resistant, stress tolerant, high secondary metabolite producing, Screening procedures.
   ii) Commercial production of tissue cultured plants – (I) Technology transfer, equipment and procedures (ii) Aseptic techniques and control of contamination in a commercial laboratory , pathological indexing, packaging cost analysis marketing.
   iii) Somatic embryogenesis system and artificial seed production technique
2. Biofertilizers and biopesticides – types general methods of production, quality assurance, and application.
3. Recycling and reuse of waste materials agricultural and animal wastes – Production of SCP and mushroom.
4. Enzymes and Pollution : monooxygenases, aminotransferases, bio-energetic enzymes, other metabolic enzymes, enzymatic rectifications.

5. Generation of agriculturally important plants and animals.
   a) Expressing viral coat proteins and bacterial toxins in plants and animals.
   b) Herbicide tolerant transgenic plants, single gene traits.
   c) New colours and patterns in flowers.
   d) Production of human proteins in plants.
   e) Recombinant bovine growth hormone.
   f) Generation of transgenic farm animals.
   g) Production of pharmaceutical proteins in transgenic animals - animal 'pharming'.
   h) Use of antisense RNA in transgenic plant technology.
   i) Regulatory aspects of novel plants and foods.

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