



RKDF UNIVERSITY, BHOPAL

M.Sc. (Microbiology)

REVISED SYLLABUS 2019-2020

Scheme

Semester – I

No	Subject Code	Subject Title	Marks Allotted						
			Assignment Marks		Theory Marks		Practical Marks		Total Marks
			Max	Min	Max	Min	Max	Min	
1	MMB 511	GENERAL MICROBIOLOGY	20	8	80	32	-	-	100
2	MMB 512	MICROBIAL ECOLOGY	20	8	80	32	-	-	100
3	MMB 513	MICROBIAL GENETICS	20	8	80	32	-	-	100
4	MMB 514	ADVANCE TECHNIQUES IN MICROBIOLOGY	20	8	80	32	-	-	100
5	MMB 515 (P)	PRACTICAL I (Based on MMB 511 & MMB 512)	-	-	-	-	50	20	50
6	MMB 516(P)	PRACTICAL II (Based on MMB 513 & MMB 514)	-	-	-	-	50	20	50
Total			80	16	320	128	100	40	500



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M.Sc. (Microbiology)

Syllabus

SEMESTER – I

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	GENERAL MICROBIOLOGY	MMB- 511

Unit - 1

History, Taxonomy and Classification:

History and Scope of microbiology- Contributions of pioneers, Introduction to major groups of microorganisms and fields of Microbiology, Spontaneous generation *versus* biogenesis hypothesis, Whittaker's classification system of prokaryotes. Introduction to Bergey's manual of determinative and systematic classification, Bacterial nomenclature. Size, shape and arrangement of bacterial cells, Structures external to cell wall- Flagella, pili, capsule, sheath and prosthecae, Structures internal to cell wall- Cell membrane, nuclear material, cell wall (Protoplast and Spheroplast), spores, cytoplasmic inclusions, magnetosomes and plasmids. Classification of bacteria – Numerical taxonomy, Chemotaxonomy, Nucleic acid-based, and 16s RNA-based classification. Fatty acid profile and Cell wall composition in classification of bacteria. Based on nutritional requirements, energy derivation, temperature and pH requirement, and salt tolerance.

Unit-2

Microscopy and Staining Techniques- Bright Field, Dark Field, Phase Contrast, Fluorescence and Scanning and Transmission Electron Microscopy, calibration

Stains and staining techniques- Stains and Dyes: classification and types, Types of staining- Simple (Monochrome, Negative), Differential (Gram and Acid fast).

Unit – 3

Isolation of microorganisms Serial dilution to extinction in liquid medium and streaking/spreading on solid medium,. Other methods for isolating bacteria and fungi from soil and water. Replica-plating techniques for isolation of mutants. Identification of isolated microorganisms, Automated identification. Culturing of microorganisms: Solid culturing techniques Solidifying agents, gel surface culture, membrane surface culture, liquid culturing technique.

Unit - 4

Microbial growth – Growth curves: S-shaped and J-shaped growth curves, growth rate and generation time. Growth measurement: Direct count, colony counts, most-probable numbers, biomass measurements, light scattering (turbidometry, nephelometry). Ultrastructure of a bacterial cell –Chemotaxis and Quorum sensing in bacteria. Biology of *Agrobacterium tumefaciens*, *Escherichia coli*, *Saccharomyces cerevisiae*, *Aspergillus* sp. and *Streptomyces* sp.

Unit-5

Principles and methods of sterilization. Physical methods - autoclave, hot-air oven, pressure cooker, laminar air flow, filter sterilization. Radiation methods - UV rays, gamma rays, ultrasonic methods. Chemical methods - Use of alcohols, aldehydes, fumigants, phenols, halogens and hypochlorites. Phenol coefficient. Isolation of pure culture techniques - Enrichment culturing, dilution-plating, streak-plate, spread-plate and micromanipulator.

Recommended Books:

1. Bergey's Manual of Systematic Bacteriology (9th edition) volumes I to IV. 2005. Springer.
2. Methods for General and Molecular Bacteriology (2nd edition) by Gerhardt (Editor-in-Chief) American Society for Microbiology
3. Microbiology (5th edition) Pelczar, Chan and Krieg.1993. Tata McGraw-Hill Education.
4. Brock Biology of Microorganism (9th edition) by Madigan, Martinko and Parker. 2000. Prentice Hall.
5. Introduction to Modern Virology (4th edition) by Dimmock and Primrose.1980. Blackwell.
6. Mathews Plant Virology by R.Hull.2006. Academic Press.



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7. An Introduction to viruses (2nd edition) by Biswas and Biswas.1984. Vani Educational Books.
8. General Virology by Luria, Darnell, Baltimore and Campbell.
9. Introduction to Microbiology by Ross.1986. Addison-Wesley Educational Publishers, Incorporated.
10. Basic Microbiology by Volk and Wheeler.1984. Harper & Row.
11. Introduction to Virology by Smith and Ritche.1980. Chapman and Hall.
12. Bacteriology by Humphries.1974. Murray.
13. An Introduction to Microbiology by Tauro, Kapoor and Yadav.1986. New Age International.
14. Fundamental Principles of Bacteriology by Salle.1984. Tata McGraw-Hill Education.
15. Microbiology: A laboratory manual by Cappuccino and Sherman. Pearson Education India.
16. Plant viruses. M.V.Nayudu, 2006, Prentice Hall.

Practicals

1. Study of typical compound microscope
2. Micrometry & measurement of a fungal spore
3. Determination of cell density by counting chamber
4. Isolation of bacteria from soil, air and water
5. Isolation of fungi from soil
6. Contact slide technique
7. Streak and Pour plate techniques
8. Development of a single colony of a bacterium
9. Preservation of microorganisms, Subculturing on agar slants Preservation in soil Preservation by overlaying cultures with mineral oil Preservation in glycerol stocks
10. Stab culturing technique for motility demonstration
11. Hanging drop technique
12. Simple staining of a bacterium
13. Negative staining of a bacterium
14. Gram staining – Positive and negative



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Syllabus SEMESTER – I

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL ECOLOGY	MMB- 512

Unit-I

Microbial Ecosystems: Population, guilds, communities, homeostasis, Environment and microenvironment, Biofilms, Terrestrial environment, deep surface microbiology. Fresh water environment, lake and river microbiology. Marine Microbiology and Hydrothermal vents.

Unit-II

Diversity, stability and succession: Diversity indices, dominance indices, information statistics indices, Shannon index, Brillouin Index, Rank abundance diagrams, community similarity analysis, Jaccard Coefficient, Sorensen coefficient, cluster analysis. Community stability, stability hypothesis, Intermediate-disturbance hypothesis.

Meaning of succession: Tolerance and inhibition patterns of succession, theories of succession.

Unit-III

Ecology and Genetics

Genetic structure of population: Genotype frequency, allele frequencies.

Mutations and their role in evolution - the neutralist hypothesis - population size and evolution - the role of genetic drift - hybridization and evolution - The role of polyploidy, isolating mechanisms - premating, post mating - problems of the origin of isolating mechanism.

Structure of species - Clones, peripheral population isolates,

Genetics and Ecology of speciations. Mayer's founder principle and genetic evolution in the peripheral isolates - Ecological opportunities for speciation.

Hardy-Weinberg Law: Assumptions, predictions, derivation, extension and natural selection, Measuring genetic variation at protein level, measuring genetic variation at DNA level.

Factors effecting gene frequencies:- Mutation, Random genetic drift, migration, Hardy-Weinberg natural selection, Assortative mating, Inbreeding.

Unit-IV

Interactions and Ecosystem Management

Microbial Interactions: Competetion and coexistence, Gause hypothesis, syntrophy, commensalism and Mutualism, predation, parasitism, and antagonism, Interaction with plants and animals.

Unit-V

Concept of sustainable development: Microbial technology and sustainable development.

Management and improvement of waste land/barren land.

Oil spills, damage and management petroleum and oil shore management.



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3. Microbiology (5th edition) Pelczar, Chan and Krieg.1993. Tata McGraw-Hill Education.
4. Brock Biology of Microorganism (9th edition) by Madigan, Martinko and Parker. 2000. Prentice Hall.
5. Introduction to Modern Virology (4th edition) by Dimmock and Primrose.1980. Blackwell.
6. Mathews Plant Virology by R.Hull.2006. Academic Press.
7. An Introduction to viruses (2nd edition) by Biswas and Biswas.1984. Vani Educational Books.

Practicals

- (1) Isolation and microscopic examination of Myxobacteria, Thiobacteria and Ferrobacteria.
- (2) Isolation of microflora from different ecological niches such as freshwater, mangroves, salt pan bed, hot water spring, acid –zone soil, rhizosphere etc. (any two niches)
- (3) Demonstration microbial Interactions:-competition, syntrophy, antagonism and isolation of nitrogen fixing bacteria.
- (4) Development of biofilm on metal strips.
- (5) Microbial production and processing of polysaccharide schizophyllan.
- (6) Production of protoplast.
- (7) Isolation and purification of Photosynthetic pigments.
- (8) Determination of Shannon index as a measure of evenness H/H_{max} from garden soil.
- (9) Isolation of sulphate reducing bacteria.
- (10) Isolation of bacteria capable of degrading polycyclic aromatic hydrocarbons from oil contaminated earth.



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Syllabus SEMESTER – I

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL GENETICS	MMB- 513

Unit-1

Concept of gene – Muton, recon and cistron. One gene-one enzyme, one gene-one polypeptide, one gene-one product hypotheses. Types of RNA and their functions. Outlines of RNA biosynthesis in prokaryotes. Genetic code. Structure of ribosomes and a brief account of protein synthesis. Operon concept. Regulation of gene expression in bacteria – *lac* operon. Basic principles of genetic engineering - restriction endonucleases, DNA. polymerases and ligases, vectors.

Unit-2

Genetic recombination – Types of recombination: homologous, reciprocal and nonreciprocal. Coefficient of coincidence of double crosses, chiasma interference. Plasmids – Types, properties, functions, detection, amplification, incompatibility and isolation of plasmids. Episomes. Replication and transfer of F plasmid.

Unit-3

MOLECULAR STRUCTURE OF GENETIC MATERIAL: Molecular structure of DNA and RNA - Replication, theories, Gene concept - One gene one polypeptide concept, Identification of DNA and RNA as the genetic material; Microbial Genetics - Conjugation, transformation and transduction and Sexduction; Chromosome mapping in prokaryotes (Virus, Bacteria) and eukaryotes (*Neurospora*, and Man). In vitro transformation – Cold CaCl₂ technique, electroporation and triparental mating. Development of Hfr strains. F⁺ × F⁻, Hfr × F⁻ and F' × F⁻ (sexduction) crosses and their significance.

Unit-4

Recombination in bacteriophages. Genetics of yeast and *Neurospora*. Benzer's studies on r-II locus of T4 bacteriophage to establish the units recon, muton and cistron. Mutagenesis – Mutagens (physical, chemical and biological), types of mutations, molecular mechanism of mutation. Isolation and analysis of mutants. Site-directed mutagenesis, transposon mutagenesis and their applications.

Unit-5

Mitochondrial and chloroplast genomes. Concept of gene structure – Classical geneticist view to modern concept. Experimental evidences for colinearity of the gene and its product. Genetic material – DNA and RNA. Organization of histone genes, rRNA and tRNA genes in prokaryotes and eukaryotes. Constitutive genes, overlapping genes, split genes, regulatory genes, luxury genes, oncogenes and tumour suppressor genes.



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Recommended Books:

1. Chromosome techniques: Theory and Practice. Sharma, A.K and A. Sharma. 1980. Butterworth.
2. Molecular Biology. Freifelder, D. 1990. Narosa Publication House, New Delhi
3. Principles of Genetics. Gardner, E.J and D.P. Snustad. 1996. John Willey, New York.
4. Genetics. Sambamurthy, A.V.S.S. 1999. Narosa Publishing House, New Delhi.
5. Principles of Genetics. Sinnot, E.W., L.C Dunn and T. Dobzhansky 1958. McGraw Hill, New York.
6. Theory and Problems in Genetics. Stansfield, W.D. 1991. McGraw Hill, New York.
7. Genetics. Strickberger, M.W. 1996. 3rd Edn. McMillan, New York.
8. Genetics. Winchester, A.M. 1967. Oxford and IBH., New Delhi.
9. Microbial Genetics. Maloy, S. R., J.E. Cronan and D. Freifelder. 1994. Jones and Bartlett Publishers, UK.
10. Genetics – A Conceptual Approach. Pierce, B. A.2006. 2nd Edn. W.H.Freeman and Company, New York.
11. Principles of Genetics. Gardner, E. J., M. J. Simmons and D. P. Snustad. 2004. 8th Edn. John Wiley and Sons, New York.
12. Genetics – A molecular approach. Russell, P.J. 2006. Pearson Education, USA.
13. Genetics analysis of Genes and Genomes. Hartl, D.L and E.W.Jones. 2001. 5th Edn. Jones and Bartlett Publishers, London.
14. Bacterial and Bacteriophage genetics, 4th Ed.2000.E.A.Birge, Springer publication.
15. Microbial genetics.1995. David Friefelder. Narosa Public. House.

List of Practicals:

1. Bacterial spore staining
2. Lactophenol-Cotton blue mounting of fungi
3. Oligodynamic action of metals
4. Isolation and quantification of bacteriophages from sewage
5. Symptomatic observation of plant virus infection.
6. Estimation of chlorophyll in virus-infected and non-infected leaves
7. Preparations of buffers and pH measurement of buffers
8. General reactions of monosaccharides and specific reactions of individual sugars (glucose, fructose, galactose and ribose)
9. General reactions of amino acids (solubility, ninhydrin reaction)
10. Specific reactions for different amino acids - Xanthoproteic reaction, Millon's test, Glyoxylic reaction
11. Pauly's test, nitroprusside test and Ehrlich's test
12. General reactions (solubility) and tests of fatty acids, glycerol and terpenes
13. Tests for unsaturation
14. Titration of fatty acids
15. Titration curve of an amino acid and calculation of pK and pI values
16. Quantification of monosaccharides



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Syllabus SEMESTER – I

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	ADVANCE TECHNIQUES IN MICROBIOLOGY	MMB- 514

Unit-I

Biophysical Techniques-I: Determination of size, shape and Molecular weight of Macromolecules:- by Viscosity, CD/ORD, Light scattering, diffusion sedimentation and Centrifugation techniques.

UNIT-II

Biophysical Techniques-II: Electrophoresis- Principle and working, Type of electrophoresis- immune-electrophoresis, two-dimensional gel electrophoresis, capillary electrophoresis, Agarose gel, native PAGE and SDS-PAGE, Principle, working and applications of centrifuge.

UNIT-III

Microscopical Techniques: Electron Microscopy: SEM, TEM, Staining procedures and microscopy. Fluorescent Microscopy: Staining procedures and Microscopy, FISH. Laser scanning, confocal microscopy. Scanning tunneling and atomic force microscopy. Immunoelectron microscopy, cryoelectron microscopy.

UNIT-IV

Blotting techniques: Western, southern, northern, Radioimmunoassay.

Unit-V

Other advance techniques: NMR and its biological importance. Site-directed mutagenesis, transcriptional start point mapping, Atomic absorption, Ramanspectrum, X-ray Crystallography.

BOOKS :

- 1 Bioinformatics. Baxevanis A., D. and Quelette, B. F. F. Z
- 2 Bioinformatics. Des Higgins & Willie Taylor
- 3 Bioinformatics Methods and protocols. Macsewer, S.
- 4 Bioinformatics Sequence and genome analysis. Mount, D. W.
5. Computer fundamentals. Nagpal, D. P.

Practicals

- 1) Separation of DNA by agarose gel electrophoresis and estimation of DNA by Diphenylamine method.
- 2) Estimation of RNA by Orcinol method.
- 3) Separation of amino acids by paper chromatography.
- 4) Separation of serum proteins by paper electrophoresis.
- 5) Thin layer chromatography of mycotoxins
- 6) SDS-Page of proteins.
- 7) Performance of affinity chromatography.
- 8) Performance of Gel filtration chromatography.
- 9) Demonstration of blotting technique.[any one].
- 10) Ion exchange chromatography



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Scheme

Semester – II

No	Subject Code	Subject Title	Marks Allotted						
			Assignment Marks		Theory Marks		Practical Marks		Total Marks
			Max	Min	Max	Min	Max	Min	
1	MMB 521	MOLECULAR BIOLOGY	20	8	80	32	-	-	100
2	MMB 522	MICROBIAL FERMENTATION TECHNOLOGY	20	8	80	32	-	-	100
3	MMB 523(a)/ 523(b)/ 523(c)	MEDICAL MICROBIOLOGY/ IMMUNOLOGY/ MICROBIAL ENZYME TECHNOLOGY	20	8	80	32	-	-	100
4	MMB 524	FOOD MICROBIOLOGY	20	8	80	32	-	-	100
5	MMB 525(P)	PRACTICAL III (BASED ON MMB 521 & MMB 522)	-	-	-	-	50	20	50
6	MMB 526(P)	PRACTICAL IV (BASED ON MMB 523 & MMB 524)	-	-	-	-	50	20	50
Total			80	16	320	128	100	40	500



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Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MOLECULAR BIOLOGY	MMB- 521

Unit I

Nucleic acids as genetic information carriers: experimental evidence, DNA structure: historical aspects and current concepts, melting of DNA. The central dogma: Law of DNA-, chromosome-and gene constancy. Evidence that DNA is the genetic material Structure of DNA, RNA and polypeptide. DNA replication: general principles, various modes of replication, isolation and properties of DNA polymerases. Asymmetric and dimeric nature of DNA polymerase, exonuclease activity in eukaryotic DNA polymerases. mechanism of action of topoisomerases.

Unit 2

Retroviruses and their unique mode of DNA synthesis. Relationship between replication and cell cycle. Inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization, altering DNA structure). DNA damage and repair: types of DNA damage (deamination, oxidative damage, alkylation, pyrimidine dimers). Repair pathways – methyl-directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair.

Unit 3

Structural features of RNA (rRNA, tRNA and mRNA) and relation to function. Initiator and elongator class of tRNA, ribosome binding site on mRNA and corresponding site on rRNA, peptidyl transferase activity of 23S rRNA. Transcription: structure of a transcriptional unit, mRNA and coding sequence. Transcription and processing of rRNA and Mrna Capping, polyadenylation and splicing reaction Regulatory signal elements: promoter, hLh motifs. Transcription factors. Translation: ribosomes and tRNAs. Mechanism and regulation of protein synthesis PostTranslational modification of proteins, inhibitors of protein synthesis.

Unit 4

Regulation of gene expression: operon concept, catabolite repression, instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation – *E. coli* lac operon; positive regulation – *E. coli* ara operon; regulation by attenuation – his and trp operons; antitermination – N protein and nut sites in I.

Maturation and processing of RNA: methylation, cutting and trimming of rRNA; capping. Polyadenylation and splicing of mRNA; cutting and modification of tRNA degradation system. Catalytic RNA, group I and group II intron splicing, RNase P.

Unit 5

Protein synthesis: steps, details of initiation, elongation and termination, role of various factors in the above steps, inhibitors of protein synthesis. In vitro transcription and translation systems. BCG and design of vaccine for TB and leprosy. DNA vaccines, design and advantages.

Books:

1. Genes VII. Lewin, Oxford University Press.
2. Molecular Cell Biology (W. H Freeman) by Lodish, Berk, Zippursky.



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PRACTICAL MOLECULAR & MICROBIAL GENETICS

1. Estimation of proteins by Biuret method and Folin Ciocalteau method.
2. Estimation of DNA by Diphenyl amine method.
3. Estimation of RNA by Orcinol method
4. Estimation of Inorganic and organic phosphates by Fiske-SubbaRow method.
5. Estimation of Ammonical nitrogen and nitrates.
6. Strain improvement using chemical mutagens.
7. Isolation of mutants using EMS.
8. UV Survival curve of *E.coli*. or any other bacteria.
9. Study of the repair mechanism for the damage caused by UV radiation.
10. Demonstration of Ames test.



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M.Sc. (Microbiology)

Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL FERMENTATION TECHNOLOGY	MMB- 522

Unit-1

General Principles of Fermentation

Bioreactors: Bioreactor types, immobilized bioreactors, types of fermentation.

Fermentation kinetics and Monod's Model.

Unit-2

Growth kinetics and Monod's Model, Substrate accelerated death, specific growth rate, stringent response, Ntr and Pho system, growth limiting substrate, maintenance energy, growth yield and product formation Process optimization: factors of optimization, rheology of fermentation fluid, oxygenation, and oxygen transfer kinetics. chemostat, turbidostat.

Unit-3

Downstream processes: types of processing units and systems, Storage and packaging methods. Scale up: scale down, criteria involved in scale up. Productivity, power requirements Basic control theory.

Unit-4

Industrial Fermentation Products

Biofuels: Ethanol, Hydrogen, Methane

Antibiotics: β -lactum antibiotics (Synthetic penicillin), Streptomycin, Cephalosporin.

Biopreservative: Lactobacillus sakei. Biopolymers: Xanthan, Polyhydroxyalkanoates.

Thermostable enzymes: Proteases. Biosurfactants: a comparative account.

Unit-5

Food and Healthcare products

Beneficial microorganisms: SCP- Microorganisms used, raw materials used as substrate, condition for growth and production, nutritive value and use of SCP; Fat from microorganisms- Microorganisms used, raw materials, production of fat; Production of amino acids; Production of other substances added to foods. Production of enzymes- amylases, invertase, pectolytic enzymes, proteolytic enzymes, other enzymes. Fermentation- tempeh kedele, soya sauce production, vinegar, lactic acid bacteria fermented food, Dairy based fermented foods- Kefir, yoghurt, cheese and butter; Yeast based fermented foods- bread, wine and beer, various types and processes.

Amino acids: Lysine, Glutamic acid.

Vitamins: riboflavin, Vit. B12. Fatty acids (Palmitate, oleate).

RECOMMENDED BOOKS

1. Solid State fermentation in Biotechnology by Pandey.
2. Industrial Microbiology by Waiter.
3. Fermentation Microbiology and Biotechnology by Mansi.
4. Industrial Microbiology by Patel.
5. Biotechnology: A text book of Industrial Microbiology by Greger
6. Principles of Fermentation technology by Whitaker.
7. Industrial Microbiology by Prescott & Dunn.



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8. Microbial Technology by J.H. Pepler & D. Perlman.
9. Industrial Microbiology by L.E. Casida.
10. Industrial Microbiology by B.M. Miller & W. Litsky.
11. Economic Microbiology by Rose, Vol-I to V.
12. Advances in Applied Microbiology by Ed. Perlman, Series of volumes

PRACTICAL: FERMENTATION TECHNOLOGY

1. Production of citric acid by *A.niger*. Recovery & Fermentation.
2. Estimation of Ethanol by dichromate method.
3. Production of Ethanol by fermentation and recovery.
4. Preparation of Wine from grapes by fermentation.
5. Production of glutamic acid by fermentation.
6. Estimation of bacteria, actinomyces and fungi in soil by dilution – Plating method.
7. Observation of air-borne microflora by petriplate exposure.
8. Effect of pesticides on pure cultures of bacteria.
9. DO Estimation.
10. BOD Estimation.
11. COD Estimation



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Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MEDICAL MICROBIOLOGY	MMB- 523(a)

Unit 1

Early discovery of pathogenic microorganisms, development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora of human body; role of resident flora; normal flora and the human host.

Unit 2

Establishment, spreading, tissue damage and anti-phagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Role of aggressins, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response.

Unit 3

Classification of pathogenic bacteria. *Staphylococcus*, *Streptococcus*, *Pneumococcus*, *Neisseria*, *Cornebacterium*, *Bacillus*, *Clostridium*, Non sporing Anaerobes, Organisms belonging to *Enterobacteriaceae*, *Vibrios*, Non fermenting gram negative bacilli *Yersinia*; *Haemophilus*; *Bordetella*, *Brucella*, *Mycobacteria*, *Spirochaetes*, *Actinomycetes*, *Rickettsiae*, *Chlamdiae*. Basic concepts, action of pathogens, human pathogenic viruses and bacteria, Gram-positive and Gram- negative Bacilli of medical importance. Miscellaneous bacterial agents of disease; DNA and RNA viruses and their diseases, Fungal diseases.

Unit 4

General properties of Viruses: Viruses host interactions; Pox viruses; Herpes virus, adeno viruses, picarno viruses, orthomyxo viruses, paramyxo viruses, arboviruses, rhabdo viruses, hepatitis viruses; oncogenic viruses; Human immuno deficiency viruses (AIDS). Life cycle of some important pathogens like- Malaria, hepatitis, filaria, Kalazar and AIDS. Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis.

Unit 5

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and schedules; passive prophylactic measures; Noscomical infection, common types of hospital infections and their diagnosis and control.



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Books:

1. Text of Microbiology: R. Ananthanarayanan and C.K. Jayaram Panicker, Orient Longman.
2. Mackie and McCartney: Medical Microbiology Vol 1: Microbial infection, Vol 2: Practical medical microbiology. Churchill Livingstone.
1. Reviews of Medical Microbiology by JAWETZ, MELNICK and ADEBERY
2. Medical Microbiology by CRUICKSHANK Vol. I and II.1975. Churchill Livingstone.
3. A text book of Microbiology (6th edition) by ANANTANARAYAN .2006. Orient Blackswan.
4. Clinical diagnosis and management – Laboratory methods by JOHN BERNARD HENRY.1996, Saunders.
5. Zinser Microbiology by JOKLIK, WILLE, AMOS and WILFERT.1992, Appleton & Lange.
6. Microbiology (4th edition) by BERNARD, DAVIS, DULBECCO
7. Text book of Medical parasitology (4th edition) by JAYARAM PANIKER.2007, Jaypee Brothers, Medical Publishers.
8. Bailey and Scott's Diagnostic microbiology by Ellen Jo Baron, Lance R. Peterson, Sydney M. Finegold.1994, Mosby.
9. Medical Virology. 2000 6th Edi.White and Fenner. Academic Press.

Practical

- (V) Anaerobic culture method
- (VI) Principles of automated methods for diagnostic microbiology
- (VII) Isolation of pure cultures and preservation techniques
- (VIII) Drug susceptibility testing by various methods
- (IX) Diagnostic immunologic principles and methods
 - precipitation method
 - ELISA method
 - Immunoelectrophoresis
 - Haemagglutination
 - Agglutination method
 - Immunodiffusion
 - Widal test
- (X) Separation of serum protein by electrophoresis
- (XI) Separation and characterization of lymphocytes from blood.
- (XII) Demonstration of lymphocyte sub population.

Blood tests – TC, DC and ESR.

Estimation of blood haemoglobin.

Determination of blood groups and Rh typing.

Acid-fast staining of mycobacteria (stained/permanent slides).

Isolation and identification of medically important bacteria (*E. coli*, *Klebsiella*, *Pseudomonas*, *Staphylococcus* and *Streptococcus*) by cultural, microscopic and biochemical tests.



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Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	IMMUNOLOGY	MMB- 523(b)

UNIT-I

Immunology fundamental concepts and anatomy of the immune system Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility.

UNIT-II

Immune responses generated by B and T lymphocytes: Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signalling; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines-properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

UNIT-III

Antigen-antibody interactions: Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immune electron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction, CMI techniques- lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, 26 microarrays, transgenic mice, gene knock outs.



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UNIT-IV

Vaccinology: Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology- role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering- chimeric, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

UNIT-V

Clinical Immunology: Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity – Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation – immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumorimmunology – tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency - primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy. Immunogenetics: Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

PRACTICALS

1. Immunodiagnosics using commercial kits.
2. Blood smear identification of leucocytes by Giemsa stain.
3. TOTAL LEUKOCYTE COUNT
4. WIDAL Test
5. SINGLE RADIAL IMMUNODIFFUSION
6. OUCHTERLONY DOUBLE DIFFUSION – PATTERN
7. WESTERN BLOTTING
8. IMMUNOPRECIPITATION



RKDF UNIVERSITY, BHOPAL

M.Sc. (Microbiology)

Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL ENZYME TECHNOLOGY	MMB- 523(c)

Unit- I

Extraction and purification of microbial enzymes. Importance of enzyme purification, different sources of enzymes. Extracellular and intracellular enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods. Enzyme crystallization techniques. Criteria of purity of enzymes. Pitfalls in working with pure enzymes.

Unit- II

Enzyme inhibition and Co-factors, Irreversible, reversible, competitive, non- competitive and un-competitive inhibition with suitable examples and their kinetic studies. Allosteric inhibition, types of allosteric inhibition and their significance in metabolic regulation & their kinetic study Vitamins and their co-enzymes: structure and functions with suitable examples Metallo enzymes and Metal ions as co-factors and enzyme activators.

UNIT- III

Immobilization of microbial enzymes, Methods viz. adsorption, covalent bonding, entrapment & membrane confinement and their analytical, therapeutic & industrial applications. Properties of immobilized enzymes.

UNIT-IV

Enzyme Engineering, Chemical modification and site-directed mutagenesis to study the structure-function relationship of industrially important enzymes.

UNIT-V

Microbial enzymes in textile, leather, wood industries and detergents. Enzymes in clinical diagnostics. Enzyme sensors for clinical processes and environmental analyses. Enzymes as therapeutic agents.



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M.Sc. (Microbiology)

Practicals

1. Microbial production , Extraction , purification and Confirmation of alpha amylase/ Lipase.
2. Determination of efficiency of enzyme purification by measuring specific activity at various stages viz. Salt precipitation, dialysis, electrophoresis etc.
3. Studies on enzyme Activation and Inhibition of extracted alpha amylase /Lipase. Effect of heavy metal ions, Chelating agents activators and inhibitors.
4. Immobilization of cells and enzyme using Sodium alginate and egg albumin and measurement of enzyme activity [amylase/Lipase].
5. Studies on impact of immobilization on enzyme activity in terms of temperature tolerance and V_{max} and K_m using various forms of alpha amylase/Lipase.



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M.Sc. (Microbiology)

Syllabus SEMESTER – II

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	FOOD MICROBIOLOGY	MMB- 524

Unit 1

Food as substrate for microorganisms: Microorganisms important in food microbiology - Molds, Yeasts and Bacteria – General characteristics – classification and importance. History of microbiology of food. Types of micro-organism normally associated with food- mold, yeast, and bacteria, Microbial growth pattern, physical and chemical factors influencing destruction of micro-organisms. Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Biochemical changes caused by micro-organisms, deterioration and spoilage of various types of food products, microbial food fermentation

Unit 2

Contamination and spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Milk and Milk products – Fish and sea foods – poultry – spoilage of canned foods. Detection of spoilage and characterization.

Unit 3

Food-borne infections and intoxications: Bacterial and nonbacterial – with examples of infective and toxic types - *Clostridium*, *Escherichia*, *Salmonella*, *Shigella*, *Staphylococcus*, *Vibrio*, *Yersinia*, Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks laboratory testing procedures; Prevention measures – Food sanitation in manufacture and retail trade; Food control agencies and its regulations.

Unit 4

Food fermentations: bread, cheese, vinegar, fermented vegetables, fermented dairy products; Experimental and Industrial production methods. Spoilage and defects of fermented dairy products – oriental fermented foods, their quality standards and control.

Unit 5

Food produced by Microbes: Fermented foods, microbial cells as food (single cell proteins) Microorganisms used, raw materials used as substrate, condition for growth and production, nutritive value and use of SCP – mushroom cultivation. Bioconversions – Production of alcohol – fermented beverages – beer and wine, Yeast based fermented foods- bread, wine and beer. Steroid conversion – Industrial enzymes production – amylases, proteinases, cellulases; Amino acid production – glutamic acid and lysine productions. Genetically modified foods.

Books:

1. Adams M.R and Moss M.O: Food microbiology: Royal society of chemistry.
2. Stanbury, P.F, Whitekar, A and Hall, S.J: Principles of fermentation technology, Pergamon Press.
3. Banwart, G.J: Basic Food Microbiology. CBS Publishers.



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M.Sc. (Microbiology)

List of Practicals:

1. Quantitative estimation of amino acids using the ninhydrin reaction and titration curves of amino acids
2. Spectra and quantitative estimation of base and nucleotides
3. Quantitative analysis of lipids
4. Determination of acid value of fat b) Saponification value of fat c) Iodine number of fat d) Estimation of cholesterol
5. Fixation of smears for microscopy by different methods
6. Different staining techniques
 - a. Simple (Loeffler's polychrome methylene blue and Negative staining)
 - b. Gram's staining
 - c. Ziehl-Neelson method for AFB
 - d. Fluorochrome staining
 - e. Leishman's staining
 - f. Giemsa's staining
 - g. Special staining methods to demonstrate granules, capsules and spores
7. Preparation of culture media: Simple tissue culture methods for growing different pathogenic microorganisms
8. Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi.



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M.Sc. (Microbiology)

Scheme Semester – III

No	Subject Code	Subject Title	Marks Allotted						
			Assignment Marks		Theory Marks		Practical Marks		Total Marks
			Max	Min	Max	Min	Max	Min	
1	MMB 531	INDUSTRIALMICROBIOLOGY	20	8	80	32	-	-	100
2	MMB 532	BIOSTATISTICS AND COMPUTER APPLICATIONS	20	8	80	32	-	-	100
3	MMB 533	MICROBIAL METABOLISM	20	8	80	32	-	-	100
4	MMB 534	APPLIED MICROBIOLOGY	20	8	80	32	-	-	100
5	MMB 535 (P)	PRACTICAL V (Based on MMB 531 & MMB 532)	-	-	-	-	50	20	50
6	MMB 536 (P)	PRACTICAL VI (Based on MMB 533 & MMB 534)	-	-	-	-	50	20	50
Total			80	16	320	128	100	40	500



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M.Sc. (Microbiology)

Syllabus

SEMESTER – III

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	INDUSTRIAL MICROBIOLOGY	MMB- 531

Unit 1

Biotechnological innovations in the chemical industry, biocatalyst in organic chemical synthesis, efficiency of growth and product formation, microbial growth kinetics, measurement of growth (cell number, direct and indirect methods), growth and product formation, effect of environment (temperature, pH, high nutrient concentration), growth stoichiometry, maintenance energy requirement and maximum biomass, yield, P/O quotients, metabolite overproduction and growth efficiency.

Unit 2

Media formulation. Sterilization, kinetics of thermal death of microorganisms, batch and continuous sterilization. Shake flask, stirred tank airlift fermenter, fed batch continuous and immobilized cell reactor.

Unit 3

Aeration and agitation, power requirement, oxygen transfer kinetics, concepts of Newtonian and Non-Newtonian fluids, plastic fluid apparent viscosity, foam and antifoam. Large scale production.

Unit 4

Metabolic pathways and metabolic control mechanism, industrial production of citric acid, enzymes, ethanol, acetic acid, production and diversification of antibodies. Biofertilizers, biopesticides, mushroom production, fermented food/beverages, Biopolymers.

Unit 5

Industrial strains. Strategies for selection, improvement & maintenance, large-scale production using recombinant microorganisms. Scale up and DSP-Inoculum development, Scale up of fermentation process, Raw material for media preparation, Harvesting and product recovery.

Books:

1. Biotechnological innovations in chemical synthesis. BIOTOL. Publisher.
2. Industrial microbiology, G. Reed, CBS Publishers.
3. Biology of Industrial microorganisms. A. L. Demain.
4. Stanbury P.F.A. Whitaker and Hall. Principles of fermentation technology.
5. Industrial Microbiology by Waiter.
6. Industrial Microbiology by Patel.
7. Biotechnology: A text book of Industrial Microbiology by Greger
8. Principles of Fermentation technology by Whitaker.
9. Industrial Microbiology by Prescott & Dunn.
10. Microbial Technology by J.H. Peppler & D. Perlman.
11. Industrial Microbiology by L.E. Casida.
12. Industrial Microbiology by B.M. Miller & W. Litsky.
13. Economic Microbiology by Rose, Vol-I to V.



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14. Advances in Applied Microbiology by Ed. Perlman, Series of volumes
15. 1. L E Casida. *Industrial Microbiology*.
16. 2. Peter F Stanbury, Allan Whitaker. *Principles of Fermentation technology*.
17. 3. Ronald M Atlas. *Basic and Practical Microbiology*.
18. 4. R C Dubey, D K Maheshwari. *A text book of Microbiology*.
19. 5. Richard G Burns, J Howard Slater. *Experimental Microbial Ecology*.
20. 6. Arnold L Demain, Julian E Davies. *Manual of Industrial Microbiology and Biotechnology*.
21. 7. Rita Singh, S K Ghosh. *Industrial Biotechnology*.
22. 8. John I D'Souza, S G Killedar. *Biotechnology and Fermentation process*.
23. 9. Michael J Waites, Neil L Morgan, John S Rockey, Gary Higon. *Industrial Microbiology: An introduction*.
24. A H Patel. *Industrial Microbiology*.
25. Wulf Crueger, Anneliese Crueger. *Biotechnology: A text book of industrial microbiology*.
26. B McNeil, L M Harvey. *Practical fermentation technology*.

Practical

1. Screening and isolation of microbes for production of organic acids and enzymes.
2. Preparation and maintenance of stock cultures (Bacteria and Fungi).
3. Preparation of fungal spore inoculum and enumeration of spores by Hemocytometer.
4. Preparation of bacterial inoculum by measuring OD and enumeration of bacterial cells by serial dilution and pour plate (or spread plate) method.
5. Solid state and Submerged fermentation for amylase (or any other enzyme) production and quantification of product by suitable assay methods.
6. Optimization of process parameters for enzyme production in submerged fermentation.
7. Partial purification of amylase (or any other enzyme) produced by microbial fermentation using acetone precipitation.
8. Lab level production of metabolites (Wine, Vinegar).
9. Immobilization of yeast cells and sugar fermentation using immobilized cells.



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M.Sc. (Microbiology)

Syllabus SEMESTER – III

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	BIostatISTICS AND COMPUTER APPLICATIONS	MMB- 532

Unit –1

Introduction to Biostatistics

Basic definitions and applications. Sampling: Representative sample, sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data, methods of data presentation, graphical representation by histogram, polygon, ogive curves and pie diagram.

Unit –2

Measures of central tendency Measures of central tendency: Mean, Median, Mode.

Measures of variability: Standard deviation, standard error, range, mean deviation and coefficient of variation. Correlation and regression: Positive and negative correlation and calculation of Karl-Pearsons co-efficient of correlation. Linear regression and regression equation and multiple linear regression, ANOVA, one and two way classification. Calculation of an unknown variable using regression equation.

Unit – 3

Tests of significance

Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test) and standard error. Introduction to probability theory and distributions, (concept without deviation) binomial, poisson and normal (only definitions and problems) Computer oriented statistical techniques. Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, t test, correlation coefficient

Unit- 4

Introduction to computers and computer applications

Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, concept of hardware and software, concept of file, folders and directories, commonly used commands, flow charts and programming techniques. Introduction to Q basic and C. Introduction in MS Office software concerning Word processing, spreadsheets and presentation software.

Unit - 5

Net working concepts

Networking fundamentals, client, server, LAN, WAN, Flp, TelNET, INTERNET, NICNET, WWW, html, e mail, introduction to MEDLINE, CCOD and PUBMED, for accessing biological information. An introduction to bioinorganic software, C/C++, bioperl, biojava, bioXML, bioORACLE, etc. Introduction to Havard graphics and coral draw.



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M.Sc. (Microbiology)

RECOMMENDED BOOKS

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) Mc Graw Hill, NewYork.
2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).
3. Programming in C by E. Ballaguruswamy
4. How Computers work - 2000. By Ron White. Tech. Media
5. How the Internet Work 2000 by Preston Gralla Tech. Media.
6. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.
7. Biostatistics - 7th Edition by Daniel

PRACTICAL BIOSTATISTICS AND COMPUTER APPLICATIONS

1. Representation of Statistical data by
 - a) Histograms b) Ogive Curves c) Pie diagrams
2. Determination of Statistical averages/ central tendencies.
 - a) Arithmetic mean b) Median c) Mode
3. Determination of measures of Dispersion
 - a) Mean deviation
 - b) Standard deviation and coefficient of variation
 - c) Quartile deviation
4. Tests of Significance-Application of following
 - a) Chi- Square test b) t- test c) Standard error
5. Computer operations-getting acquainted with different parts of Computers. [DOS] and basics of operating a computer.
6. Creating files, folders and directories.
7. Applications of computers in biology using MS-Office.
 - A] MS-Word B] Excel C] Power Point
8. Creating an e-mail account, sending and receiving mails.
9. An introduction to INTERNET, search engines, websites, browsing and Download



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M.Sc. (Microbiology)

Syllabus SEMESTER – III

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL METABOLISM	MMB- 533

Unit – 1

Transport of nutrients in microbes – Structural organisation of plasma membrane in relation to transport, mechanisms of membrane transport (passive, facilitated, active and group translocation) with specific reference to sugars (glucose, lactose and arabinose), amino acids (proline) and ions (Na⁺ and K⁺). Coupling of transport of ions and metabolites to ATP/proton gradient. Porins.

Unit – 2

Photosynthesis – Oxygenic and anoxygenic photosynthesis, structure of synthetic pigments, primary photochemistry of PS I and PS II, and photosynthetic electron transport, CO₂ fixation, halobacterial photosynthesis. Energy yield during aerobic respiration – Tricarboxylic acid cycle: Discovery, intracellular location, reactions of the cycle, amphibolic nature, anaplerotic reactions, glyoxylate pathway.

Unit -3

Carbohydrate metabolism – Various pathways underlying utilization of different sugars (EMP, ED, HMP and phosphoketolase pathways) in microorganisms. Gluconeogenesis. Protein metabolism – Assimilation of inorganic nitrogen and sulphur, Biochemistry of nitrogen fixation. Biosynthesis of amino acids and their regulation with emphasis on tryptophan and histidine.

Unit-4

Lipid metabolism – Biosynthesis of triacyl glycerols, phospholipids and sphingolipids. Oxidation of saturated and unsaturated fatty acids. Microbial metabolism of aromatic and aliphatic hydrocarbons (camphor, 2,4-D and toluene) with emphasis on the role of monooxygenase and dioxygenase in the ring cleavage (*ortho*, *meta* and *gentisate* cleavage) and reductive catabolism.

Unit-5

Nucleotide metabolism – Biosynthesis of purine and pyrimidine nucleotides, biosynthesis of deoxyribonucleotides. Regulation of nucleotide synthesis, catabolism of nucleotides. Secondary metabolism – Utilization of secondary metabolites for production of vitamins, toxins (aflatoxin and corynebacterial), hormones (GA), and antibiotics (penicillin and streptomycin).



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M.Sc. (Microbiology)

Recommended Books:

1. Microbial Physiology (3rd edition) by Moat and Foster. 2002, Wiley-Liss.
2. Fundamentals of Enzymology by Price and Stevens.1999, Oxford University Press.
3. An Introduction to bacterial physiology by Oginsky and Umbreit. 1954, W. H. Freeman.
4. Bacterial metabolism by Gottschalk.1986, Springer-Verlag.
5. Growth of bacterial cell by Ingraham, Lod and Neidhardt.1983, Sinauer Associates.
6. Microbial energetics by Dawes.1986 Blackie.
7. Principles of Biochemistry by Lehninger, Nelson and Cox. 2005, W H Freeman - Usa.
8. Biochemistry by Zubay.1992, McGraw-Hill Higher Education.
9. Biochemistry by Stryer.2010, W. H. Freeman. 10. Biochemistry by Garrett and Grisham.2010, Cengage Learning.

PRACTICAL MICROBIOAL PHYSIOLOGY

1. Isolation of Photosynthetic bacteria
2. Glucose uptake by *E. coli* / *Saccharomyces cerevisiae* [Active and Passive diffusion]
3. Effect of UV, gamma radiations, pH, disinfectants, chemicals and heavy metal ions on spore germination of *Bacillus* SP.
4. Determination of Iron Oxidation Rate of *Thiobacillus ferrooxidans*.
5. Determination of Sulfur Oxidation Rate of *Thiobacillus thiooxidans*.
6. Microbial degradation, decolorization and adsorption of organic dyes (by free and immobilized cells).
7. Estimation of calcium ions present in sporulating bacteria by EDTA method.
8. Demostration of utilization of sugars by oxidation and fermentation techniques.



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M.Sc. (Microbiology)

Syllabus SEMESTER – III

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	APPLIED MICROBIOLOGY	MMB- 534

Unit - I

Agricultural Microbiology

Physical and chemical characteristics of soil. Rhizosphere and phyllosphere. Plant growth-promoting microorganisms -mycorrhizae, rhizobia, *Azospirillum*, *Azotobacter*, cyanobacteria, *Frankia* and phosphate-solubilizing microorganisms. Outlines of biological nitrogen fixation (symbiotic, non-symbiotic).

Unit - II

Environmental Microbiology

Microorganisms of environment (soil, water and air). Role of microorganisms in nutrient cycling (carbon, nitrogen, sulphur). Microbial interactions – mutualism, commensalism, antagonism, competition, parasitism, predation. Microbiology of potable and polluted waters. *E. coli* and *Streptococcus faecalis* as indicators of water pollution. Sanitation of potable water. 5 Hrs Sewage treatment (primary, secondary and tertiary).

Unit - III

Food Microbiology

Microorganisms of food spoilage and their sources. Spoilage of different food materials - fruits, vegetables, meat, fish. Canned foods. Food intoxication (botulism and staph poisoning), foodborne diseases (salmonellosis and shigellosis) and their detection. Microbiological production of fermented foods – bread, cheese, yogurt. Biochemical activities of microbes in milk. Microorganisms as food – SCP, edible mushrooms (white button, oyster and paddy straw).

Unit - IV

Industrial Microbiology

Microorganisms of industrial importance – yeasts, moulds, bacteria, actinomycetes. Types of fermentation – aerobic, anaerobic, batch, continuous, submerged, surface, solid state. Design of a stirred tank reactor fermentor. Fermentation media. Industrial production of alcohols (ethyl alcohol), beverages (beer), enzymes (amylases), antibiotics (penicillin), amino acids (glutamic acid), organic acids (citric acid), vitamins (B12), biofuels (biogas - methane).

UNIT-V

Microbiology of cheese and beverage fermentation.

Microbiology of fermented milk products (acidophilus milk, yoghurt). Role of microorganisms in beverages – tea and coffee fermentations. Vinegar Fermentation



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TEXT AND REFERENCE BOOKS:

- Stanbury, P.F., Whitaker, A. and Hall, S.J. (1997). Principles of Fermentation Technology, Aditya Books (P) Ltd. New Delhi.
- Doyle, M.P., Beuchat, L.R. and Montville, T.J. (1997). Food Microbiology: Fundamentals and Frontiers. ASM Press, Washington D.C., USA.
- Frazier, W.C. and Westhoff, D.C. (1988). Food Microbiology, Mc Graw-Hill, New York.
- Jay, J.M. (1996). Modern Food Microbiology, Chapman and Hall, New York.
- Ray, B. (1996). Fundamentals of Food Microbiology, CRC Press, USA.
- Subba Rao, N.S. (1993). Biofertilizers in Agriculture and Forestry, 3rd Edition Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Rangaswami, G. and Bhagyaraj, D.J. (2001). Agricultural Microbiology, 2nd Edition, Prentice Hall of India, New Delhi.
- Atlas, R.M. and Bartha, R. (1998). Microbial Ecology - Fundamentals and Applications, Addison Wesley Longman, Inc., USA
- Paul, E.A. and Clark, F.E. (1989). Soil Microbiology and Biochemistry, Academic Press, USA.
- Lynch, J.M. and Poole, N.J. (1979). Microbial Ecology – A Conceptual Approach, Blackwell Scientific Publications, USA
- Alexander, M. (1985). Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi.
- Adams, M.R. and Moss, M.O. (1996). Food Microbiology, New Age International (P) Ltd, New Delhi.
- Banwart, G.J. (1987). Basic Food Microbiology, CBS Publishers and Distributors, New Delhi.
- Patel, A.H. (1984). Industrial Microbiology, Mac Milan India Ltd., Hyderabad.
- Cassida, L.E. (1968). Industrial Microbiology, Wiley Eastern Ltd. & New Age International Ltd., New Delhi.
- Crueger, W. and Crueger, A. (2000). Biotechnology – A Text Book of Industrial Microbiology, Panima Publishing Corporation, New Delhi
- Reed, G. (Ed.) (1987). Prescott & Dunn's Industrial Microbiology, 4th Edition, CBS Publishers & Distributors, New Delhi.
- Subba Rao, N.S. (1999). Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
- Reddy, S.R. and Singara Charya, M.A. (2007). A Text Book of Microbiology – Applied Microbiology. Himalaya Publishing House, Mumbai.
- Singh, R.P. (2007). Applied Microbiology. Kalyani Publishers, New Delhi.
- Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology, ASM Press, Washington, D.C., USA.



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Practicals

1. Isolation and enumeration of major groups of microorganisms from rhizosphere and nonrhizosphere.
2. Study of root nodules and isolation of *Rhizobium* from legume root nodules.
3. Isolation of *Azospirillum* / *Azotobacter*.
4. Staining and observation of vesicular-arbuscular mycorrhizal (VAM) fungi.
5. Observation of plant diseases of local importance – Rusts, smuts, powdery mildews, tikka disease of groundnut, citrus canker, bhendi yellow vein mosaic, tomato leaf curl, little leaf of brinjal.
6. Isolation of antagonistic microorganisms by crowded plate technique.
7. Isolation of microorganisms of air by Petri plate exposure method.
8. Determination of biological oxygen demand (BOD) of polluted water.
9. Microbial testing of water by coliform test (multiple tube fermentation method).
10. Determination of microbiological quality of milk – MBRT.
11. Observation of different spoiled foods.
12. Isolation of fungi and bacteria from spoiled fruits and vegetables.
13. Alcohol production and estimation; Calculation of fermentation efficiency.
14. Isolation of amylase-producing organisms.
15. Citric acid production and estimation.
16. Estimation of ascorbic acid from fruit juices.



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M.Sc. (Microbiology)

Scheme Semester – IV

No	Subject Code	Subject Title	Marks Allotted						
			Assignment Marks		Theory Marks		Practical Marks		Total Marks
			Max	Min	Max	Min	Max	Min	
1	MMB 541	ENZYMOLGY	20	8	80	32	-	-	100
2	MMB 542(A)/542(B)/542(C)	MICROBIAL BIOTECHNOLOGY/ GENETIC ENGINEERING/ Microbial Diversity and Ecology	20	8	80	32	-	-	100
3	MMB 543	DISSERTATION	-	-	-	-	250	125	250
4	MMB 544	PRACTICAL VII(BASED ON MMB 541 & MMB 542	-	-	-	-	50	20	50
Total			40	16	160	64	300	145	500



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M.Sc. (Microbiology)

Syllabus SEMESTER – IV

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	ENZYMOLGY	MMB- 541

UNIT-I

Outlines of enzyme classification, nomenclature, assay of enzymes and kinetics of enzyme catalyzed reactions – Michaelis – Menton equation, determination of K_m , V_{max} and k_{cat} values. Factors affecting enzyme reaction – pH, temperature, radiation, enzyme and substrate concentrations, activators, coenzymes and metalloenzymes. Ribozymes and abzymes

UNIT-II

Enzyme inhibitors, competitive and noncompetitive inhibition. Active site determination. Mechanism of action of ribonuclease, lysozyme and chymotrypsin. Isoenzymes, Regulatory enzymes – covalent modification, zymogen activation, Allosteric enzymes – ATCase, Glutamine synthetase. Hemoglobin & Myoglobin. Enzyme purification - Methods of isolation, purification. Recovery and yield of enzymes. Criteria for testing purity of enzyme preparations. Immobilised enzymes - Methods of immobilisation.

UNIT-III

Properties of Enzymes: Classification of enzymes into six major groups with suitable examples. Numerical classification of enzymes. Different structural conformations of enzyme proteins. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action. Mechanism of action of lysozyme, chymotrypsin and ribonuclease.

UNIT – IV

Enzyme kinetics: Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction.

UNIT-V

Immobilized enzymes - principles & techniques of immobilization - commercial production of enzymes; amylases, proteases, cellulose, artificial enzymes, industrial applications, fermentation, enzymes modification, site directed mutagenesis; immobilized enzyme in industrial processes.



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M.Sc. (Microbiology)

RECOMMENDED BOOKS :

1. Methods in Enzymology. Volume 22 - Enzyme purification and related techniques.
Edited by William B. Jakoby. Academic Press, New York.
2. Allosteric Enzymes - Kinetic Behaviour. 1982. by B.I. Kurganov. John Wiley and Sons. Inc., New York.
3. Biotechnology. Volume 7 A - Enzymes in Biotechnology. 1983 Edited by H. J. Rehm and G. Reed.
Verlag Chemie.
4. Hand Book of Enzyme Biotechnology by Wiseman.
5. Enzymes as Drugs Edited by John S. Holcenberg and Joseph Roberts , John Wiley & Sons New York.
6. Methods of Enzymatic Analysis by Hans Ulrich, Bergmeyer, Academic Press.
7. Methods in Enzymology by W.A. Wood, Academic Press.
8. Advances in Enzymology by Alton Meister, Interscience Publishers.
9. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman, John Wiley and Sons.

PRACTICAL ENZYMES

- 1) Assay of microbial enzymes (any two) – Amylase, protease, catalase, urease and pectinase.
- 2) Production, isolation, purification and assay of any one of the above enzymes
- 3) Enzyme Kinetics: (any one of the above enzymes):
 - a) Effect of substrate and enzyme concentration on enzyme activity; Determination of K_M and V_{max} values.
 - b) Effect of pH, temperature and inhibitors on enzyme activity.
- 4) Enzyme and Whole cell immobilization.
- 5) Microbial production , Extraction , purification and Confirmation of alpha amylase/ Lipase
- 6) Determination of efficiency of enzyme purification by measuring specific activity at various stages viz.
Salt precipitation, dialysis, electrophoresis etc.
- 7) Studies on enzyme Activation and Inhibition of extracted alpha amylase /Lipase .Effect of Heavy metal ions, Chelating agents activators and inhibitors



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M.Sc. (Microbiology)

Syllabus SEMESTER – IV

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	MICROBIAL BIOTECHNOLOGY	MMB- 542(a)

Unit-1

Raw materials used as media for industrial fermentations. Development of inocula for industrial fermentations. Isolation, preservation and strain improvement of industrially-important microorganisms. Bioreactor – Designing and application of a biofermentor. Aeration, agitation and sterilization of fermentors. Surface, submerged, batch and continuous fermentations. Scale-up of fermentations.

Unit-2

Bioprocessing – Recovery of particulates, product isolation, extraction, precipitation, chromatography, centrifugation, membrane separation, electrophoresis, distillation, super-critical fluid extraction, whole broth processing, integrated product separation, and purification. Single cell protein (SCP) – Production from cellulose and sewage. Food from microorganisms – edible mushrooms and cultivation of mushrooms (button). Commercial production of cheese, yogurt, production of flavoring components. Biofuels – Methane, hydrogen, alcohol (gasohol).

Unit-3

Industrial production of (1) antibiotics – Streptomycin, penicillin, cephalosporin, and tetracyclin, (2) biomass production of *Bacillus megaterium*, *Acinetobacter cerificans*, *Candida utilis* from hydrocarbons, (3) organic acids – Citric acid, lactic acid, (4) amino acids – L-lysine, (5) enzymes – Amylases, proteases and laccases, stabilization of enzymes, (6) vaccines – rabies, FMD vaccine, hepatitis B, (7) alcohol – ethanol and butanol. Esterification of biofuels, Steroid transformations.

Unit-4

Microbial leaching – Organisms of leaching, chemistry of microbial leaching, commercial process. Immobilization of enzymes and immobilization of cells – Methods, applications, advantages and disadvantages.

Unit-5

Recombinant DNA products - interferon. Fermentation economics – Market potential, some effects of legislation on production of antibiotics and recombinant proteins, plant and equipment, continuous culture, recovery costs, water usage and recycling, effluent treatment. Basics of Nanomaterials, Introduction to Nanobiotechnology and role of microbes in Nanobiotechnology and their applications.



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M.Sc. (Microbiology)

Recommended Books:

1. Principles of fermentation technology (2nd edition) by Stanbury, Whitaker and Hall.1999, Butterworth-Heinemann.
2. Biotechnology: A Text Book of Industrial microbiology 2nd edition by Crueger and Crueger.1990, Sinauer Associates.
3. Microbial Technology Vol I by Peppler and Pearlman (Editors).1979, Academic.
4. Microbial Technology Vol II by Peppler and Pearlman (Editors). 1979, Academic
5. Microbial enzymes and bioconversions by Rose.1980, Academic Press.
6. Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd edition) by Glazer and Nikaido.2007, Cambridge University Press.
7. Prescott & Dunn's Industrial Microbiology 4th edition Editor Reed. 1982, AVI Pub. Co.
8. Biotechnology Vol III. Dellweg (Editor).1983, VCH.
9. Concepts in Biotechnology by Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman.2004, Universities Press.
10. Immobilized cells: Principles and Application by Tampion and Tampion.1987, Cambridge University Press.
11. Industrial Microbiology by Thoma.1977, Dowden, Hutchinson & Ross.
12. Methods in Food and Dairy Microbiology by Diliello.1982, Avi Pub. Co.
13. Industrial Microbiology by Casida.1968, Wiley.
14. Industrial Microbiology by Miller and Litsky.1976, McGraw-Hill.
15. Microbiology: A Laboratory Manual by Cappuccino and Sherman. Pearson Education India

Practical

Estimation and enumeration of bacteria, actinomycetes and fungi in soil by dilution-plating method.

Isolation of *Azospirillum* spp. from soil by enrichment culture technique.

Soil enzyme activities - Urease, catalase.

Observations of root nodules of legumes.

Effects of pesticides on populations of bacteria in soil.

Effect of pesticides on pure cultures of bacteria.

Enumeration of microflora in water samples.

Qualitative and quantitative analysis of sewage for coliforms.

Differentiation of coliforms isolated from sewage.

Observation of air-borne microflora by Petri plate exposure.

Winnogradsky column

Ammonification and Nitrification in soil

Fermentation process during curdling – Estimation of lactose, lactic acid,protein and bacterial count.

Screening of microorganisms for antimicrobial activity. Strain improvement.

Production and estimation of streptomycin/penicillin by dye method.

Testing of disinfectants by phenol-coefficient method.



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Determination of MIC of antimicrobial agents.

Screening for amylase producing organisms.

Screening for organic acid-producing organisms.

Isolation of yeasts.

Alcohol fermentation by yeast.

Preparation of wine from grapes/fruits.

Citric acid production by *Aspergillus niger*, lactic acid fermentation by *Lactobacillus delbrueckii*.

Production of xylanase from *Penicillium* sp.

Immobilization of microbial cells.

DISSERTATION for 3 months



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M.Sc. (Microbiology)

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	GENETIC ENGINEERING	MMB- 542(b)

UNIT-I

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes, hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

UNIT-II

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, hagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag *etc*; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vector system, plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.

UNIT-III

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, realtime PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; T-vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

UNIT-IV

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay.



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M.Sc. (Microbiology)

UNIT-V

DNA footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

PRACTICALS

1. Isolation of DNA from onion.
2. Isolation of DNA from liver.
3. Isolation of DNA from coconut. 4: Isolation of DNA from spleen.
4. Estimation of DNA by DPA method.
5. Estimation of RNA by Orcinol method.
6. Estimation of bacterial genomic DNA.
7. Extraction of RNA from baker's yeast.
8. Isolation of Plasmid DNA.
9. Separation of DNA by agarose gel electrophoresis.
10. Demonstration of Restriction digestion.
11. Demonstration of ligation.



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M.Sc. (Microbiology)

BRANCH	SUBJECT TITLE	SUBJECT CODE
M.Sc(Microbiology)	Microbial Diversity and Ecology	MMB- 542(c)

UNIT-I

Microbial Systematics: Overview of course, what is microbial systematics. Concept of identification, nomenclature and classification, the species concept, importance of morphological, biochemical and physiological differences for species delineation.

UNIT- II

Morphological, Biochemical and Molecular Taxonomy: Concept of chemotaxonomy and use of membrane fatty acids, lipid, protein, quinone, peptidoglycan as biomarker, tree nomenclature: tree rooting, trees and distances, trees and character evolution, gene trees and species, trees, consensus trees, molecular chronometers in phylogeny: single gene & multi-gene sequence based microbial typing

UNIT-III

Phylogenetic Analysis and Whole genome: Whole genome comparisons, tree- building algorithms: distance-matrix methods, minimum evolution, maximum parsimony, maximum likelihood and Bayesian, inference, model fitting and hypothesis testing, Sources and types of errors in phylogenetic inference

UNIT-IV

Microbial Ecology:How to do microbial sampling, isolations, concept of diversity (α , β & γ), calculation of diversity indices (richness and evenness) and rarefaction analysis, collection of ecological samples for community analysis

UNIT-V

Modern Approaches to Study Microbial Diversity:Omics in diversity analysis (metagenomics, metaproteomics, metatranscriptomics), techniques used in microbial ecology, conservation of microbes, culture collections and microbial resources, preserving and exploiting microbial resources.

PRACTICALS-

1. ASEPTIC PROCEDURES, CULTURE MEDIA AND HABITAT OF MICROORGANISMS
2. ISOLATION AND PREPARATION OF PURE CULTURES OF BACTERIA AND FUNGI
3. STAINING AND MORPHOLOGICAL STUDY OF BACTERIA
4. METHODS IN STUDY AND IDENTIFICATION OF BACTERIA
5. METHODS OF DETERMINING CONCENTRATION OF MICROORGANISMS IN A SAMPLE
6. MICROSCOPIC EXAMINATION AND GENERAL MORPHOLOGY OF FUNGI
7. SPECIAL TECHNIQUES FOR THE STUDY OF MORPHOLOGY OF FUNGI
8. DILUTION AND SPREAD PLATES, STREAK PLATES AND STAINS
9. BACTERIAL GROWTH CURVE MEASUREMENTS
10. DETERMINATION OF HETEROTROPHIC ACTIVITY