KUVEMPU UNIVERSITY

Department of P.G. Studies and Research in Microbiology

Jnana Sahyadri-577451, Shimoga Dist. Karnataka, INDIA

Proceedings of Post Graduate Board of Studies in Microbiology held on **16th June 2025** at the Department of P.G. Studies & Research in Microbiology, Kuvempu University, Shankaraghatta-577451 at 10-30 AM.

The Chairman (BOS-PG) has welcomed all the members and placed the agenda for discussion and approval.

AGENDA

1. Approval of Panel of Examiners for the M.Sc., & Ph.D Course Work Examinations related work of M.Sc., Microbiology for the Academic Year 2025-26.

2. Approval of Revision of M.Sc., Microbiology Syllabus for the Academic Year 2025-26 onwards.

MEMBERS PRESENT:

01	**Prof Mohan D C** Dept. of Microbiology Bangalore University Bangalore.	External Member	
02	**Prof. Virupakshaiah. D. B. M** Dept. of Microbiology Davangere University Davangere.	External Member	
03	**Prof. N. B. Thippeswamy** Dept. of Microbiology Kuvempu University Shankaraghatta-577 451	Member	
04	**Prof. B. Thippeswamy** Dept. of Microbiology Kuvempu University Shankaraghatta-577 451	Chairman (BOS-PG)	

MEMBERS ABSENT:

	Prof. Satish. S Dept. of Microbiology University of Mysore Mysore	External Member	-ABSENT-
	Prof. Prashanth Naik, Dept. of Bioscience Mangalore University Mangalore.	External Member	-ABSENT-

Resolutions:-

1. Board has discussed and approved the Panel of Examiners for M.Sc., & Ph.D Microbiology for the Academic Year 2025-26, and authorized to Chairman for needful.

2. Board has discussed and made necessary revision of M.Sc., Microbiology syllabus for the Academic Year 2025-26 onwards and approved the same.

The Chairman thanked all the members.

Chairman (BOS-PG)

CHAIRPERSON
Board of Studies in Microbiology
Kuvempu University, Jnana Sahyadri
Shankaraghatta-577 451.

KUVEMPU UNIVERSITY

M.Sc., Microbiology (CBCS)

Revised Syllabus

(Effective from 2025-26 onwards)

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Department of Post Graduate Studies and Research in Microbiology

Jnanasahyadri, Shankaraghatta–577451

SHIVAMOGGA, INDIA.

KUVEMPU UNIVERSITY

M.Sc., Microbiology (CBCS)

Syllabus- I Semester

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
I	**Hard Core**	TheoryMB-1.1	Fundamentals of Microbiology	4	64	4	25	75	**100**
		TheoryMB-1.2	Biochemistry and Biostatistics	4	64	4	25	75	**100**
		TheoryMB-1.3	Microbial Physiology and Bioinformatics	4	64	4	25	75	**100**
		PracticalMB-1.4	Fundamentals of Microbiology	4	64	2	-	50	**50**
		PracticalMB-1.5	Biochemistry and Biostatistics	4	64	2	-	50	**50**
		PracticalMB-1.6	Microbial Physiology and Bioinformatics	4	64	2	-	50	**50**
I	**Soft Core**	TheoryMB-1.7	A. Mycology	4	64	4	25	75	**100**
			B. Principles of Genetics						
		PracticalMB-1.8	A. Mycology	4	64	2	-	50	**50**
			B. Principles of Genetics						
Total Credits						**24**	**Total Marks**		**600**

Additional Mandatory Credits:

1. Communications Skills: 01 Credit
2. Computer Applications: 01 Credit
3. Personality Development: 01 Credit

KUVEMPU UNIVERSITY

M.Sc., Microbiology (CBCS)

Syllabus- II Semester

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							IA	Examination	
II	**Hard Core**	Theory MB-2.1	Microbial Genetics and Molecular Biology	4	64	4	25	75	**100**
		Theory MB-2.2	Medical Microbiology	4	64	4	25	75	**100**
		Practical MB-2.3	Microbial Genetics and Molecular Biology	4	64	2	-	50	**50**
		Practical MB-2.4	Medical Microbiology	4	64	2	-	50	**50**
II	**Soft Core**	Theory MB-2.5	A. Plant-Microbe Interactions	4	64	4	25	75	**100**
			B. Microbial Enzymology						
		Practical MB-2.6	A. Plant-Microbe Interactions	4	64	2	-	50	**50**
			B. Microbial Enzymology						
II	**Elective**	Theory MB-2.7	A. Water Microbiology	2	32	2	10	40	**50**
			B. Agriculture Microbiology						
Total Credits						**20**		**Total Marks**	**500**

KUVEMPU UNIVERSITY

M.Sc., Microbiology (CBCS)

Syllabus- III Semester

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
III	**Hard Core**	Theory MB-3.1	Agriculture Microbiology	4	64	4	25	75	**100**
		Theory MB-3.2	Immunology	4	64	4	25	75	**100**
		Practical MB-3.3	Agriculture Microbiology	4	64	2	-	50	**50**
		Practical MB-3.4	Immunology	4	64	2	-	50	**50**
III	**Soft Core**	Theory MB-3.5	A. Immunotechnology	4	64	4	25	75	**100**
			B. Fermentation Technology						
		Practical MB-3.6	A. Immunotechnology	4	64	2	-	50	**50**
			B. Fermentation Technology						
III	**Elective**	Theory MB-3.7	A. Diagnostic Microbiology	2	32	2	10	40	**50**
			B. Industrial Microbiology						
Total Credits						**20**	**Total Marks**		**500**

KUVEMPU UNIVERSITY

M.Sc., Microbiology (CBCS)

Syllabus- IV Semester

Semester	Type	Paper Code	Paper Title	Hrs/ Week	Total Hrs	Credits	Marks		Total
							Internal Assessment	Examination	
IV	Hard Core	Theory MB-4.1	Food &Industrial Microbiology	4	64	4	25	75	**100**
		Theory MB-4.2	Microbial Biotechnology	4	64	4	25	75	**100**
		Theory MB-4.3	Environmental Microbiology	4	64	4	25	75	**100**
		Practical MB-4.4	Food &Industrial Microbiology	4	64	2	-	50	**50**
		Practical MB-4.5	Microbial Biotechnology	4	64	2	-	50	**50**
		Practical MB-4.6	Environmental Microbiology	4	64	2	-	50	**50**
		Theory MB.4.7	Project work	6	80	4	25	75	**100**
					Total Credits	**22**		**Total Marks**	**550**

Total Marks for the Course: 2150, Total Credits for the Course: 89

1. Project work should be based on experimental/review work and valued by two examiners (one external and one internal).The Candidate is required to present the work in open Viva-Voce examination in presence of examiners.
2. Each candidate shall have to complete01Credit each in Communications Skills, Computer applications and Personality development within first two semesters.
3. Examination duration: 03hrs for both theory and practical of each paper.
4. Study Tour (Industrial visit/Field work/Research Institutes etc.,) is mandatory for Final year students

Internal Assessment for Papers:

1. Two Session tests : 10 marks
2. Seminar/Tutorial/Group discussion : 05 marks
3. Assignment/Fieldwork/Submission of specimen : 05 marks
4. Regularity and Attendance : 05 marks

Total: 25 Marks

MB-1.1: Fundamentals of Microbiology (Hard Core) 64 hours

UNIT-1; 16h

Introduction to Microbiology: History of Microbiology, theory of spontaneous generation, golden age of microbiology, Biogenesis, The discovery of Microorganisms, members of microbial world, Relationship between microorganisms and diseases, Koch's postulates, scope and relevance of microbiology. **Microscopy and Specimen preparation**; Lenses and the Bending of Light, Magnification, Resolution, Numerical aperture, Types of Microscopes: Bright-Field, Dark-Field, Phase-Contrast, Fluorescence and Confocal Microscope, Atomic force microscope (AFM), Electron Microscope: Transmission Electron Microscope (TEM), Scanning Electron Microscope (SEM), Freeze-etch and freeze fracture methods for EM, image processing methods in microscopy, confocal microscopy. **Preparation and staining of Specimens:** Fixation, Dyes and simple staining, basic dyes, acidic dyes, differential staining, Gram's staining, Acid fast staining, staining specific Structures, Capsule staining, Negative staining, Endospore staining.

UNIT-II; 16h

Ultra structure of Prokaryotes: An overview of Prokaryotic cell structure; Shape, arrangement, size, and prokaryotic cell organization, Prokaryotic cell membranes, Bacterial and Archaeal membranes, Fluid mosaic model, Cytoplasmic matrix, Ribosomes, Nucleoid, Plasmids, Bacterial cell wall, Gram-Positive and Gram-Negative cell walls, Archaeal cell walls, Components external to the cell wall; Capsules, Slime layers and S-Layers, Pili and fimbriae, flagella and motility, Chemotaxis and Bacterial Endospore. An overview of Eukaryotic cell structure: Structure of Plasma membrane, Cytoplasmic matrix, Microfilaments, intermediate filaments and Microtubules, Cell organelles; Golgi apparatus, Lysosomes, Ribosomes, Mitochondria, Chloroplasts, Nucleus, Cilia and Flagella. Comparison of Prokaryotic and Eukaryotic Cells. **Microbial Nutrition:** Nutritional requirements, Nutritional types of Microorganisms, Growth factors, Uptake of Nutrients by the cell; Passive and facilitated diffusion, Active transport, Group translocation, Iron uptake.

UNIT-III; 16h

Microbial growth and Control of Microorganisms

Culture Media: Synthetic or Defined, Complex, Supportive, Enriched and Selective media. Isolation of Pure cultures: Spread plate, Streak plate and Pour plate methods. **Microbial Growth:** Prokaryotic cell cycle; Chromosome replication and Partitioning, Cytokinesis. Growth curve; Lag phase, Exponential or Log phase, Stationary phase, Decline or Death phase. **Measurements of Microbial Growth:** Measurement of cell Numbers and cell mass. Batch and Continuous Culture; Chemostat, Turbidostat. Factors influencing on Growth; Solutes, water activity, pH, Temperature, Oxygen concentration, Pressure and Radiation. **Sterilization, and Disinfection**: Sanitization, Antisepsis, Bactericide, Fungicide, Viricide, Bacteriostatic, Fungistatic. Conditions influencing the effectiveness of Antimicrobial agents. **Physical methods of Sterilization:** Dry heat and Wet heat, Pasteurization, TDP and TDT, Filtration, Radiation. **Chemical methods of Sterilization:**Phenolics, Alcohols, Halogens, Heavy metals, Quaternary ammonium compounds, Aldehydes, Gases, Phenol coefficient test. Culture preservation techniques**.**

UNIT-IV; 16h

Microbial classification and Taxonomy: Taxonomy: Origin, Nomenclature, Identification, Natural classification of Carolus Linnaeus, Phenetic classification, Phylogenetic classification, Genotypic classification, Numerical Taxonomy, Taxonomic ranks. **Techniques used for Microbial Taxonomy and Phylogeny:** Classical characteristics- Morphological, Physiological and metabolic, Ecological

and Genetic analysis. Molecular characteristics- Nucleic acid base composition, Nucleic acid hybridization, Nucleic acid sequencing, Phylogenetic trees. **Major Divisions of Life:** Haeckel's three kingdom classification, Whittaker's five kingdom classification, Three domain concept of Carl Woese, Bergy's Manual of systematic bacteriology. **Diversity of Microorganisms:** General structural properties of Bacteria, Fungi, Algae, Viruses and Protozoa,

References:

1. Alcamo, I.E. 1997. Fundamentals of Microbiology, 5th edition, an imprint of Addison Wesley Longman, New York.
2. Cappacino, J.G. and Sherman, N. 2005.Microbiology, A Laboratory Manual, 7th edition, Pearson Education INC. Delhi, India
3. Cooper, G.M and Hausman, R. 2009. The Cell A molecular Approach, 5th edition, ASM Press, Washington, D.C.
4. Willey, J.M., Sherwood, L.M and Woolverton, C.J. 2008. Prescott, Harley, and Klein's Microbiology, 7th edition, McGraw-Hill, New York.
5. Black, J. G., & Black, L. J. 2018. Microbiology: principles and explorations. John Wiley & Sons.
6. Tortora, G. J., Funke, B. R., & Case, C. L. 2009. Microbiology: an introduction (Vol. 8). New Delhi (India): Pearson.

Practical Syllabus: Practical MB-1.4; Fundamentals of Microbiology

1. Safety measures in Microbiology laboratory
2. Study of Microscopes
3. Preparation of Glass ware and their Sterilization methods
4. Preparation of culture media and Culturing of microorganisms
5. Isolation of microorganisms from natural soil
6. Pure culture techniques and aseptic transfer
7. Study of cultural characteristic of bacteria
8. Bacterial motility-Hanging drop technique
9. Preparation of stains and indicators
10. Simple staining
11. Negative staining
12. Differential staining techniques: a. Gram's staining b. Acid fast staining
13. Endo spore staining
14. Measurement of microbial cell` number / Spore number using haemocytometer
15. Measurement of microorganisms by micrometry
16. Study of microbial culture preservation methods
17. Microbial growth assessment-viable count and turbidity
18. Evaluation of disinfectant and antiseptic by filter paper disc method
19. Study of Algae and Protozoa
20. Study of Fungi

MB-1.2: Biochemistry and Biostatistics (Hard Core) 64 hours

UNIT-1:

Biochemistry 16h

Origin of biomolecules: Abiotic synthesis of organic monomers and polymers, Concept of Oparin and Haldane; Experiment of Miller (1953). **Water**: Properties of water, weak interaction in aqueous systems, ionization of water, pH, weak acids and weak bases, buffers, types of buffers and their importance. **Molecular interactions:** Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc. **Carbohydrates**: Definition, classification, structural properties and importance of glucose, fructose, mannose, galactose, sucrose, lactose, maltose, starch, cellulose, agar and glycogen. **Amino acids, peptides and proteins:** Definition, classification, structure, general properties, confirmation of proteins by Ramachandran plot. **Lipids and fats:** Definition, classification, structure and importance of lipids and fats.

UNIT-II; 16h

Nucleotides: Structure and properties of nucleosides and nucleotides. **Vitamins**: Definition, classification, structure and importance. **Porphyrins**: Definition, structure, properties and importance of chlorophyll, cytochrome, plasma proteins and haemoglobin. **Enzymes**: Classification, nomenclature, General properties:- activation energy, transition state, binding energy, turnover number, enzyme kinetics and Michaelis-Menten Equation, Importance of Km and Vmax, coenzymes, activators, inhibitors, isoenzymes, multienzyme complex, allosteric enzymes, mechanism of enzyme action.

UNIT-III; 16h

Biochemical Techniques: Centrifugation techniques: Basic principles of sedimentation. Methods and applications of preparative and analytical centrifugation. **Chromatographic techniques**: General principles, Methods and applications of Paper chromatography, Thin-layer chromatography, Exclusion chromatography, Affinity chromatography, Ion-exchange chromatography, HPLC, Gas-liquid chromatography. **Electrophoretic techniques**: General principles and application of Gel electrophoresis, zone electrophoresis, free flow electrophoresis and capillary electrophoresis. **Spectroscopic techniques**: General principles and laws of radiation, colorimetry, Beers and Lamberts law, Ultraviolet-Visible Spectrophotometry, Nuclear Magnetic Resonance Spectrophotometry, XRD, Electron Spin Resonance Spectrometry and mass spectroscopy. **Radioisotopic techniques**: General principles, nature of radio activity, detection and measurement of radioactivity, applications of radioisotopes in biological investigation.

UNIT-IV; 16h

Biostatistics: Scope, sample and population concepts, sampling techniques, collection and organization of data, graphical presentation of data frequency distribution, polygon, histogram, bar graph, pie diagram. Measures of central tendency and dispersion: Mean, Median, Mode, Range, mean deviation, variance, standard deviation. Probability distributions: Concepts of probability, Binomial, Poisson and Normal distribution. Tests of significance: Student's 't' test, Chi-square test, F-test, Analysis of Variance-one way and two way ANOVA.

References ;

1. Cazes, J. 2005. Ewing's Analytical Instrumentation Handbook, 3rd edition, Marcel Dekker.Inc., USA.
2. Miller, J.M. 2005. Chromatography concepts and contrasts, 2nd edition, John Wiley &Sons.Inc Publication, Canada.
3. Mohan, J. 2003. Organic Analytical Chemistry (Theory and Practice), Narosa Publishing House, New Delhi.
4. Williard, Merritt, Deal and Settle. 1986. Instrumental methods of Analysis, 7th edition, CBS Publishers, New Delhi.
5. Wilson, K and Walker, J. 2000. Practical Biochemistry (Principles in Techniques), 5th edition, Cambridge University Press, UK.
6. Devlin, J.M. 2011. Text book of Biochemistry with clinical correlations, 7th edition, John wiley and sons, Inc. USA.
7. Voet, D.J., Voet, J.G. and Pratt, C.W. 2008. Principles of Biochemistry, 3rd edition, John wiley and sons.
8. Elliott, W.H and Elliott, D.C. 2009.Biochemistry and molecular biology, 4th edition, Oxford University press, New York.
9. Upadhyay, A., Upadhyay, K., & Nath, N. 1993. Biophysical chemistry principles and techniques.

Practical Syllabus: Practical MB-1.5; Biochemistry and Biostatistics

1. Preparation of molar and normal solutions
2. Determination of the concentration of HCl by volumetric analysis
3. Determination of the concentration of NaOH by volumetric analysis
4. Ionization of water and concept of pH and pOH
5. Titration curve of strong acid and strong base
6. Titration curve of weak acid and strong base
7. Buffers: Types and preparation of buffers
8. Qualitative analysis of carbohydrate
9. Qualitative estimation of proteins
10. Quantitative estimation of total carbohydrate by Anthrone method
11. Quantitative estimation of amino acid by Ninhydrin method
12. Quantitative estimation of protein by Biuret method
13. Estimation of free fatty acids
14. Circular paper chromatogram
15. Thin layer chromatography
16. Component and uses of Colorimeter / Spectrophotometer
17. Component and uses of pH meter
18. Mean, mode, median
19. Standard deviation
20. Chi-square test

MB-1.3; Microbial Physiology and Bioinformatics (Hard Core) 64 hours

UNIT-1; 16h

Metabolic Pathways: Bioenergetics; The laws of thermodynamics and concept of entropy; First and Second law of thermodynamics, Gibb's Free energy, free energy changes in chemical reactions, spontaneous reactions, free energy changes in metabolic reactions, coupling endergonic and exergonic reactions. Free energy values of different components of chemical reactions and their calculations.

Metabolism of carbohydrates: Overview of metabolism, Glycolysis and ATP formation, gluconeogenesis, Glyoxylate cycle, Tricarboxylic acid cycle, substrate level phosphorylation, Pentose phosphate pathway, Hexose monophosphate pathway, Entner-Doudoroff pathway, electron transport chain and oxidative phosphorylation,. Anaerobic oxidation of pyruvate: the process of fermentation.

UNIT-II; 16h

Photosynthesis: Overview of Photosynthetic metabolism, absorption of light, Photosynthetic pigments, light reactions; cyclic and non-cyclic photophosphorylation in eukaryotes, cyanobacteria, green and purple bacteria, Carbon dioxide fixation and synthesis of carbohydrates. **Metabolism of lipids:** Biosynthesis of lipids, Catabolism of lipids by beta-oxidation, yield of ATP for Stearic acid and Linoleic acid, Biosynthesis of cholesterol and ergo sterol. **Metabolism of nitrogenous compounds:** Transamination, oxidative deamination, decarboxylation, urea cycle. General biosynthetic pathways of amino acids, biosynthesis of purines and pyrimidines and their regulation.

UNIT-III; 16h

Fungal and bacterial secondary metabolism: Secondary metabolites and regulation of secondary metabolism. Antibiotics: Definition, Discovery, classification, structure and mode of action. **Biosynthesis of secondary metabolites:** beta-lactum antibiotics, patulin, Aflatoxin, ergot alkaloids. **Fungal toxins:** Types of toxins, aromatic and phenolic toxins, terpenoid toxins. **Bacterial toxins:** Exo and endotoxins, enterotoxins. **Pigments**: Melanin, carotenoids. **Microbial peptides:** Bacteriocin and mycocin. **Fungal hormones:** Sirenin (Allomyces) Sterols (Achlya). Trisporic acid (Ascomycetes), peptide hormones (Basidiomycetes). **Bioluminescence in microorganisms:** Mechanism and significance.

UNIT-IV; 16h

Bioinformatics: An overview, introduction and scope of bioinformatics. **Biological databases:** Types of databases: NCBI, BDBJ, EMBL (Entrez, SRS or Sequence Retrieval system). PIR or protein identification resource, GENE BANK, SWISS-PROT and other databases).Pubmed, OMIA and OMIM. **Sequence analysis:** Models for sequence analysis, methods for alignment pair wise and multiple alignment. **Tools for sequence searches**- FASTA, BLASTA, PSI Blast. **Phylogenetic analysis:** Phylogenetic trees, Methods of phylogenetic evaluation, Molecular docking.

References ;

1. Batzing, B. L. 2002. Microbiology (An Introduction), Brooks/Cole Thamson Learning, Canada.
2. Cooper, G. M and Hausman, R. 2009. The Cell A molecular Approach, 5th edition, ASM Press, Washington, D.C.
3. Moat, A.G., Foster, J. W and Spector, M. P. Microbial Physiology, 4th edition, A John Wiley & Sons, Inc., Publication.
4. Ratledge, C and Kristiansen, B. 2001. Basic Biotechnology, 2nd edition, Cambridge University Press, USA.
5. Willey, J. M., Sherwood, L. M and Woolverton, C. J. 2008. Prescott, Harley, and Klein's Microbiology, McGraw-Hill, New York.
6. Rastogi, S. C, Menndiratta, N. and Rastogi, P. 2007. Bioinformatics methods and applications, 2nd edition, Printice-hall of India. Pvt. Ltd. New Delhi.
7. Rajan, S. S and Balaji, R. 2002. Introduction to bioinformatics, Himalaya publishing house, Mumbai.

Practical Syllabus: Practical MB-1.6; Microbial Physiology and Bioinformatics

1. Quantitative estimation of total carbohydrate by DNS method
2. Estimation of free fatty acids
3. Starch Hydrolysis test
4. Gelatin hydrolysis test
5. Casein hydrolysis test
6. Urease test
7. IMViC test
8. Melonate utilization test
9. Phenylalanine test
10. Fermentation ability of the microorganisms
11. Triple sugar iron agar test
12. H2S production test
13. Lecithinase test
14. Lipase test
15. Galactosidase test
16. Catalase test
17. Oxidase test
18. KOH Solubility test
19. Identification of unknown bacteria using different physiological tests
20. Prediction of nucleotide and amino acid sequence

MB-1.7(A): Mycology (Soft Core) 64 hours

UNIT- I; 16h

Introduction to fungi, developmental milestones in the field of mycology, development of mycology in India. **Ecology of fungi:** Distribution of fungi in nature, factors influencing fungal distribution. Characteristics of fungi. Morphological, structural and ultra-structural details of fungi, chemistry of the fungal cell. **Fungal biodiversity and systematics:** Diversity of fungi, systematic position of fungi, parameters for fungal systematics, classification of fungi to the level of Order (with suitable examples)..

UNIT-II; 16h

Reproduction in fungi: Asexual and sexual reproduction methods, reproductive structures and organs in different fungi, spore development in fungi, heterokaryosis, parasexuality and heterothallism**.**

Mycological techniques: Isolation, culturing and maintenance of fungi.

UNIT-III; 16h

Physiology of fungi: Fungal growth, nutritional requirements, Mycological media and methods, culture collections, assessment of fungal growth, and effect of environmental factors on growth.

Primary and secondary metabolism; fungal enzymes, mycotoxins, regulation of metabolism, Fungal diseases of humans and plants.

Application of fungi: Usefulness of fungi and their metabolites in different fields.

UNIT-IV; 16h

Biology and significance of the following genera: *Saprolegnia, Phytophthora, Rhizopus, Aspergillus, Penicillium, Neurospora, Saccharomyces, Erysiphae, Xylaria, Polyporus, Peziza, Lycoperdon, Agaricus, Puccinia, Ustilago, Colletotrichum, Fusarium, Alternaria, Drechslera, Sclerotium, Trichoderma.*

References;

1. Alexopoulos, C.J., Mims, C.W and Blackwell, M. 2002. Introductory Mycology, 4th edition, John Willey & Sons (ASIA) Pvt. Ltd, Singapore.
2. Bhatnagar, D., Lillehej, E.B. and Arora, D.K., 1992. Hand Book of Applied Mycology, Mycotoxins in Ecological Systems. Vol. 5, Marcel Dekker, Inc. New York.
3. Bilgrami, K.S. and Verma, R.N.1997. Physiology of Fungi. Vikas publishing house Pvt. Ltd.
4. Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
5. Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.
6. Rampal Singh. 2018. The DBS handbook of fungi. DBS imprints, New Delhi.

Practical Syllabus: Practical MB-1.8(A): Mycology

1. Preparation and use of mycological media
2. Isolation of fungi from soil by Warcup method
3. Isolation of fungi from air by plate exposure method
4. Isolation of fungi from water by serial dilution method
5. Isolation of yeast from different sources
6. Single spore isolation and establishment of pure culture
7. Culture preservation of fungi
8. Population count of fungi in soil by serial dilution method
9. Mounting media and stains for fungi
10. Techniques for microscopic preparation of fungi
11. Fungal growth assessment by colony diameter measurement
12. Types of spores in fungi
13. Extraction and estimation of intracellular and extra cellular proteins of fungi
14. Determination of fungal enzyme activity
15. Effect of different sugars on fungal spore germination.
16. Detection of antibiotic activity of fungal culture broth
17. Biodegradation of agricultural wastes by fungi
18. Microbial interaction; Fungi and fungi, Fungi and bacteria
19. Detection of aflatoxin by TLC
20. Study of fungal genera based on theory syllabus.

MB-1.7(B): Principles of Genetics (Soft Core) 64 hours

UNIT-I; 16h

Introduction to Genetics: Overview of Genetics; genetics in medicine, modern agriculture and society. Prokaryotic and eukaryotic cells, chromosome, cell cycle, mitosis, meiosis, spermatogenesis, oogenesis, union of gametes, gamete formation in plants. Life cycles of model organisms, *Neurospora*, Yeast, Drosophila.

Mendelism: Mendel study of heredity: concept of phenotype and genotype, monohybrid (law of dominance and segregation), dihybrid (law of independent assortment). Applications of Mendel principles; punnet square, forked line. Testing genetic hypothesis: chi-square test, pedigree analysis.

UNIT-II; 16h

Extension of Mendelism: Allelic variation and gene function; incomplete dominance, co dominance, multiple alleles. Gene action; environmental effects on the expression of Human genes, penetrance and expressivity. Gene interactions; epistasis, pleiotropy.

The chromosomal basis of Mendelism: Chromosomes; chromosomal number, sex chromosomes, chromosome theory of heredity. Chromosomes as arrays of genes, non-disjunction, the chromosomal basis of Mendel principles of segregation and independent assortment. Sex linked genes; haemophilia, blood clotting disorders, colour-blindness. Sex determination in Human beings and Drosophila.

UNIT-III; 16h

Variation in chromosome number and structure: Cytological techniques; analysis of mitotic chromosomes, the Human karyotype. Cytogenetic variation; polyploidy (sterile, fertile, tissue specific polyploidy and polyteny). Aneuploidy; monosomy, trisomy, deletions and duplications of chromosome segments.

Linkage, crossing over and chromosome mapping in Eukaryotes: Exceptions to the Mendelian principle of independent assortment, frequency of recombination and linkage intensity. Gene mapping using the frequency of crossing over, recombination by two point and three-point test cross, and chiasma formation. Tetrad analysis in Yeast and *Neurospora*. Linkage analysis in humans; detection of linked loci by pedigree analysis.

UNIT-IV; 16h

Quantitative and population genetics: Complex pattern of inheritance, analysis of quantitative traits, threshold traits, the multiple factor hypothesis, partitioning the phenotypic variance, broad sense heritability, narrow sense heritability, predicting phenotypes, artificial selection. Inbreeding; the effects of inbreeding and its analysis. Darwin's theory of evolution, theory of allelic frequency; estimating allelic frequencies, relating genotype frequencies to allele frequencies. The Hardy-Weinberg principle and exceptions. Natural selection at the level of the gene, and phenotypes. Random genetic drifts; random changes in allele frequencies, the effects of population size, populations in genetic equilibrium.

References:

1. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 2008. Introduction to Genetic Analysis. W.H. Freeman and Company, New York.
2. Hartt, D and Jones, E.N. 2005. Genetics (Analysis of genes and genomes), 6th edition, Jones and Barlett Publishers.
3. Pierce, B.A. 2006. Genetics (A Conceptual Approach), 2nd edition, W.H. Freeman and Company, New York.
4. Russel, P.J. and Cumming, P.B. 2008. Genetics (A Molecular Approach), 2nd edition, Pearson Benjamin Cummings Publishers, New York.
5. Strickberger, M.W. 2006. Genetics, 3rd edition, Prentice-Hall of India Private Limited, New Delhi

Practical Syllabus: Practical MB-1.8(B); Principle of Genetics

1	Mitosis in plants
2	Meiosis in plants/animals
3	Study of polytene chromosomes in salivary glands of Drosophila
4	Study of human karyotype
5	Genomic DNA extraction of bacteria
6	Genomic DNA extraction of Plant
7	Genomic DNA extraction of Fungi
6	Study of Drosophila Morphology
7	Study of Drosophila Culturing
8	Study of Drosophila Mutants
9	Study of Drosophila X- linked inheritance
10	Agarose gel electrophoresis for DNA separation
11	Quantification of DNA by U.V spectrophotometer
12	Determination of Tm of DNA from different sources by spectrophotometer method
13	Photographs of genetic disorders
14	Karyotyping of different syndromes
15	Study of human karyotyping
16	Genetic problems of Restriction mapping
17	Genetic problems of Linkage mapping
18	Genetic problems of DNA sequencing
19	Genetic problems of different types of vectors
20	Applications of Chi-square test in Genetics

MB-2.1; Microbial Genetics and Molecular Biology (Hard Core) 64 hours

UNIT-I; 16h

Structure of nucleic acids: Structure and types of DNA, Watson - Crick Model of DNA, Organization of DNA in cells, melting temperature of DNA, structure and types of RNA:- Mrna, Rrna, tRNA. **Historical developments of DNA as a genetic material**: Griffith experiment of transformation, enzymatic approach by Avery, MacLeod and McCarty. Hershey and Chase Experiment with Phage virus. Central dogma of molecular biology: C-value paradox. **DNA replication:** Semiconservative, Rolling model, Replication machinery, Enzymes in DNA replication, events at the replication fork, fidelity of replication, termination, Prokaryotic and eukaryotic DNA replication mechanism.

UNIT-II; 16h

Transcription (RNA synthesis): Initiation, Elongation and termination of Transcription, post transcriptional modifications. **Genetic code**: Properties of Genetic code, identifying the codons, organization of Genetic code, Triplet codon, arrangement of initiation and termination codons. **Translation** (Protein synthesis): Role of mRNA, role of ribosomes and tRNA in translation. Activation of Amino acids, Initiation, Elongation and termination of translation, post translational modifications of proteins. **Regulation of Bacterial gene expression**: Principles of regulation, mechanism to control transcription. The lac operon, effect of lactose and glucose on the control of lac operon. Tryp-operon.

UNIT-III; 16h

Mutation and Repair mechanisms: Spontaneous and induced mutations: silent mutation, missense mutation, nonsense mutation, frame shift mutations, Mutagenesis-physical and chemical mutagens, base and nucleoside analog, alkylating agents, interchelating agents, ionizing radiation. **Repair mechanisms of DNA**: Excision repair, Mis-match repair, Recombinational repair, SOS response. Auxotrophs and Prototrophs, selection of mutants, testing of chemicals for their cancer causing ability by Ames test. **Recombination in fungi**: Linkage detection, linkage mapping in two and three point crosses in *Neurospora*. **Recombination in bacteria**: Bacterial conjugation; Mechanism of bacterial conjugation, F^{+}xF- conjugation, Hfr conjugation, F' conjugation, Gene mapping by conjugation. Transduction: Types and mechanisms of generalized and specialized transduction. **Recombination in viruses**: Phage phenotypes, phenotype mixing, recombination.

UNIT-IV; 16h

Recombinant DNA technology: Historical Perspectives, Restriction enzymes, classification and functions; General features of DNA polymerases, RNA polymerases, reverse transcriptase and ligases, Oligonucleotides as probes and primers. **Vectors**: General characteristics of vectors, Plasmids, Ori site, selectable markers, multi-cloning sites, Phage vectors, Construction of genomic Library and cDNA library, Expression vectors and their importance. **Transfer of recombinant DNA into host cells:** Genetic transformation of bacteria, yeast, animal and plant cells. Plating, screening and selection of recombinants. General principles and applications of DNA sequencing (Sangers dideoxy method), DNA finger printing (RFLP), PCR, CRISPR technology, Southern and Northern blotting. **Gene silencing technology (RNA interference)**: Principle of gene silencing, si RNA, siRNA technology, micro RNA, construction of si RNA vector, application of RNA interference.

References:

1. Nelson, D and Cox, M.M. 2000. Lehiniger Principles of Biochemistry, 3rd edition, Worth Publishers, USA.
2. Strickberger, M.W. 2006. Genetics, 3rd edition, Prentice-Hall of India Private Limited, New Delhi.
3. Watson, Baker, Bell, Gall, Levina and Lorick. 2008. Molecular Biology of the Gene, 6th edition, Pearson Benjamin Cummings Publishers, Cold Spring Harbor Laboratory Press, New York.
4. Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. 2022. Molecular Biology of the Cell: Seventh International Student Edition. WW Norton & Company.
5. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. 2017. Lewin's genes XII. Jones & Bartlett Learning.
6. Weaver, R. 2011. EBOOK: Molecular Biology. McGraw Hill.

Practical Syllabus: Practical MB-2.3: Microbial Genetics and Molecular Biology

1. Isolation of bacterial DNA
2. Isolation of bacterial RNA
3. Quantitative estimation of DNA by Diphenyl amine method
4. Quantitative estimation of RNA by Orcinol method
5. Estimation of protein by Bardford's method
6. Isolation of Coliphages from sewage
7. Bacterial survival against UV-radiation
8. Isolation of antibiotic resistant mutant by gradient plate method
9. Isolation and characterization of petite mutant in yeast
10. Induction of mutation in yeast and bacteria by chemicals / radiation
11. Replica plating technique
12. Agarose Gel electrophoresis
13. Bacterial plasmid isolation
14. Restriction digestion of DNA
15. Ligation
16. Bacterial transformation
17. Bacterial conjugation
18. Genetic problems
19. Prediction of nucleotide sequence
20. Predication of Protein sequence

MB-2.2: Medical Microbiology (Hard Core) 64 hours

UNIT-I; 16h

Historical development of Medical microbiology, Host parasite relationships; Symbiosis, parasites, pathogenicity, Inhibitory concentration (IC_{50}), Lethal dose 50 (LD_{50}). **Pathogenesis of Viral Diseases:** Maintaining a reservoir, contact, entry, and primary replication, vectors, release from host cells, viral spread and cell Tropism, virus-host interactions, recovery from infection, virus shedding.

Pathogenesis of Bacterial diseases: Maintaining a reservoir of the bacterial pathogen, transport of bacterial pathogen to the host, attachment and colonization of the pathogen, invasion of the host tissues, growth and multiplication of the bacterial pathogen, leaving the host, regulation of Bacterial virulence factors expression, pathogenicity islands.

Toxigenicity: Exotoxins; AB toxins, specific host site exotoxins, membrane disrupting exotoxins, superantigens, roles of exotoxins in diseases. Endotoxins.

UNIT-II; 16h

Host defense against Microbial invasion: Primary defenses, secondary defenses, factors influencing host defenses. Microbial mechanisms for escaping host defenses, evasion of host defenses by bacteria and viruses, evading the complement system, resisting phagocytosis, survival inside phagocytic cells, evading the specific immune response.

Antimicrobial chemotherapy: The development of chemotherapy, general characteristics of antimicrobial drugs, therapeutic index, narrow and broad spectrum drugs, cidal or static. **Determining the level of Antimicrobial activity;** Dilution susceptibility tests, Disc diffusion tests, Kirby-Bauer method, the Etest. Antimicrobial drugs: Inhibitors of cell wall synthesis (Penicillins, Cephalosporins), Protein synthesis inhibitors (Tetracyclines, Chloramphenicol), metabolic antagonists (Sulfonamides, Trimethoprim), nucleic acid synthesis inhibitors (Quinolones). Factors influencing Antimicrobial Drug: Drug resistance; mechanism of drug resistance, origin and transmission of drug resistance, Antifungal drugs, Antiviral drugs, Antiprotozoan drugs.

UNIT-III; 16h

Pathogenesis, clinical conditions, laboratory diagnosis, epidemiology, chemotherapy and prevention of following infectious agents. **Bacteria:***Staphylococcus, Streptococcus,Pneumococcus, Escherichia coli, Salmonella, Shigella, Neisseria, Vibrio, Clostridium, Haemophilus, Brucella, Mycobacterium, Mycoplasma, Chlamydia*,

UNIT-IV; 16h

Virus: Measles, Mumps, Influenza, Yellow fever, HIV, Common cold, Rabies, Hepatitis, Poliomyelitis, Dengue, Corona virus, Prions and Viroids. **Fungi:** Superficial mycosis, cutaneous mycosis, subcutaneous mycosis, systemic mycosis, opportunistic mycosis, Protozoa: Ameobiasis, Giardiasis, Malaria, Leishmaniasis, Trypanosomiasis. **Dental infections:** Dental plaque, dental caries, periodontal diseases. **Nosocomial infections:**Bacteraemia, burn wounds, respiratory tract infections, surgical site infections, urinary tract infections, miscellaneous infections.

References;

1. Ananthanarayan, R and Paniker, C.K.J. 2009.Text book of Microbiology, 8th edition, Universities press Private Limited, Hyderabad, India.
2. Black, J.G. 1996. Microbiology Principles and Applications, 3rd edition, Prentice Hall Publications, USA.
3. Coiw, R and Sunshine, G. Immunology (A short course), 6th edition, Wiley Blackwell.
4. Forbes, B., Sahm, D.F and Weissfeld, A.S. 1998. Diagnostic Microbiology, 11th edition, Mosby, Inc.Missouri.
5. Janeway, Travers, Walport and Shlomchik. 2005. Immunobiology (The immuno system in health and diseases), 6th editions, Garland Science Publishers, New York.
6. Kindt, T.J., Goldsby, R.A and Osborne, B.A. 2007. Kuby Immunology, 6th edition, W.H. Freeman & Company, New York.
7. Male, D., Brostoff, J., Roth, D.B and Roitt, I. 2006. Roitt Immunology, 7th edition, Mosby Elsevier Publishers.
8. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3rd edition, Elsevier Mosby, New York.
9. Prescott, Harley, and Kleins. Microbiology, 7th Edition, McGraw Hill Publication.

Practical Syllabus: Practical MB-2.4: Medical Microbiology

1	Isolation of normal micro flora of human
2	Isolation and identification of *Staphylococci*
3	Isolation and identification of *Streptococci*
4	Isolation and identification of *Escherichia, Pseudomonas, Salmonella*,
5	Isolation of Gram-negative intestinal pathogen
6	Detection of Urinary tract pathogens
7	Examination of bacteria by using urine dip slide technique
8	Detection of *Mycobacterium tuberculosis* in sputum by AFB staining
9	Determination of dental caries susceptibility by Snyder Agar test
10	Detection of Malarial parasite in blood smear
11	Stool examination for parasites
12	Determination of antibiotic sensitivity of bacteria: Kirby-Bauer method
13	Determination of Phenol-coefficient of antimicrobial compounds
14	Estimation of Haemoglobin content in blood
15	Total RBC count
16	Total WBC count
17	Differential WBC count
18	Determination of Erythrocyte sedimentation rate (ESR)
19	Syphilis detection by VDRL Test
20	Detection of *Salmonella* by WIDAL test

MB-2.5(A): Plant-Microbe Interactions (Soft Core) 64 hours

UNIT-I; 16h

Introduction to microbial interactions with plants. Pre-penetration, Penetration and Post penetration of microorganisms with plants. Nature of plant-microbe interaction: **Symbiotic relationship of microorganisms with plants:** *Rhizobium* and mycorrhizal fungi.

UNIT-II; 16h

Plant-pathogen interactions: Biology of *Agrobacterium*, *Peronospora*, *Alternaria* and TMV interactions with their hosts. Role of receptors, elicitors, lectins, cell wall surface components, suppressors, enzymes, toxins, PR-proteins and growth regulators in plant-microbe interactions.

UNIT-III; 16h

Molecular approaches in the study of plant-microbe interactions, genetic basis of pathogenicity and parasitism, signal transduction, compatibility and incompatibility, gene-for-gene concept. Plant interaction with endophytic bacteria and fungi, Use of Avirulent mutants in control of bacterial, fungal and viral disease of plants. Interactions of plants with soil pathogens and their antagonists in natural ecosystem.

UNIT-IV; 16h

Transgenic approaches for crop protection pathogen derived resistance, plantibodies, over expressing defense genes, use of cloned resistance genes, expression of vaccines in plants, engineering broad spectrum resistance. **Systemic acquired resistance in plants:** Hypersensitive response and associated defense reactions in plants, induced structural and biochemical defense mechanisms.

References;

1. Agrios, G. 2005. Plant Pathology, 5th edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
3. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
4. Carlile, M.g., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
5. Geger, M.J. and Stence, M.J. 2001. Biotic interactions in plant pathogen association. CAB-International, United Kingdom.
6. Gow, N.A.R and Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.
7. Mehrotra, R.S. 1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.
8. Pelczar, M.J, Chan, E.C.S and Krieg, N.R. 1986. Microbiology, 5th edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
9. Rangaswami, G and Bagyarai, D.J. 2005. Agricultural Microbiology, 2nd edition, Prentice-Hall of India Private Limited, New Delhi

Practical Syllabus: Practical MB-2.6(A); Plant-Microbe Interactions

1. Isolation of plant saprophytes-bacteria and fungi
2. Isolation of plant pathogens-bacteria and fungi
3. Isolation of plant pathogens form seeds by standard blotter method
4. Isolation of plant pathogens form seeds by seed wash method
5. Effect of plant saprophytic bacteria on seed germination and seedling vigour
6. Effect of plant saprophytic fungi on seed germination on seedling vigour
7. Effect of plant pathogenic bacteria on seed germination on seedling vigour
8. Effect of plant pathogenic fungi on seed germination on seedling vigour
9. Selective isolation of plant growth promoting rhizobacteria - *Pseudomonas*
10. Effect of extra cellular bacterial/fungal enzymes on plants
11. Effect of extra cellular bacterial/fungal phytotoxins on plants
12. Biological seed treatment for prevention of seed / seedling infections
14. Histopathological preparations for necrotroph induced reactions in plants
15. Effect of plant root exudates on fungal spore germination
16. Analysis of plant root exudates for sugars
17. Effect of plant extracts on fungal growth
18. Analysis of plant root exudates for amino acids
19. Isolation and identification of *Rhizobium* from root nodules
20. Isolation and identification of endophytic bacteria and fungi

MB-2.5(B): Microbial Enzymology (Soft Core) 64 hours

UNIT-I; 16h

Bio energetics: importance of Thermodynamics, First and second law of thermodynamics; enthalpy, entropy, and Gibbs free energy. Enzyme nomenclature, classification, general properties of enzymes, factors affecting enzyme activity, activation energy, transition state, turnover number, enzyme co-factors. **Enzyme kinetics**: General kinetic principles; steady-state enzyme kinetics, Michelis-Menton equation, importance of Km and Vmax, linear transformation of MM-equation (LB Plot). Enzyme inhibition studies; Kinetics of competitive, non-competitive, uncompetitive and mixed inhibitors.

UNIT-II; 16h

Enzyme regulation: Allosteric and cooperative effects, conquered model of Monod et al, and sequential model of Koshland et al. **Principles of metabolic regulations**; feedback regulations of multifunctional pathway. **Mechanism of enzyme action**: Acid base catalysis, covalent catalysis, chymotrypsin, pyruvate kinase, Multi enzyme complex, Fatty acid synthatase complex: biological significance of multi enzyme complex. **Coenzymes**: Structure and functions of different coenzymes.

UNIT-III; 16h

Isolation and purification of enzymes: Enzyme extraction –Inter and intra cellular enzymes purification methods, soluble enzymes, membrane bound enzymes, purification-precipitation methods, concentration of biomolecules: salting with ammonium sulphate precipitation, dialysis, lyophilisation, chromatographic methods, total activity and specific activity. **Assay techniques for microbial enzymes**: Amylases, proteases, cellulases, and lipases, Basic principles of cell and enzyme immobilization.

UNIT-IV; 16h

Applications of Enzymes – Enzyme electrodes. Enzyme as biosensor, potentiometric biosensor, industrial applications of enzymes. Commercial value: steriodical conversions, penicillin and antibiotic conversion, immunosensor. **Recent advances and future prospects of enzyme engineering**; artificial enzymes, enzyme therapy. Enzymes in organic solvents, enzyme targeting using liposomes, isoenzymes.

References:

1. Palmer T. 2004. Enzymes Biochemistry, Biotechnology, Clinical chemistry, East West press, New Delhi.
2. Palmer T and Bonner P. L. 2008. Enzymes Biochemistry, Biotechnology and Clinical chemistry, 2nd edition, East West press, New Delhi.
3. Singh S. 2007. A text Book of Enzymes, Campus Books International, New Delhi.
4. N S Kulakarni and M S Deshpande. 2007. General Enzymology. 1st edition, Himalaya publishing house PVT. LTD. Mumbai.

Practical Syllabus: Practical MB-2.6(B); Microbial Enzymology

1. Preparation of solutions
2. Preparation of buffers
3. Principle and use of pH meter
4. Screening of microorganism for invertase
5. Screening of microorganism for amylase
6. Screening of microorganism for proteases
7. Screening of microorganism for lipases
8. Principle and use of colorimeter- Beer and Lamberts law
9. Quantitative estimation of total carbohydrate by DNS method
10. Quantitative estimation of protein by Lowry's method
11. Construction of glucose-calibration curve
12. Determination of activity of microbial lipase
13. Determination of activity of microbial invertase
14. Determination of activity of microbial amylase
15. Determination of activity of microbial protease
16. Determination of specific activity of microbial amylase
17. Determination of optimum pH for microbial amylase activity
18. Determination of optimum temperature for microbial amylase activity
19. Effect of inhibitor on microbial amylase activity
20. Determination of Km and Vmax of microbial amylase

MB-2.7(A); Water Microbiology (Elective) 32 hours

UNIT-I; 16h

Sources of Microbial contamination of water. Factors influencing microbial Contamination of water. Sampling of water for microbiological analyses. Types of water samples. Collection, transport and processing of samples. Detection of microbial populations in water phenotypic detection. Determination of microbial members: Direct count and viable count procedures.

UNIT-II; 16h

Detection methods for water-borne pathogens-multiple tube fermentation method, membrane filter method, P-A technique, rapid detection of coliforms. Detection of indicators of pathogenic bacteria-enterococci, bacteriophages. Water disinfection methods. Safe limits for drinking water. Water Quality standards.

References;

1. Alcamo,I.E. 1997. Fundamentals of Microbiology,5th edition, Anim print of Addison Wesley Longman, New York.
2. Batzing,B.L. 2002. Microbiology (An Introduction), Brooks/Cole Thamson Learning, Canada.
3. Bauman, R. 2007. Microbiology (With diseases by Taxonomy), 2nd edition, Pearson Benjamin Cummings Publishers, San francisco.
4. Cappucino, J.G. and Sherman, N. 2005. Microbiology, A Laboratory Manual, 7th edition, Pearson Education INC. Delhi, India
5. Patnail, P.1997. Hand Book of Environmental Analysis. CRCPress,Inc.,USA.

MB- 2.7(B); Agricultural Microbiology (Elective) 32 hours

UNIT-I; 16h

Concepts and scope of agricultural microbiology, importance of microorganisms in agriculture, influence of microorganisms in plant growth, modern concept of microbial inoculants in agriculture; biological nitrogen fixation-symbiotic and non-symbiotic nitrogen fixation, mechanism of nitrogen fixation and importance. Interaction of soil microorganisms with plants; Rhizosphere and phylloplane microorganisms. *Rhizobium* inoculants: Brief account of production and application of *Rhizobium* inoculant; physiology and genetics of nodulation and nitrogen fixation, strain selection and mass culturing.

UNIT-II; 16h

Brief account of production and utility of *Azotobacter, Azospirillum,* cyanobacteria, *Azolla, Frankia.* Phosphate-solubilizing, microorganisms-importance, application of these microorganisms in agriculture. Mycorrhizae, Types and applications of mycorrhizae. Methods of biofertilizer application-seed inoculation, soil amendment and nursery application.

References;

1. Agrios,G. 2005. Plant Pathology,5th edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Carlile, M.G., Watkinson, S.C and Gooday, G.W. 1994. The Fungi, Academic Press, UK.
3. Gow, N.A. Rand Gadd, G.M. 1996.The Growing Fungus, Chapman and Hall Publishers, London.
4. Mehrotra, R.S. 1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.

MB-3.1: Agriculture Microbiology (Hard Core) 64 hours

UNIT-I; 16h

Concepts and scope of agricultural microbiology and phytopathology: Interaction of soil microorganisms with plants: Rhizosphere and phylloplane microorganisms. Influence of microorganisms in plant growth. Significance of plant diseases, types of plant diseases, basic procedure of plant disease diagnosis, parasitism, pathogenicity and plant disease development, disease cycle, infection cycle and plant disease triangle.

Epidemiology of plant diseases: Effect of environmental factors on disease development; Dissemination of plant pathogens; Disease forecasting and its Significance.

Seed Pathology: Importance of seed-borne diseases and seed health testing methods.

UNIT-II; 16h

Importance of microorganisms in agriculture: Modern concepts of microbial inoculants in agriculture. Mass culturing and quality control of microbial inoculants-mother culture, shake culture and brief account of large scale production of carrier materials, packing, storage, bench life and transportation of biofertilizers, types ISI standards and quality testing at different levels. Methods of biofertilizer application- seed inoculation, soil amendment and nursery application.

Symbiotic and non-symbiotic nitrogen fixation, mechanisms of nitrogen fixation and importance. Brief account of production and application of *Rhizobium* inoculant; strain selection and mass culturing. Brief account of production and utility of *Azotobacter*, *Azospirillum*, cyanobacteria, *Azolla*, *Frankia*. Salient features and significance of strains and application of these organisms. Phosphate-solubilizing microorganisms-importance, culturing and applications of these microorganisms in agriculture. Mycorrhizae: types, Mass production and application of mycorrhizae.

UNIT-III; 16h

Levels of plant- pathogen interaction: Prepenetration, host recognition, role of host exudates, entry by plant pathogens through natural openings and wounds, direct penetration, process of pathogenesis, infection and establishment of pathogens in the host tissues.

Role of pathogen enzymes in pathogenesis- production of different enzymes and action of pathogen enzymes on host tissues and significance of these enzymes in disease development. Role of phytotoxins in plant pathogenesis-types of toxins produced by plant pathogens, effect of toxins on disease development. Role of plant growth regulators in plant pathogenesis. **Defense mechanisms in plants:** Structural and biochemical defense mechanisms, role of elicitors, receptors and suppressors in disease development, molecular mechanisms in expression of plant disease resistance.

UNIT-IV; 16h

Plant Disease Management: Cultural methods-exclusion, eradication, crop rotation and sanitation. Inspection and certification, quarantine regulations. Physical methods-soil solarization, hot water treatment, mulching and other methods. Chemical control of plant diseases-preparation and use of different chemicals, types of chemicals used in plant disease management; application of chemicals to soil, seeds, plant and store house problems and remedies for fungicidal resistance. Biological control of plant disease, selection, testing and use of antagonistic microorganisms and their metabolites, application methodology and significance. Breeding for disease resistance, systemic acquired resistance; protoplast, cell, tissue culture and somaclonal variation for disease resistance, biotechnological approaches in obtaining disease resistance plants, induced resistance, transgenic plants for plant disease management. Integrated disease management practices. Brief account of some important plant diseases (with one example for each group with description of pathogen, symptoms and management)- rots, damping-offs, downy mildews, white rust, powdery mildews, smuts, rusts, wilts, leaf spots, anthracnose, galls, ergots, bacterial diseases, viral diseases, phytoplasmal diseases, nematode diseases, protozoal diseases, viroid diseases, non-parasitic diseases and post-harvest diseases.

References;

1. Purohit, S.S. 2003. Agricultural Biotechnology, 2nd edition, Agrobios Publisher, Jodhpur, India.
2. Rangaswami, G and Bagyarai, D.J. 2005. Agricultural Microbiology, 2nd edition, Prentice-Hall of India Private Limited, New Delhi.
3. Rao, N.S.S. 1993. Biofertilizers In Agriculture and Forestry, 3rd edition, Oxford & IBH Publishing Pvt. Ltd, New Delhi.
4. Subba Rao N S. 2020. Soil microbiology. 5th edition. Scientific international private ltd.
5. L. L. Somani. 1990. Biofertilizers. RLW Press.
6. R.C. Dubey and D.K. Maheshwari. 2019. A text book of microbiology. Vikas publishing house.

Practical Syllabus: Practical MB-3.3; Agricultural Microbiology

1. Isolation of *Rhizobium*
2. Isolation of *Azotobacter*
3. Isolation of phosphate solubilizing microorganisms
4. Isolation and identification of cyanobacteria
5. Isolation of fluorescent *Pseudomonas* from rhizosphere soil
6. Isolation of *Azospirillium*
7. Seed health testing by dry seed examination
8. Detection of seed-borne fungi by agar plate method
9. Detection of seed-borne fungi by blotter method
10. Histopathological preparations of diseased specimens
11. Effect of seed-borne pathogens on seed germination and seedling vigour
12. Effect of biocontrol agent (*Trichoderma/Pseudomonas)* for the prevention of seed borne pathogens by paper towel method.
13. Effect of fungicidefor the prevention of seed borne fungal pathogens by paper towel method.
14. Estimation of phosphate by Fiskay-Subbarao method
15. Estimation of phosphate by Koening and Johnson's method
16. Detection and quantification of mycorrhizae by root clearing technique
17. Fungicide evaluation by agar diffusion method
18. Effect of fungicidal seed treatment on seed-borne fungi
19. Study of plant diseases caused by fungi, bacteria and viruses
20. Post-harvest diseased samples

MB-3.2; Immunology (Hard Core) 64 hours

UNIT-I; 16h

Overview of the immune system: History, early theories of immunity, types of immunity - innate immunity and acquired (Natural, Artificial, active and passive) immunity. **Organs and Cells of immune system:** Central lymphoid organs-bone marrow and thymus; peripheral lymphoid system - spleen, lymph nodes, gut associated lymphoid tissues. **Lymphoid cells;** B cells, T cells, Natural killer cells, **myeloid cells;** Neutrophils, Basophils and Eosinophils, Macrophages and Dendritic cells. Development of T and B-lymphocytes.

Antigens; Immunological properties of antigens, factors influencing immunogenicity, epitope, hapten, Agretope, Adjuvants, Alumn adjuvant, Freund's incomplete and complete Adjuvants, Effect of dose size and rout of administration of antigen towards immune response, Contribution of Host towards immune response.

UNIT-II; 16h

Antibodies/Immunoglobulins: Immunoglobulin classes, basic structure and chemistry of IgG, IgM, IgA, IgE and IgD, Characteristic features of Primary response, Secondary response and Memory response; Antigenic determinants of immunoglobulins- isotypic, allotypic and idiotypic determinants; Generation of Antibody diversity and specificity

Antigen-antibody reactions: Immuno precipitation, Agglutination, Complement fixation, Immunofluorescence, ELISA, RIA, Western blotting. Production and applications of polyclonal and monoclonal antibodies. Different types of vaccines and their significance.

UNIT-III; 16h

Complement System: Classical pathway, Lectin pathway and Alternative pathway, Generation of Membrane attack complex (MAC), Biological functions of complement components. **Major Histocompatibility Complex (MHC) and Antigen presentation:** Types, Structure and functions of MHC molecules, General organization and inheritance of the MHC, Role MHC and their expression pattern. **Presentation of Bacterial and Viral Antigens:** Phagocytosis, Processing and presentation of antigens by Class I and class II MHC molecules. **Transplantation Immunology:** Introduction, Types of Grafts, Immunologic basis of Graft rejection, clinical manifestations of Graft rejection, **HLA Typing:** Antibody dependant cell mediated cytotoxicity, Mixed Lymphocyte reactions. General and specific Immunosuppressive therapy.

UNIT-IV; 16h

Hyper Sensitive Reactions: Introduction, Types of hypersensitive reactions; Type I, II, III and Delayed Type of Hypersensitivity (DTH). Autoimmune Diseases, Cytokines. **Cancer Immunology:** Origin and Terminology, Malignant Transformation of Cells, Oncogenes and Cancer Induction, Tumors of the Immune System, Tumor Antigens, Immune Response to Tumors, Tumor Evasion of the Immune System, Cancer Immunotherapy.

Vaccines: Introduction, active and passive immunization, designing vaccines for active immunization, live attenuated vaccines, Inactivated or killed vaccines, Subunit vaccines (Toxoids, Bacterial polysaccharide capsules, viral glycoproteins, Recombinant vaccines), multivalent subunit vaccines, DNA vaccines.

References:

1. Ananthanarayan, R and Paniker, C.K.J. 2009. Text book of Microbiology, 8th edition, Universities press Private Limited, Hyderabad, India
2. Black, J.G. 1996. Microbiology Principles and Applications, 3rd edition, Prentice Hall Publications, USA.
3. Coiw, R and Sunshine, G. Immunology (A short course), 6th edition, Wiley Blackwell.
4. Forbes, B., Sahm, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11th edition, Mosby, Inc.Missouri.
5. Janeway, Travers, Walport and Shlomchik. 2005. Immunobiology (The immuno system in health and diseases), 6th editions, Garland Science Publishers, New York.
6. Kindt, T.J., Goldsby, R.A and Osborne, B.A. 2007. Kuby Immunology, 6th edition, W.H. Freeman & Company, New York.
7. Male, D., Brostoff, J., Roth, D.B and Roitt, I. 2006. Roitt Immunology, 7th edition, Mosby Elsevier Publishers.
8. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3rd edition, Elsevier Mosby, New York.

Practical Syllabus: Practical MB-3.4; Immunology

1	Study of organs of immune system
2	Study of cells of immune system
3	Total WBC count
4	Differential WBC count
5	Effect of different routes of administration of Antigens on immune response
6	Effect of different adjuvants on immune response
7	Study of bacteria as Antigens
8	Study of yeast as Antigens
9	Study of fungal spores as Antigen
10	Types of antigens and adjuvants
11	Production of polyclonal antiserum
12	Methods of bleeding
13	Separation of plasma from blood
14	Separation of serum from blood
15	Determination of antibody titre of the serum
16	Purification of IgG from serum
17	Agglutination tests: Haemeagglutination
18	Passive hemagglutination
19	Immunoprecipitation Radial/ double diffusion
20	ELISA

MB-3.5(A); Immunotechnology (Soft Core) 64 hours

UNIT-I; 16h

Immune system: Brief account of immune system, types of immunity, immune response, nature of immunogens, antigens and haptens. **The structure and types of antibodies:** Molecular structure of different types of antibodies and their biological functions. **Generation of Antibodies:** Production of polyclonal antibodies, production of monoclonal antibodies, Methodology for the production of hybridoma cells, screening, selection and cloning. **Purification of immunoglobulins:** Purification of immunoglobulins from serum samples– principles and procedures of salting-out (ammonium sulphate precipitation), ion-exchange, gel filtration and affinity chromatography, isoelectric focusing, electrophoresis, assessment of purity of immunoglobulins. **Methods to determine the affinity of Antigen-Antibody interactions:** Equilibrium dialysis, Surface plasmon resonance.

UNIT-II; 16h

Immunological Techniques: Immunoprecipitation in solution, Immunoprecipitation of soluble antigens in gel matrices, characterization of cell-bound molecules by immunoprecipitation. **Agglutination Reactions:** Hemagglutination reaction to detect antigen conjugated to the surface of red blood cells, Hemagglutination inhibition reactions to detect the presence of antiviral antibodies, Agglutination reaction to detect antibacterial antibodies. **Antibody assays based on Molecule binding to Solid phase supports:** Radioimmuno assay to measure the concentration of proteins and hormones in body fluids. **ELISA:** Indirect Elisa, Sandwich ELISA, Competitive ELISA, available enzyme systems for ELISA assays, Chromogenic, Fluorogenic or Chemiluminogenic Substrates, Modifications of ELISA using Biotin-Streptavidin Bonding interactions. ELISPOT assay to measure molecules secreted by individual cells. Western Blotting to detect specific protein in a complex protein mixture. **Microscopic Visualization of Cells and Subcellular Structures:** Immunocytochemistry and Immunohistochemistry, Immunoelectron Microscopy. **Immunofluorescence:** Fluorescence to visualize Cells and Molecules, Immunofluorescence Microscopy, Confocal fluorescence microscopy, Multiphoton fluorescence Microscopy, *In vivo* observation of Immune responses by Intravital Imaging.

UNIT-III; 16h

Analysis of Cells: Flow Cytometry, Magnetic activated cell sorting. **Analysis of Cell Cycle:** Assessment of cell division by Tritiated (3H) Thymidine uptake, Colorimetric assay for cell division, Use of antibodies to detect newly synthesized DNA, Analysis of cell cycle status of cell populations using propidium iodide, Follow of cell division by Carboxyfluorescein Ester. **Assays of cell death:** 51Cr release assay to measure cell death, Detection of Apoptotic cells by Fluorecently labelled Annexin V, TUNEL assay to measure Apoptotically generated DNA fragmentation, Caspase assay to measure the activity of enzymes involved in Apoptosis. **Biochemical approaches to elucidate signal transduction pathway:** Biochemical inhibitors to identify intermediates in signalling pathways. **Whole animal Experimental Systems:** Federal guidelines to protect Non-human research subjects, inbred strains to reduce Experimental variation, Congenic strains to study the effects of particular gene loci on immune response, in vivo examination of isolated cell populations, transgenic animals in Immunology, Knock-in and knockout animals.

UNIT-IV; 16h

Vaccines: Active or Passive immunization, passive immunization by preformed antibodies, active immunization to induce immunity and memory. **Different strategies to develop vaccines;** Live attenuated vaccines (BCG, Polio), Inactivated or killed vaccines, subunit vaccines, recombinant vector vaccines, DNA vaccines, multivalent vaccines, role of adjuvants to enhance the immune response to a vaccine.

Immunotherapy: Concept of immunotherapy, **Drugs in nonspecific immunotherapy;** Cyclophosphamide or Cytoxan, Purine antagonists (Azathioprine and 6-mercaptopurine), Folic acid analog (Methotrexate). **Corticosteroid therapy;** Concept, mechanism of steroid hormone action, General aspects of glucocorticoid therapy, Clinical uses of corticosteroids, side effects of steroids in treatment. **Specific Immunotherapy:** Antibody based therapy; Inhibitors of tumor necrosis factor (TNF), Antibodies against IL-2 receptors, Anti-IgE Immunotherapy for allergic diseases.

References:

1. Coiw, R and Sunshine, G. Immunology (A short course), 6th edition, Wiley Blackwell.
2. Forbes, B., Sahm, D.F and Weissfeld, A.S.1998. Diagnostic Microbiology, 11th edition, Mosby, Inc.Missouri.
3. Janeway, Travers, Walport and Shlomchik. 2005. Immunobiology (The immuno system in health and diseases), 6th editions, Garland Science Publishers, New York.
4. Kindt, T.J., Goldsby, R.A and Osborne, B.A. 2007. Kuby Immunology, 6th edition, W.H. Freeman & Company, New York.

Practical Syllabus: Practical MB-3.6(A); Immunotechnology

1	Study of organs of immune system
2	Study of cells of immune system
3	Total WBC count
4	Differential WBC count
5	Types of antigens and adjuvants
6	Preparation of antigens a. Whole cell antigens b. Purified proteins
7	Preparation of antigen-adjuvant mixtures
8	Methods of antigen administration to animals a. Intramuscular b. Intraveinal c. Intraperitonial d. Intradermal
9	Production of polyclonal antiserum
10	Methods of bleeding
11	Separation of plasma from blood
12	Separation of serum from blood
13	Determination of antibody titre of the serum
14	Purification of IgG from serum
15	Agglutination tests: Haemeagglutination
16	Immunoprecipitation Radial/ double diffusion
17	Detection of antibodies in the serum by using Indiect ELISA
18	Detection of antigen by Sandwitch ELISA
19	Detection of antibodies in the serum by Competitive ELISA
20	Detection of antibody titre by DOT BLOT Assay

MB-3.5(B); Fermentation Technology (Soft Core) 64 hours

UNIT-I; 16h

Introduction, History, Chronological development of fermentation industry, Principle and component parts of fermentation process, Dual or multiple fermentation, Scale – up of fermentation process – Parameters and problems, Industrially important microorganisms, Isolation (Enrichment culture, pour plate and streak plate methods), Preservation, Culture collection center, Strain improvement of industrially important microorganisms (Mutation, Protoplast fusion, rDNA technology, Parasexual cycle), Microbial growth kinetics (Batch culture, fed batch culture, continuous culture).

UNIT-II; 16h

Screening of industrially important microorganisms – Primary (Crowded plate technique, Enrichment culture, Auxanography and Indicator dye technique) and secondary screening. Detection and assay of fermentation products (Physico – chemical assay and biological assay), Inoculum development – criteria for transfer of inoculum, development of inoculum for yeast process, bacterial fermentation and mycelial process. Control of fermentation conditions. Basic design of fermentor.

UNIT-III; 16h

Fermentation type reaction – alcoholic, mixed acid, propionic acid, butanediol, acetone – butanol, Fermentation media – raw materials, carbon source, nitrogen source, inducers, inhibitors, growth actors, precursors, chelators, role of buffers, antifoams, Types of fermentation process – solid state and submerged fermentation process. Immobilized enzymes and cell – methods and application.

UNIT-IV; 16h

Fermentative production of industrial alcohol, Industrial production of enzymes – Proteases, Lipases, Industrial production of alcoholic beverages – Wine and Beer, Industrial production of organic acids - Citric acid and Acetic acid, Industrial production of amino acids – Glutamic acid, Industrial production of antibiotics – Benzyl Penicillin, Single cell protein production and uses.

References;

1. Casida, L.E. 2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J. 2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H.Freemn and company, USA.
4. Stanbury, P.E, Whitaker, A. and Hall, S.J. 2017. Principles of fermentation technology. 3rd edition. Elsevier Ltd.
5. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S. 2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Tanuja.S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

Practical Syllabus: Practical MB-3.6 (B): Fermentation Technology

1. Isolation of *Actinomycectes* and their screening for antibiotic production
2. Isolation of fungi and their screening for antibiotic production
3. Assessment of secondary metabolite substances from culture filtrate
4. Separation of biomass- wet and dry biomass preparation
5. Separation and qualitative estimation of protein from soybean
6. Submerged fermentation for production of citric acid
7. Submerged fermentation for production of protease
8. Submerged fermentation for production of lipase
9. SSF for production of citric acid
10. SSF for production of proteases
11. SSF for production of lipases
12. Qualitative analysis of raw materials for presence of sugars
13. Qualitative analysis of raw materials for presence of proteins
14. Colorimetric estimation of amino acids by ninhydrin method
15. Colorimetric estimation of sugars from raw materials
16. Colorimetric estimation of vitamins by DNPH method
17. Colorimetric estimation of protein by Lowry's method
18. Study of raw materials used in fermentation industry
19. Microbial cell immobilization by calcium alginate method
20. Precipitation of protein from a crude extract by Ammonium sulphate precipitation method

MB-3.7(A); Diagnostic Microbiology (Elective) 32 hours

UNIT-I; **16h**

An overview of medical microbiology, significance of microbial diseases of humans. **Medical Specimens:** collection procedure and transport of body fluid specimens, gastrointestinal specimens, genital specimens, respiratory specimens, urine specimens and wound specimens. **Specimens processing:** General methods, microscopy, culture methods and serology.

UNIT-II- **16h**

Laboratory diagnosis of important bacterial, viral, fungal and protozoal infections. (*Mycobacterium*, *Staphylococcus*, *Treponema*, *Salmonella*, HIV, Hepatitis, *Aspergillus*, *Candida*, *Plasmodium*). Antimicrobial drug testing procedures**.** Laboratory safety measures and sample disposal.

References;

1. Coiw,R and Sunshine, G. Immunology (A short course), 6th edition, Wiley Blackwell.
2. Forbes,B.,Sahm,D.F and Weissfeld, A.S.1998. Diagnostic Microbiology,11th edition, Mosby, Inc. Missouri.
3. Janeway, Travers, Walport and Shlomchik.2005. Immunobiology (The immuno system in health and diseases), 6th editions, Garland Science Publishers, New York.
4. Kindt,T.J.,Goldsby, R.A and Osborne, B.A.2007.KubyImmunology, 6thedition, W.H.Freeman & Company, New York.
5. Male, D.,Brostoff, J., Roth, D.B and Roitt,I.2006. Roitt Immunology, 7thedition, Mosby Elsevier Publishers.
6. Mims, C., Dockrell, H.M., Goering, R.V., Roitt, I., Wakelin, D. and Zucker, M. 2004. Medical Microbiology, 3rd edition, Elsevier Mosby, New York.

MB-3.7(B): Industrial Microbiology (Elective) 32 hours

UNIT-I; **16h**

Concepts and scope of Industrial microbiology, Screening and strain improvement in industrial microbiology**. Industrial fermenters:** Basic functions, design and components. **Different types of fermenters :** Chemostat and turbiodstat, tower fermenters, membrane bioreactors, scale up of fermentation process. **Microbial growth kinetics:** Batch cultures, continuous cultures, fed-batch cultures, industrial production of biomass and metabolites.

UNIT-II; **16h**

Fermentation media: desired qualities, sources of nutrition. Downstream processing: objectives and criteria. Industrial production of penicillin, alcohol, glutamic acid, vitamin A and alcoholic beverages. Industrial enzymes: Production and applications of amylases, proteases, pectinases, cellulases and lipases. Immobilization of enzymes or cells.

References;

1. Casida,L.E. 2007. Industrial microbiology, Newage international(P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer,A and Nikaido. 1995. Microbial biotechnology fundamentals of applied microbiology, W.H.Freemn and company, USA
4. Stanbury, P.E, Whitaker, A. and Hall, S.J. 2017. Principles of fermentation technology. 3rd edition. Elsevier Ltd.
5. Patel,A.H. 1985. Industrial Microbiology, Macmillan India Ltd, New Delhi.

MB-4.1: Food and Industrial Microbiology (Hard Core) 64 hours

UNIT-I; 16h

Food Microbiology: Introduction, Food as a substrate for microorganism; factors influencing the growth of microorganisms (moisture, water activity, pH, nutrient content, inhibitory substances and biological structure**.** Source of food contamination-soil, water, air, sewage, plants and animals**.** Microbial examination of foods-microscopic techniques and culture techniques. Food spoilage-general means of food spoilage, microorganisms involved in food spoilage of cereals, vegetables, meat, fish, egg and canned foods. Chemical changes caused by microorganisms. Food preservation-general principles, removal of microorganisms, maintenance of anaerobic conditions; preservation using high temperatures; factors affecting heat resistance; determination of heat resistance; thermal death time, determination of thermal processes, heat treatments employed in food processing, growth of microorganisms at low temperatures, low temperatures storage, effect of freezing temperatures on microorganisms; preservation by drying; microbiology of dry foods; food preservatives and factors influencing their effectiveness; preservation methods using radiations. **Food-borne illnesses:** General account of food borne bacterial diseases-*Clostridium*, Gastroenteritis, Vibrio, enteropathogenic *Escherichia coli*, *Bacillus*; Food poisoning-mycotoxins (aflatoxins, ochratoxins, trichothecines, zearalenones, ergot alkaloids); food borne viruses, parasites; seafood toxicants.

UNIT-II; 16h

Food fermentation- bread, alcoholic beverages, vinegar, fermented vegetable, general principles in the production of cultures for food fermentation**.** Microbial foods: single cell proteins (*Spirulina*, yeast, *Fusarium*), fats from microorganisms, single cell oil (PuFas from fungi); mushroom-value, cultivation and preservation methods. Food Control Enforcement and control agencies, microbiological criteria for foods.

Dairy Microbiology: Nutritional level of milk, microbial flora of milk and their role in milk spoilage; sources of milk contamination. Bacteriological aspects of pasteurization, sterilization of milk; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

Microbiology of dairy products: Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yoghurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making.

Microbiology of dairy starter cultures: definition and properties of starter culture, criteria for starter selection, lactic and non-lactic starter cultures used in dairy industry; use of pure and mixed starter cultures in product manufacturing; production of flavour components by starter cultures; methods of starter maintenance, propagation and preservation; judging the quality of starter cultures. Defects associated with starter cultures – incidence, detection and control. Microbial utilization of whey; composition of different dairy effluents, methods for treatment and disposal of dairy effluents; their significance and applications. Current trends in microbiological quality control in dairy industry.

UNIT-III; 16h

Industrial Microbiology; Concepts and scope of Industrial microbiology. Screening and strain improvement in industrial microbiology: Industrial important species and strains, strain maintenance and preservation. Industrial fermentors: Basic functions, design and components impellers, spargers, baffles, sterilization of fermentor, a brief account of monitoring and control devices. Different types of fermentors: Chemostat, turbidostat, gradostat, tubular

fermentors, tower fermentors, membrane bioreactors, scale up of fermentation process parameter and problems associated with scale up. Microbial growth kinetics: Batch cultures, continuous cultures, fed-batch (variable volume, fixed volume, cyclic), Fermentation media**:** desired qualities, sources of carbon, nitrogen, vitamins and inducers and antifoams**,** minerals; role of buffers, precursors, inhibitors,

UNIT-IV; 16h

Downstream processing: objectives and criteria, foam separation, precipitation methods, filtration devices, filter aids, industrial scale centrifugation and cell disruption methods, liquid-liquid extraction, solvent recovery, chromatography, microfiltration, ultrafiltration, drying devices, crystallization and whole broth processing. Industrial fermentation of penicillin, lactic acid, glutamic acid, vitamin A. **Industrial enzymes:** production and applications of amylases, proteases, pectinases, cellulases and lipases. Immobilization of enzymes or cells: methods, substrates, advantages and applications. Modern approaches to industrial waste treatments.

References;

1. Downes, F.P and Ito, K. 2001. Compendium methods for the Microbiological Examination of Foods, 4th edition, APHA, Washington, DC
2. Doyle, M.P., Beuchat, L.R. and Montville, T.J. 2001. Food Microbiology, Fundamentals and Frontiers, 2nd edition ASM Press Washington DC.
3. Frazier, W.C and Westhoff, D.C.1988. Food Microbiology, 4th edition, Tata McGrawHill Publishing Company, New Delhi.
4. Marth, E.H and Steele, J.L.2001. Applied Dairy Microbiology, r, Marcel Dekker AG Publishers, Switzerland.
5. Parihar, P and Parihar, L.2006. Dairy Microbiology, 2nd edition, Agrobios Publishers, Jodhpur, India
6. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
7. Clark, D.P and Pazdernik, N.J. 2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
8. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi
9. Stanbury, P.E, Whitaker, A. and Hall, S.J. 2017. Principles of fermentation technology. 3rd edition. Elsevier Ltd.

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Practical Syllabus: Practical MB-4.4; Food and Industrial Microbiology

1. Microbiological examination of food utensils
2. Microbiological examination of vegetables
3. Microbiological examination of spices
4. Microbiological examination of meat
5. Microbiological examination of fruits
6. Microbiological examination of cereals
7. Detection of faecal pollution in drinking water
8. Bacteriological examination of drinking water
9. Microbiological analysis of ice-cream
10. Food preservation methods-chemical and physical
11. Estimation of lactic acid in milk
12. Estimation of lactose in milk
13. Extraction of casein form milk
14. Detection of calcium and phosphorous in milk
15. Rapid platform tests for milk quality assessment
    -Organoleptic test
    - pH test
    -Clot on boiling test
    -Alcohol test
    -Turbidity test
16. Dye reduction test a) Methylene blue reduction test b) Resazurin dye reduction test
17. Bacteriological examination of milk
    i) Presumptive test
    ii) Confirmed test
    iii) Completed test
18. Direct microscopic count of bacteria in milk: breed count
19. Standard plate count of milk
20. Different dairy products

MB-4.2; Microbial Biotechnology (Hard Core) 64 hours

UNIT-I; 16h

Microbial Biotechnology: Introduction, Definition, Concepts, Microorganisms as tools, use of microorganisms and their products in biotechnology. **Microorganisms for the production of macromolecules:** Production of chymosin in *E. coli*. Production of Hepatitis B surface antigen proteins in yeast cells; expression of foreign gene products in a secreted form (Prochymosin in yeast). **Microbial insecticides:***Bacillus thuringensis*, Baculoviruses, entomopathogenic fungi- *Beauveria*. Bacterial production of polysaccharides, xanthan gum, microbial production of polyester- polyhydroxyalkanoates. **Fungal biotechnology:** fungal production of alkaloids, antibiotics, enzymes, organic acids.

UNIT-II; 16h

Microbial production of useful products: Production and applications of insulin, human interferon, human growth hormone. **Agricultural biotechnology:** Development of insect-resistant, herbicide-resistant plants; use of plants as bioreactors for the production of immunoglobulins. Terminator seed technology. **Animal biotechnology:** General principles and applications for the production of transgenic mice, cattle, pigs. **Gene therapy:** General principles of gene therapy, brief account of genetic diseases and techniques involved in gene therapy. **Environmental Biotechnology:** Principles of degradative capabilities of microorganisms, genetic engineering for the control of pollutants. Microorganisms in mineral recovery and removal of heavy metals from aqueous effluents.

UNIT-III 16h

Biotransformations; Introduction, biocatalytic selection, biocatalytic immobilization and performance, Immobilized enzyme reactors. **Recombinant proteins of high value;** Applications of high value proteins, analytical enzymes, therapeutic proteins, regulatory aspects of therapeutic proteins. **Regulations and patenting in Biotechnology:** Regulating the use of biotechnology, deliberate release of genetically engineered organisms, regulation policies of human gene therapy. Patenting of biotechnological inventions, organisms and protocols. Social and ethical aspects of biotechnology.

UNIT-IV 16h

Nanotechnology: Microorganisms for synthesis of nanomaterials: Natural and artificial synthesis of nanoparticles in microorganisms; Use of microorganisms for nanostructure formation, testing of antimicrobial effect of nanoparticles using microorganisms**. Biological Methods of Synthesis:** Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Role of plants in nanoparticle synthesis.

References:

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.

3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H. Freemn and company, USA.
4. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechonology Principles and Applications of Recombinant DNA, 3rd edition, ASM Press, USA
5. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Ratledge, C and Kristiansen, B. 2001. Basic Biotechnology, 2nd edition, Cambridge University Press, USA.
8. Ratner, M and Ratner, D. 2003. Nanotechnology, Pearson education, New Delhi, India.
9. Rao, M.B. and Reddy.K.K. 2007. Introduction to Nanotechnology, Campus books international, New Delhi.
10. Lindsay, S.M. 2010. Introduction to Nanaoscience, Oxford university press. New York.

Practical Syllabus: Practical MB-4.5; Microbial biotechnology

1	Screening and isolation of amylase producing fungi form different sources
2	Determination of microbial amylase activity
3	Determination of specific activity of amylase
4	Production of amylase by submerged fermentation
5	Production of amylase by solid state fermentation
6	Raw materials used in industrial Microbiology
7	Study of fermentation using yeast
8	Estimation of alcohol by colorimetric method
9	Estimation of alcohol by specific gravity method
10	Estimation of citric acid by AOAC method
11	Estimation of citric acid by submerged fermentation
12	Estimation of citric acid by solid state fermentation
13	Determination of activity and specific activity of invertase in yeast
14	Study of carbohydrate utilizing capacity of bacteria
15	Estimation of Ascorbic acid in the microbial sample
16	Wine production
17	Yeast/bacterial cell immobilization
18	Synthesis of nanoparticles by bacteria
19	Synthesis of nanoparticles by fungi
20	Synthesis of nanoparticles by plants

MB-4.3; Environmental Microbiology (Hard core) 64 hours

UNIT-I;. **16h**

Environment and Ecosystem: Physical, chemical and biological aspects of environment, natural habitats of microorganisms, microorganisms in ecosystem as producers and decomposers. Biogeochemical cycles-role of microorganisms in transformation and maintenance of carbon, nitrogen, phosphorus and sulphur in nature.

Soil Microbiology Historical development of soil microbiology. Physical characteristics and nutrient status of soil. Distribution of microorganisms in soil, their importance in maintaining soil fertility, organic matter and composting. Influence of environmental factors on soil microorganisms. Role of microorganisms in formation of different soils. Enumeration and isolation of soil microorganisms. Brief account of interactions among soil microorganisms-mutualism, commensalism, antagonism, competition, synergism, parasitism and predation.

UNIT-II; **16h**

Aquatic microbiology: Aquatic environment: Temperature, hydrostatic pressure, light, salinity, turbidity, pH, nutrients. Distribution of microorganisms in the aquatic environment. Methods in the study of fresh and marine water microorganisms. Role of aquatic microorganisms in food chain of aquatic environment. Eutrophication-role of nitrogen and phosphorus in eutrophication, process and control of eutrophication. Microorganisms and water Pollution-Microflora of natural and polluted water, sources and characteristics of water pollutants; health hazards due to water pollution; microorganisms as indicators of water pollution; water quality criteria and assessment; bacteriological examination of water for potability. The role of microorganisms in the purification of waste water: waste water treatment process, aerobic-anaerobic-design and functioning of treatment plant; microbial ecology and application of trickling filters; activated sludge process, microbial treatment of sludges. Water-borne diseases and their prevention.

UNIT-III; **16h**

Microbiology of the atmosphere: Microorganisms in air, sources of air-borne microorganisms. Intramural and Extramural aeromicrobiology. Techniques for microbiological sampling of air, impactors and impingers-Gravity slide, Plate exposure, vertical cylinder, Anderson's sampler, Hirst's trap, Burkard's 7-day volumetric sampler, rotarod sampler. Brief account of air-borne diseases of humans and plants. Brief account of air-borne allergens and their significance. **Microorganisms in extreme environments:** Extreme environments of temperature, salinity, pressure, pH. Extreme thermopiles, psychrophiles, extreme halophiles, barophiles and other microorganisms in extreme environments. Radio sensitivity of microorganisms, effect of radiation on microorganisms, mechanisms of radio-tolerance in microorganisms.

UNIT-IV; **16h**

Biodeterioration and Bioremediation: Microorganisms as biodeteriogens and their role in cycling of matter. Microbial degradation of cellulose, lignin, pectin, chitin, synthetic polymers, xenobiotic compounds, petroleum and other hydrocarbons. Solid wastes, chemical wastes, utilization of microorganisms in industrial effluent treatment technologies. Bioremediation of xenobiotic pollutants. Factors influencing bioremediation. Metal toxicity to microorganisms, importance of microorganisms in ore leaching, use of microorganisms in metal extraction.

References;

1. Atlas, R and Bartha, R.2005. Microbial Ecology Fundamental and Applications, 4th edition, Pearson Education (P) Ltd. Delhi, India
2. Bhatia, S.C. 2008. Hand Book of Environmental Microbiology, Atlantic Publishers Pvt. Ltd. New Delhi.
3. Gilman, J. 2001. A Manual of Soil Fungi, Biotech Books, New Delhi.
4. Maier, R., Pepper, I and Gerba, C.P. 2006. Environmental Microbiology, Reed Elsevier India Private Limited,New Delhi, India
5. Patnail, P. 1997. Hand Book of Environmental Analysis. CRC Press, Inc., USA.
6. Subba Rao, N.S.1999. Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, India
7. Thakur, I.S. 2006. Environmental Biotechnology, I.K. International Pvt. Ltd. New Delhi.

Practical Syllabus: Practical MB-4.6; Environmental Microbiology

1. Soil moisture content determination
2. Estimation of total alkalinity of soil
3. Ammonification in soil
4. Isolation of soil microorganisms by direct plate method
5. Baiting technique for isolation of soil microorganisms
6. Estimation of dissolved oxygen of water
7. Estimation of free carbon-dioxide
8. Estimation of total solid content of water
9. Estimation of total acidity of water
10. Estimation of total alkalinity of water
11. Estimation of catalase activity in water
12. Estimation of BOD of sewage water
13. Determination of chemical oxygen demand of water
14. Estimation of chloride in water sample
15. Study of aquatic microflora-algae
16. Bacteriological examination of water-MPN method
17. Enumeration of air borne microorganisms by gravity slide method
18. Enumeration of air borne microorganisms by gravity plate method
19. Enumeration of air borne microorganisms by vertical cylinder trap
20. Pictures of different air samplers