

Syllabus

For

B.Sc. (Hons.)

MICROBIOLOGY



MANDSAUR
UNIVERSITY
MAKING FUTURE READY!

Faculty of Life Sciences

Mandsaur University, Mandsaur
M. P., India

B. Sc. (Honours) Microbiology
Semester –I

MIC010: Introduction to Microbiology and Microbial Diversity [Credit: 6(3+1+2)]

UNIT I: Introduction and Systematic Classification

12 Hours

Introductory microbiology, Definition and terminologies of Microbiology, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Introduction of Bergey's manual of bacteriological classification. Difference between prokaryotic and eukaryotic microorganisms.

UNIT II: Virus and Bacteria

12 Hours

General characteristics of acellular microorganisms (Viruses, Viroids, Prions) with special reference to T4 and lambda phage. Bacteria: General characteristics with emphasis on their morphology and cell structure.

UNIT III: Algae

12 Hours

General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

UNIT IV: Fungi

12 Hours

General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultrastructure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, industry, medicine, food, biodeterioration and mycotoxins.

UNIT V: Protozoa

12 Hours

General characteristics of protozoa including occurrence, morphology, nutrition, locomotion, reproduction and economic importance with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania* and *Giardia*.

PRACTICAL'S

1. To study the principle and applications of important instruments: biological safety cabinets, pH meter, centrifuge, laminar air flow, electrical balance.
2. Study of different shapes of bacteria.
3. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts.
4. Study of *Spirogyra*, *Chlamydomonas* and *Volvox* using temporary mounts.
5. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.
6. Preparation of culture media for bacteria (Nutrient agar), algae (F/2 medium) & fungi (Potato dextrose agar) cultivation.

SUGGESTED READINGS

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolvert on CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

B. Sc. (Honours) Microbiology
Semester –I

MIC020: Bacteriology [Credit: 6(3+1+2)]

UNIT I: Cell organization

12 Hours

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, Gram and acidfast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts. Structure, function and chemical composition of bacterial and archaeal cell membrane. Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.

UNIT II: Bacteriological techniques

12 Hours

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria. Staining techniques: Principles of staining, simple staining, negative staining, differential staining, Gram and acid fast staining, flagella staining, capsule and endospore staining.

UNIT III: Growth, nutrition and reproduction

12 Hours

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Reproduction: Asexual methods, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

UNIT IV: Bacterial systematics

12 Hours

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaeobacteria

UNIT V: Important Archaeal and Eubacterial Groups

12 Hours

Archaeobacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota, Crenarchaeota, euryarchaeota, thermophiles and Halophiles.

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups: Gram Negative: General characteristics with suitable example of Non proteobacteria & Proteobacteria. Gram Positive: General characteristics with suitable example of Low G+ C & High G+C bacteria. Cyanobacteria: morphology and general characteristics

PRACTICALS

1. To study preparation of different solid and liquid media.
2. To study smear preparation and perform isolation of pure cultures of bacteria by streaking method.
3. To perform simple staining.
4. To perform differential staining.
5. To study preservation of bacterial cultures by various techniques.
6. Estimation of CFU count by spread plate method/pour plate method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology.
4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
5. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**B. Sc. (Honours) Microbiology
Semester –I**

MIC030: Environmental Studies [Credit: 4(3+1+0)]

UNIT I: Introduction to environmental studies and Ecosystem

12 Hours

Multidisciplinary nature of environmental studies, scope and importance; Concept of sustainability and sustainable development, what is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies on: a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT II: Natural Resources: Renewable and Non-renewable Resources

12 Hours

Land resources and land use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state). Energy resources: Renewable and nonrenewable energy sources, use of alternate energy sources, growing energy needs, case studies.

UNIT III: Biodiversity and Conservation

12 Hours

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots. India as a mega-biodiversity nation. Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UNIT IV: Environmental Pollution, Policies and Practices

12 Hours

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain, Environment Laws: Environment Protection Act; Air & Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT V: Human Communities and the Environment

12 Hours

Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

SUGGESTED READINGS

1. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
2. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339:36-37.
3. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. *Environmental and Pollution Science*. Academic Press.
5. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt.Ltd.
6. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
7. Sengupta, R. 2003. *Ecology and economics: An approach to sustainable development*. OUP.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.

B. Sc. (Honours) Microbiology
Semester –I

MIC041: Introduction and Scope of Microbiology [Credit: 6(3+1+2)]

UNIT I: Development of Microbiology

15 Hours

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Microorganism and fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology. Development in the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff and Edward Jenner.

UNIT II: Microscopy & Sterilization

12 Hours

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Transmission Electron Microscope, Scanning Electron Microscope. Physical methods of sterilization: Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration, radiation. Chemical methods of microbial control: disinfectants, types and mode of action.

UNIT III: Microbes in Human Health & Environment

15 Hours

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Definitions of immunity and its types. Environmental microbiology: Definitions and examples of important microbial interactions: mutualism, commensalism, parasitism. Microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation.

UNIT IV: Food and Dairy Microbiology

9 Hours

A brief description on production and importance of Single Cell Protein and probiotics; microorganisms involved in producing fermented foods such as bread, cheese and curd.

UNIT V: Industrial Microbiology

9 Hours

Definition of fermentation, primary and secondary metabolites, types of fermentations and microbes producing important industrial products through fermentation (antibiotics, amino acids, organic acids).

PRACTICAL

1. Microbiology Laboratory Management and Biosafety.
2. To study the principle and applications of important instruments: autoclave, incubator, BOD incubator, hot air oven, light microscope.
3. Sterilization of medium using Autoclave and assessment for sterility
4. Sterilization of glassware using Hot Air Oven and assessment for sterility
5. Sterilization of heat sensitive material by filtration and assessment for sterility
6. Serial dilution with methyl orange indicator

SUGGESTED READINGS

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappuccino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

B. Sc. (Honours) Microbiology

Semester –II

MIC050: Biochemistry [Credits: 6(3+1+2)]

UNIT I: Carbohydrates

14 Hours

Families of monosaccharide: aldoses and ketoses, Classification of monosaccharides. Isomerism of monosaccharides: Structural and Stereoisomers; Geometrical and optical stereoisomers, epimers, Mutarotation and anomers. Formulations of monosaccharide: Furanose and pyranose forms, Haworth projection formula, chair and boat forms. Disaccharides: concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose. Polysaccharides: Homopolysaccharides: starch, cellulose, glycogen and chitin, Heteropolysaccharides: peptidoglycan, and Hyaluronic acid.

UNIT II: Lipids

12 Hours

Fatty acids: structure and functions, Essential fatty acids, Triacylglycerols structure, functions and properties, Saponification reaction.

Definition and major classes of storage and structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties, Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide, sphingomyelins. Glycolipids: cerebrosides and gangliosides. Lipid functions: cell signals, cofactors, prostaglandins. Introduction to lipid micelles, monolayer and bilayers.

UNIT III: Proteins

14 Hours

Amino acids: The building blocks of proteins. General formula of amino acid and concept of zwitterions, titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids, Ninhydrin reaction, natural modifications of amino acids in proteins: hydroxylysine, selenocysteine and hydroxyproline.

Peptide unit and its salient features, Functions of proteins, Level of organization of proteins: primary, secondary (alpha helix and beta pleated sheet), tertiary and quaternary Forces holding the polypeptide together Structure and functions of naturally occurring glutathione, insulin and synthetic aspartame, Human haemoglobin.

UNIT IV: Enzymes

12 Hours

Structure of enzyme, Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Definitions of terms: enzyme unit and turnover number. Lock and key hypothesis, and Induced Fit hypothesis, Enzyme kinetics: Significance of hyperbolic, double reciprocal plots of enzyme activity and Km. Allosteric mechanism, Multienzyme complex: pyruvate dehydrogenase, isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive and non-competitive.

UNIT V: Vitamins

8 Hours

Classification of Vitamins: Water soluble and fat soluble vitamins, characteristics with suitable examples, sources and importance. Vitamin deficiency diseases.

PRACTICAL

1. Properties of water, concept of pH and buffers.
2. Qualitative tests for carbohydrates.
3. Qualitative tests for lipids.
4. Qualitative tests for proteins.
5. Study effect of temperature, pH and heavy metals on enzyme activity.
6. Estimation of any one vitamin.

SUGGESTED READINGS

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning.
2. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman.
3. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company.
4. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman & co.
5. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by 9th Ed, McGraw-Hill.
6. Voet, D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons.

B. Sc. (Honours) Microbiology
Semester –II
MIC060: Virology [Credits: 6(3+1+2)]

UNIT I: Nature and Properties of Viruses

12 Hours

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions; Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of Viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses.

UNIT II: Bacteriophages

12 Hours

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage), concept of early and late proteins, regulation of transcription in lambda phage.

UNIT III: Viral Transmission, Salient features of viral nucleic acids and Replication

12 Hours

Modes of viral transmission, Salient features of viral Nucleic acid, Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses, Replication strategies of viruses as per Baltimore classification.

UNIT IV: Viruses and Cancer

12 Hours

Introduction to oncogenic viruses; Types of oncogenic DNA and RNA viruses: Concepts of oncogenes, proto-oncogenes and tumor suppressor genes.

UNIT V: Prevention & control of viral diseases

12 Hours

Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

PRACTICAL

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and (retroviruses) using electron micrographs.
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs.
3. Study of the structure of important bacterial viruses (ϕ X174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
5. Studying isolation and propagation of animal viruses by chick embryo technique.
6. Study of cytopathic effects of viruses using photographs.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology, 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications, John Wiley and Sons.
3. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology, 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology, 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology, Hull R. Academic Press, New York.
7. Nayudu MV, (2008). Plant Viruses, Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology, Wolfe Medical Publication.

B. Sc. (Honours) Microbiology
Semester –II
MIC072: Industrial and Food Microbiology [Credits: 6(3+1+2)]

UNIT I: Introduction to Industrial microbiology

12 Hours

Brief history and developments in industrial microbiology, types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous, types of fermenters – laboratory, pilot-scale and production fermenters, bioreactor.

UNIT II: Isolation of Industrial Strains and Fermentation Medium

12 Hours

Primary and secondary screening, Preservation and maintenance of industrial strains, Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract.

UNIT III: Microbial fermentation processes

12 Hours

Downstream processing - filtration, centrifugation, cell disruption, solvent extraction, Microbial production of industrial products - citric acid, ethanol and penicillin. Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases.

UNIT IV: Food as a substrate for microbial growth

12 Hours

Intrinsic and extrinsic parameters that affect microbial growth in food, Microbial spoilage of food - milk, egg, bread and canned foods, Fermented dairy products, Probiotics, Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*, Food infection by *Salmonella* and *E.coli*.

UNIT V: Principles and methods of food preservation and food sanitation

12 Hours

Physical methods - high temperature, low temperature, irradiation, aseptic packaging Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite. Food sanitation and control – HACCP.

PRACTICAL

1. Microbial fermentation for the production and estimation of amylase.
2. Microbial fermentation for the production and estimation of citric acid.
3. Microbial fermentation for the production and estimation of ethanol.
4. Determination of the microbiological quality of milk sample.
5. Isolation of fungi from spoilt bread/fruits/vegetables
6. Isolation of *Lactobacillus* from curd

SUGGESTED READINGS

1. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd Edition. Panima Publishing Company, New Delhi.
2. Patel AH. (1996). Industrial Microbiology. 1st Edition. MacMillan India Limited Publishing Company Ltd. New Delhi, India.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An introduction. 9th Edition. Pearson Education.
4. Willey JM, Sherwood LM AND Woolverton CJ (2013), Prescott, Harley and Klein's Microbiology. 9th Edition. McGraw Hill Higher education.
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
7. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
8. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
9. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.

B. Sc. (Honours) Microbiology
Semester –II
MIC161: English [Credit: 4(3+1+0)]

UNIT I: Introduction Theory of Communication, Types and modes of Communication	10 Hours
UNIT II: Language of Communication Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication	12 Hours
UNIT III: Speaking Skills Monologue Dialogue Group Discussion Effective Communication/ Mis- Communication Interview Public Speech	12 Hour
UNIT IV: Reading and Understanding Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation (from Indian language to English and vice-versa) Literary/Knowledge Texts	12 Hours
UNIT V: Writing Skills Documenting Report Writing Making notes Letter writing	14 Hours

SUGGESTED READINGS

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr.Ranjana Kaul, Dr. Brati Biswas

B. Sc. (Honours) Microbiology
Semester –III

MIC250: Microbial Physiology and Metabolism [Credit: 5(3+0+2)]

UNIT I: Microbial Growth & its factors

9 Hours

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment: Temperature, pH, solute and water activity, oxygen, pressure. Microbial growth in response to nutrition and energy: Autotroph, heterotrophy Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph and Photoorganoheterotroph.

UNIT II: Nutrient uptake and Transport

8 Hours

Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation (phosphotransferase system), Iron uptake.

UNIT III: Aerobic Respiration

10 Hours

Concept of aerobic respiration. Central metabolic pathways: EMP, ED, Pentose phosphate pathway and TCA cycle. Electron transport chain: Components of respiratory chain, comparison of mitochondrial and bacterial ETC, Oxidative phosphorylation, uncouplers and inhibitors

UNIT IV: Anaerobic respiration and fermentation

9 Hours

Concept of anaerobic respiration and fermentation. Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

UNIT V: Chemolithotrophic and Phototrophic Metabolism

9 Hours

Introduction to aerobic and anaerobic chemolithotrophy with an example of each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria.

PRACTICAL

1. Study and plot the growth curve of *E. coli*.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Effect of temperature on growth of *E. coli*.
4. Effect of pH on growth of *E. coli*.
5. Effect of carbon and nitrogen sources on growth of *E. coli*.
6. Effect of salt on growth of *E. coli*.

SUGGESTED READINGS

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingraham JJ, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

B. Sc. (Honours) Microbiology
Semester –III

MIC260: Cell and Molecular Biology [Credit: 5(3+0+2)]

UNIT I: Structure and organization of cell

10 Hours

Cell Organization – prokaryotic and Eukaryotic (Plant and animal cells); Plasma membrane: Structure and transport of small molecules; Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions; Mitochondria, Chloroplasts and Peroxisomes; Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments and microtubules.

UNIT II: Nucleus, Cell cycle, Protein Sorting and Transport

12 Hours

Nuclear envelope, nuclear pore complex and nuclear lamina; Chromatin – Molecular organization, Nucleolus, Eukaryotic cell cycle: Mitosis and Meiosis. Ribosomes, Endoplasmic Reticulum, targeting and insertion of proteins in the ER, protein folding; Golgi apparatus: Organization, protein glycosylation, protein sorting and export, Lysosomes.

UNIT III: DNA structure and replication

7 Hours

Miescher to Watson and Crick- historic perspective, DNA structure, Types of DNA. Replication of DNA in prokaryotes and eukaryotes: Bidirectional and unidirectional replication, semi- conservative nature of DNA replication, Enzymes involved in DNA replications, Mechanism of DNA replication in prokaryote and eukaryotes.

UNIT IV: Transcription in Prokaryotes and Eukaryotes

8 Hours

Structure and types of RNA, RNA polymerases, Mechanism of transcription- Initiation, elongation and termination. General and specific transcription factors, regulatory elements. Post transcriptional modification: 5'-cap formation, 3'-end processing and polyadenylation, RNA splicing.

UNIT V: Regulation of gene expression and Translation

8 Hours

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system). Translation in Prokaryotes and eukaryotes: Genetic code, translational machinery, Mechanism of initiation, elongation and termination.

PRACTICAL

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell.
3. Study of different types of DNA using micrographs and model/schematic representations
4. Estimation of RNA using colorimeter (orcinol reagent).
5. Study of different stages of Mitosis.
6. Study of different stages of Meiosis

SUGGESTED READINGS

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition, Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
6. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
7. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning

B. Sc. (Honours) Microbiology
Semester –III
MIC270: Chemistry I [Credit: 6(4+0+2)]

UNIT I: Concept of atom & atomic structure

12 Hours

Atomic & Molecular Structure, shape of orbital's, Heisenberg uncertainty principle, quantum numbers, Rules for filling electrons in orbital's & electronic configuration of atoms.

UNIT II: Aliphatic & Aromatic compounds

14 Hours

Aliphatic Compounds: Classification, IUPAC Nomenclature system, General reactions of preparation & Properties of hydrocarbons (alkanes, Alkenes, alkynes: up to three carbon chain), Halogen compounds: chloroform (CHCl_3), iodoform (CHI_3), carbon tetrachloride (CCl_4), benzene hexachloride (BHC), DDT. Aromatic Compounds: Huckel's rule, structure and resonance in benzene. Hydrocarbons: Compounds containing one, two and three hydroxyl groups Ethers, carbonyl compounds (aldehydes and ketones, carboxylic acids, esters, anhydrides, amides), Amines, imines, amides and nitro compounds.

UNIT III: Chemical bonding & reactions

10 Hours

Chemical bonding: van der Waals forces, Hydrogen bonding and its applications, effects of these forces on melting point, boiling point and solubility. Types of Reagents: Homolytic and heterolytic cleavage, Electrophiles and Nucleophiles, Types, shape and relative stability of carbocations, carbanions and free radicals. Types of organic reactions: Addition, Substitution, Elimination, Reduction, Oxidation Acids-Bases: Arrhenius, Bronsted-Lowry, Lewis, HSAB Concept and Applications.

UNIT IV: Elements & their periodicity

12 Hours

s, p, d, f block elements, detailed discussion of the following properties of the elements, with reference to s & p-block: Effective nuclear charge, Atomic and Ionic radii, Ionization enthalpy, Electron gain enthalpy and electro negativity.

UNIT V: Noble gases & Buffer

12 Hours

The noble gases: Occurrence, general properties, electronic structure & position in the periodic table. Elementary Xenon compounds (bonding and structures excluded).

Buffer: Concept of pH, Mechanism of buffer action, Preparation of buffer solution

PRACTICAL

1. Concept and preparations of molarity and normality.
2. Identification of functional group and compound: Benzoic acid, Oxalic acid.
3. Identification of functional group and compound: Glucose & Sucrose
4. Identification of functional group and compound: Urea
5. Identification of functional group and compound: α -naphthalene.
6. Preparation of buffer of specific pH.

SUGGESTED READING

1. L. Finar: *Organic Chemistry* (Vol. I), 6thEd.
2. Arun Bahl and B. S. Bahl : *Advanced Organic Chemistry*, S. Chand
3. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 9th Ed., Oxford University
4. F.A. Cotton, G. Wilkinson & P.L Gaus, *Basic Inorganic Chemistry*
5. Morrison & Boyd, *Organic Chemistry*, 6thEd.
6. *Physical Chemistry*, Puri, Sharma & Pathania, Vikas Publications, New Delhi
7. A.K. De, *Inorganic Chemistry*
8. Gurdeep Raj, *Advanced Inorganic Chemistry*, Vol I
9. Arun Sethi, *Systematic Lab Experiments in Organic Chemistry* 2ndEd.

B. Sc. (Honours) Microbiology
Semester –III

MIC281: Microbial Quality Control in Food and Pharmaceutical Industries [Credits: 2 (2+0)]

UNIT I: Microbiological Laboratory and Safe Practices

7 Hours

Good laboratory practices - Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

UNIT II: Determining Microbes in Food / Pharmaceutical Samples

7 Hours

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products. Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

UNIT III: Enrichment culture technique

6 Hours

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar.

UNIT IV: Quality test for milk

4 Hours

Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

UNIT V: HACCP for Food Safety and Microbial Standards

6 Hours

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

SUGGESTED READINGS

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

B. Sc. (Honours) Microbiology
Semester –III

MIC282: Microbial Diagnosis in Health Clinics [Credit: 2(2+0+0)]

UNIT I: Importance of Diagnosis of Diseases

6 Hours

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

UNIT II: Collection of Clinical Samples

5 Hours

How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

UNIT III: Direct Microscopic Examination and Culture

7 Hours

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

UNIT IV: Serological and Molecular Methods

6 Hours

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes.

UNIT V: Rapid Detection of Pathogens & Antibiotic Sensitivity test

6 Hours

Typhoid, Dengue and HIV, Swine flu, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial dilution method.

SUGGESTED READINGS

1. Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
1. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and
2. Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.

B. Sc. (Honours) Microbiology
Semester –III

MIC283: Biofertilizers and Biopesticides[Credits: 2(2+0)]

UNIT I: Biofertilizers

7 Hours

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers.

Symbiotic N₂ fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants

Frankia- Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla*- Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

UNIT II: Non - Symbiotic Nitrogen Fixers

6 Hours

Free living *Azospirillum*, *Azotobacter*- free isolation, characteristics, mass inoculums, production and field application.

UNIT III: Phosphate Solubilizers

5 Hours

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

UNIT IV: Mycorrhizal Biofertilizers

6 Hours

Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

UNIT V: Bioinsecticides

6 Hours

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

SUGGESTED READINGS

1. Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. SubbaRao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. New Delhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbHKG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

B. Sc. (Honours) Microbiology
Semester –III

MIC291: Microbes in Environment [Credit: 4(4+0+0)]

UNIT I: Microorganisms and their habitats

12 Hours

Structure and function of ecosystems; Terrestrial Environment: Soil profile and soil microflora; Aquatic Environment: Microflora of fresh water and marine habitats; Atmosphere: Aeromicroflora and dispersal of microbes; Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles-Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity & low nutrient levels.

UNIT II: Microbial Interactions

12 Hours

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria.

UNIT III: Biogeochemical Cycling

12 Hours

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin. Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: Phosphate immobilization and Solubilisation. Sulphur cycle: Microbes involved in sulphur cycle. Other elemental cycles: Iron and manganese.

UNIT IV: Waste Management

12 Hours

Solid waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

UNIT V: Microbial Bioremediation & water Potability

12 Hours

Principles and degradation of common pesticides, hydrocarbons (oil spills). Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
3. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer,
4. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Heidelberg
5. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
6. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
7. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
8. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
9. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
10. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

**B. Sc. (Honours) Microbiology
Semester –III**

MIC292: Medical Microbiology and Immunology [Credits: 4(4+0)]

UNIT I: Normal microflora of the human body and host pathogen interaction 12 Hours

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract

Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection

UNIT II: Human infectious diseases, diagnosis & Antimicrobial agents 16 Hours

List of diseases of various organ systems: Bacteria, Virus, Protozoa & Fungus.

Collection, transport and culturing of clinical samples and their identification characteristics.

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine.

UNIT III: Immune Response, Cells and Organs 10 Hours

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen

UNIT IV: Antigens and Antibodies 10 Hours

Characteristics of an antigen; Haptens; Epitope, Adjuvants, Structure, Types and Functions of antibodies.

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

UNIT V: Immunological Disorders & Immunological Techniques 12 Hours

Types of autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice).

Principles of Precipitation, Agglutination, Immunodiffusion, Immuno-electrophoresis, ELISA, ELISPOT.

SUGGESTED READINGS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
6. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

B. Sc. (Honours) Microbiology
Semester –IV
MIC300: Microbial Genetics [Credits: 5(3+2)]

UNIT I: Genome organization and mutations

9 Hours

Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*. Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test, Mutator genes.

UNIT II: Plasmids

9 Hours

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast-2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.

UNIT III: Mechanisms of genetic exchange

9 Hours

Transformation- Discovery, mechanism of natural competence. Conjugation- Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping. Transduction- Generalized transduction, specialized transduction, LFT & HFT lysates.

UNIT IV: Phage genetics

9 Hours

Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda.

UNIT V: Transposable elements

9 Hours

Prokaryotic transposable elements: Insertion sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Eukaryotic transposable elements: Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds).

PRACTICAL

1. Preparation of master and replica plates.
2. Study the effect of chemical/physical mutagens on bacterial cells.
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
4. Study of R plasmids in bacteria.
5. Study of Lytic & Lysogenic lifecycle of lambda phage
6. Demonstration of AMES test.

SUGGESTED READINGS

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings.
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley India
6. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D (2004) Microbial Genetics 2nd EDITION., Jones and Bartlett Publishers.

B. Sc. (Honours) Microbiology
Semester –IV

MIC310: Microbes in Sustainable Agriculture and Development [Credits: 5(3+2)]

UNIT I: Soil Microbiology

9 Hours

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

UNIT II: Microbial activity in Soil

9 Hours

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin, humus phosphate, nitrate, silica, and potassium, Green House Gases production and control: Carbon dioxide, methane, nitrous oxide, nitric oxide.

UNIT III: Microbial Control of Soil Borne Plant Pathogens

9 Hours

Biocontrol mechanisms, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds.

UNIT IV: Bio fertilization and Phytostimulation

9 Hours

Plant growth promoting bacteria, biofertilizers – symbiotic, Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs.

UNIT V: Secondary Agriculture Biotechnology and GM crops

9 Hours

Biotech feed, Silage, Bio manure, biogas, biofuels – advantages and processing parameters. GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

PRACTICAL

1. Study of soil profile and study micro flora of different types of soils.
2. Isolation of *Rhizobium* and *Azotobacter* from root nodules.
3. Design and functioning of a biogas plant.
4. Study of microbial plant pathogens.
5. Isolation of cellulose degrading organisms.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (amylase, Cellulase) in soil.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, 1st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

B. Sc. (Honours) Microbiology
Semester –IV
MIC320: Chemistry – II [Credit: 6(4+2)]

UNIT I: Stereochemistry

9 Hours

Concept of isomerism, types of isomerism, structure & stereoisomerism, Geometrical Isomerism, Optical Isomerism, Conformations: Restricted rotation about single bonds, various conformations of ethane, butane, ethane, 1, 2-diol and cyclohexane, Configurations, Relative and absolute configuration, D / L nomenclature system for configuration of Carbohydrates, Threo and Erythro designation. R & S-Configuration.

UNIT II: Structure of molecules

9 Hours

Valence Bond theory, Hybridization, VSEPR theory and ions containing lone pairs, Sigma and pi bonds, Molecular Orbital Theory for homonuclear & heteronuclear diatomic molecule

UNIT III: Transition Elements & their properties

9 Hours

Electronic configuration of first & second transition series elements, oxidation state, magnetic property, Coordination compounds, Werner's coordination theory, Complex stability & effective nuclear charge

UNIT IV: Chemical Kinetics

9 Hours

Chemical kinetics, rate of a reaction, factors influencing the rate of a reaction, chemical kinetics: transition state theory & collision theory, Arrhenius equation, concept of activation energy, Thermodynamics, types of thermodynamic processes, & their applications in daily life.

UNIT V: Spectroscopy

9 Hours

Electromagnetic Radiation & spectrum, IR Spectroscopy: Fundamental and non-fundamental molecular vibrations, Fingerprint and their significance Characterization of functional groups: alkanes, alkenes, alkynes (only alicyclic systems), Aldehydes, ketones, carboxylic acids and their derivatives, hydroxy compounds and amines, Application of IR spectroscopy, UV spectroscopy: Types of electronic transitions, bathochromic shift, hypsochromic shift, NMR spectroscopy: Basic principles of NMR spectroscopy, chemical shifts (Concept of shielding and deshielding), factors influencing chemical shifts, Application of NMR spectroscopy

PRACTICAL

1. Preparation (inorganic)
 - a. Ni-DMG Complex
 - b. A pure sample of potash alum (Fitkari) $[K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O]$
 - c. Sodium trioxalato ferrate (III)
 - d. Potassium Dioxalato Diaqua chromate
2. Preparation (Organic) - a. m-DNB b. Benzoic acid
3. To determine alkalinity of a given water sample.
4. Determination of concentration of total hardness of a given sample of water by Complex metric titration.
5. Determination of % of acetic acid in commercial vinegar using NaOH.
6. Determination of alkali content in antacid tablet using HCl.

SUGGESTED READING

1. Pavia, Lampman,riz, Vyvyan ,Spectroscopy
2. Chatwal &Anand, Instrumental Methods of Chemical Analysis
3. Y.R. Sharma, Elementary Organic Spectroscopy byS.Chand
4. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 9th Ed., Oxford University
5. Morrison &Boyd, Organic Chemistry, 6thEd.
6. Physical Chemistry, Puri, Sharma &Pathania, Vikas Publications, New Delhi
7. I.L. Finar, Orgainc Chemistry, Vol. II, 5thEd.

B. Sc. (Honours) Microbiology
Semester –IV

MIC331: Food Fermentation Techniques [Credits: 2(2+0)]

UNIT I: Fermented& Probiotic Foods

6 Hours

Fermented food: Definition, types, advantages and health benefits, Probiotic microorganisms with health benefit

UNIT II: Milk Based Fermented Foods

6 Hours

Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

UNIT III: Grain Based Fermented Foods

6 Hours

Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

UNIT IV: Vegetable Based Fermented Foods

6 Hours

Pickels, Saeurkraut: Microorganisms and production process

UNIT V: Fermented Meat and Fish

6 Hours

Types, microorganisms involved, fermentation process

SUGGESTED READINGS

1. Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
2. Holzapfel W (2014) Advances in Fermented Foods and Beverages, Wood head publishing.
3. Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

B. Sc. (Honours) Microbiology
Semester –IV

MIC332: Management of Human Microbial Diseases [Credits: 2(2+0)]

UNIT I: Human diseases

6 Hours

Categories of Human diseases: Infectious and non-infectious diseases, microbial and non-microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections.

UNIT II: Microbial diseases

6 Hours

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases:, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola).

UNIT III: Therapeutics of Bacterial diseases

6 Hours

Treatment using antibiotics: beta lactam antibiotics, quinolones, polypeptides and aminoglycosides, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.

UNIT IV: Therapeutics of Viral diseases

5 Hours

Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

UNIT V: Prevention of microbial diseases

7 Hours

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

SUGGESTED READINGS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication. Microbiology. 4th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education.

B. Sc. (Honours) Microbiology

Semester –IV

MIC333: Microbiological Analysis of Air and Water [Credits: 2(2+0)]

UNIT I: Aero microbiology

6 Hours

Bio aerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

UNIT II: Air Sample Collection and Analysis

6 Hours

Bio aerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

UNIT III: Control Measures

5 Hours

Fate of bio aerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

UNIT IV: Water Microbiology

7 Hours

Water borne pathogens, water borne diseases, Sample Collection, Treatment and safety of drinking (potable) water, methods to detect portability of water samples: (a) standard qualitative procedure: presumptive/MPN tests confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

UNIT V: Control Measures

6 Hours

Precipitation, chemical disinfection, filtration, high temperature, UV light

SUGGESTED READINGS

1. da Silva N, Taniwaki MH, Junqueira VC, Silveira N, Nascimento MS, Gomes RAR (2012) Microbiological Examination Methods of Food and Water A Laboratory Manual, CRC Press.
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Hurst CJ, Crawford RL, Garland JL, Lipson DA (2007) Manual of Environmental Microbiology, 3rd edition, ASM press

B. Sc. (Honours) Microbiology
Semester –IV

MIC341: Genetic Engineering and Biotechnology [Credits: 4(4+0)]

UNIT I: Introduction to genetic engineering

12 Hours

Milestones in genetic engineering and biotechnology, Restriction modification systems, DNA modifying enzymes and their applications, Cloning, Use of linkers and adaptors, Transformation of DNA, Methods of DNA, RNA and Protein analysis.

UNIT II: Vectors

14 Hours

Cloning Vectors: Definition and Properties. Plasmid vectors: pBR and pUC series. Bacteriophage lambda and M13 based vectors, Cosmids, BACs, YACs. Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

UNIT III: DNA Amplification and DNA sequencing

12 Hours

PCR: Basics of PCR, RT-PCR, Real-Time PCR. Genomic and cDNA libraries: Preparation and uses, Genome sequencing. Sanger's method of DNA Sequencing: traditional and automated sequencing

UNIT IV: Application of Genetic Engineering and Biotechnology

14 Hours

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery. Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering.

UNIT V: Intellectual Property Rights

8 Hours

Patents, Copyrights, Trademarks

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2013). Prescott, Harley and Klein's Microbiology. 8th edition, McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

B. Sc. (Honours) Microbiology
Semester –IV

MIC342: Instrumentation and Biotechniques [Credits: 4(4+0)]

UNIT I: Microscopy

12 Hours

Principle, types of microscopy, Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

UNIT II: Chromatography

12 Hours

Principles and applications of paper chromatography (including Descending and 2-D), thin layer chromatography, Column packing and fraction collection, Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC.

UNIT III: Electrophoresis

12 Hours

Principle, types of electrophoresis, Agarose gel electrophoresis, native polyacrylamide gel electrophoresis (Native- PAGE), SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing and Zymogram preparation.

UNIT IV: Spectrophotometry

12 Hours

Principle, types of Spectrophotometry, use of study of absorption spectra of biomolecules, Analysis of biomolecules by using UV and visible range, Colorimetry and turbidometry.

UNIT V: Centrifugation

12 Hours

Principle, types of centrifugation, fixed angle and swinging bucket rotors RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed. McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

B. Sc. (Honours) Microbiology
Semester –V
MIC350: Microbial Biotechnology [Credits: 5(3+2)]

UNIT I: Microbial Biotechnology and its Applications **9 Hours**

Microbial biotechnology: Scope and its applications in human therapeutics, agriculture, environmental, and food technology. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications, genetically engineered microbes for industrial application: Bacteria and yeast.

UNIT II: Therapeutic and Industrial Biotechnology **9 Hours**

Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine). Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics, Microbial biosensors.

UNIT III: Applications of Microbes in Bio-transformations **9 Hours**

Microbial based transformation of steroids and sterols. Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute,

UNIT IV: Microbial Products and their Recovery **9 Hours**

Microbial product purification: filtration, ion exchange & affinity chromatography techniques. Immobilization methods and their application: Whole cell immobilization.

UNIT V: Microbes for Bio-energy and Environment **9 Hours**

Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass. Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents.

PRACTICAL

1. Study yeast cell immobilization in calcium alginate gels
2. Study enzyme immobilization by sodium alginate method
3. Pigment production from fungi (*Trichoderma* / *Aspergillus* / *Penicillium*)
4. Isolation of xylanase or lipase producing bacteria
5. Study of algal Single Cell Proteins.
6. Study production of ecofriendly agricultural chemicals, bio pesticides, bio fertilizers, bio-fuels, etc.

SUGGESTED READINGS

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, McGraw Hill Publishers.
5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition, Elsevier Science.
9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

B. Sc. (Honours) Microbiology
Semester –V

MIC360: Recombinant DNA Technology [Credits: 6(4+2)]

UNIT I: Enzymes of RDT

12 Hours

Nuclease- exonucleases and endonucleases; Restriction enzymes- nomenclature, types, applications; Restriction endonuclease- blunt and sticky ends; RNases, DNA Ligase, Polymerases; DNA Modifying enzymes- alkaline phosphatase, polynucleotide kinase and terminal deoxynucleotidyl transferase.

UNIT II: Vectors for gene cloning and expression

12 Hours

Characteristics of cloning and expression vectors; Plasmids - pBR322, pUC, pET and pTrcHis, Ti plasmid; Bacteriophage vectors; Yeast vectors- plasmids and YAC; Shuttle vectors; Cosmid and phagemid vectors.

UNIT III: Gene libraries and Gene delivery

12 Hours

Linkers, adaptors and homopolymer tailing; Construction of genomic library; cDNA construction: hairpin loop strategies; Directional and non-directional cDNA synthesis; Screening of libraries; Transformation of DNA; Gene delivery: Lipofection, Microinjection, Electroporation.

UNIT IV: Techniques for genetic engineering

12 Hours

Polymerase chain reactions; RAPD, RFLP; Molecular beacons and Taqman assay; Nucleic acid sequencing; Southern and northern blotting.

UNIT V: Applications of genetic engineering

12 Hours

Gene therapy; Genetic engineering in medicine- recombinant therapeutics and biopharmaceuticals; Genetic engineering in agriculture- bio pesticides, herbicides; Applications in environment-bioremediation or environment clean-up.

PRACTICAL

1. Plasmid DNA isolation
2. Restriction digestion of DNA.
3. Preparation of competent cells using CaCl₂.
4. Transformation using heat shock.
5. Blue White screening.
6. Demonstration of PCR Process.

SUGGESTED READINGS

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
3. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
4. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
5. Brown TA. (2007). Genomes-3. Garland Science Publishers
6. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

B. Sc. (Honours) Microbiology
Semester –V

MIC370: Industrial Chemistry [Credit: 6(4+2)]

UNIT I: Drugs and Pharmaceuticals

12 Hours

Drug discovery, design and development; Basic Retrosynthetic approach. Synthesis of the representative drugs of the following classes: analgesics agents, antipyretic agents, anti-inflammatory agents (Aspirin, paracetamol, Ibuprofen); antibiotics (Chloramphenicol); antibacterial and antifungal agents (Sulphonamides; Sulphanethoxazol, Sulphacetamide, Trimethoprim); antiviral agents (Acyclovir), Central Nervous System agents (Phenobarbital, Diazepam), Cardiovascular (Glyceryltrinitrate), antilaprosy (Dapsone), HIVAIDS related drugs (AZT- Zidovudine)

UNIT II: Catalysis

12 Hours

General principles and properties of catalysts, Homogenous and heterogeneous catalyst, Basic principles of catalysis, Mechanism of catalysis, Factors affecting the catalysis reactions, Industrial uses of catalysis reactions, application of zeolites as catalysts. Enzyme catalyzed reaction: Industrially important reactions, Basic chemical calculations: Atomic weight, molecular weight, equivalent weight.

UNIT III: Distillation & Essential oils

12 Hours

Introduction, types of distillation: Simple distillation, Fractional distillation, Steam distillation, Distillation under reduced pressure, Batch & continuous distillation, Plate columns & packed columns distillation. Essential oils and their importance in cosmetic industries - Eugenol, Geraniol, Sandalwood oil, Eucalyptus, Rose oil, Jasmine, Civetone, and Muscone.

UNIT IV: Food additives and adulterants

12 Hours

General study of food flavors, colors, preservatives, artificial sweeteners and antioxidants. Analysis of food products: Nutritional value of food, idea about food processing, food preservations and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

UNIT V: Green Chemistry

12 Hours

What is Green Chemistry? Need for Green Chemistry, Goals of Green Chemistry, Limitations/Obstacles in the pursuit of the goals of Green Chemistry, Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles.

PRACTICAL

1. Preparation of Aspirin and its analysis.
2. Preparation of soap
3. Production of Eugenol by distillation.
4. Extraction of natural coloring and flavoring agent from flowers and fruits
5. Testing of turmeric powder, milk and mustard oil for adulterants.
6. Estimation of glucose in food samples.

SUGGESTED READINGS

1. E. Stocchi: Industrial Chemistry, Vol -I, Ellis Horwood Ltd.UK.
2. G.L. Patrick: Introduction to Medicinal Chemistry, Oxford University Press, UK
3. Hakishan, V.K. Kapoor: Medicinal and Pharmaceutical Chemistry, Vallabh Prakashan, Pitampura, New Delhi.
4. B.K. Sharma, Industrial Chemistry, Goel publishing house
5. Arun Sethi, Systematic Lab Experiments in Organic Chemistry 2ndEd.
6. J. A. Kent: Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.
7. S. C. Bhatia: Chemical Process Industries, Vol. I & II, CBS Publishers, New Delhi.
8. P.T. Anastes & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
9. A.S. Matlack: Introduction to Green Chemistry, Marcel Deckkar (2001).

**B. Sc. (Honours) Microbiology
Semester –V**

MIC381: Biostatistics [Credit: 3(3+0)]

UNIT I; Statistics in Biology

6 Hours

Statistical methods: Principles and scope of statistical analysis of biological data. Difference between Sample and Population; Sampling Errors; Difference between parametric and non- parametric statistics.

UNIT II; Biological data and analysis

8 Hours

Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT III; Probability in Biological data

10 Hours

Probability classical & axiomatic definition of probability, Theorems on total and compound probability, Elementary ideas of Binomial, Poisson and Normal distributions.

UNIT IV; Statistics parameters and calculations

12 Hours

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, Z- test and F test, chi-square test for goodness of fit and analysis of variance (ANOVA).

UNIT V; Correlation and regression in Biological data

9 Hours

Correlation and Regression: Emphasis on examples from Biological Sciences.

SUGGESTED READINGS

1. Le CT (2003) Introductory biostatistics. 1st edition, John Wiley, USA
2. Glaser AN (2001) High Yield TM Biostatistics. Lippincott Williams and Wilkins, USA
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons.
5. Kumar S and Veeri A (2008) Basic Biostatistics, Campus Book International.
6. Banerjee PK (2011) Introduction to Biostatistics, S Chand Publication.

B. Sc. (Honours) Microbiology
Semester –V
MIC382: Advances in Microbiology [Credits: 3(3+0)]

UNIT I: Evolution of Microbial Genomes

9 Hours

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics.

UNIT II: Metagenomics

9 Hours

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral meta-genome, meta-transcriptomics, metaproteomics and metabolomics.

UNIT III: Molecular Basis of Plant-Microbe Interactions

9 Hours

Epiphytic fitness and its mechanism in plant pathogens, hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant pathogens.

UNIT IV: Animal pathogens & Biofilms

9 Hours

Secretion system of animal Pathogens, Biofilms; types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

UNIT V: Systems and Synthetic Biology

9 Hours

Networking in biological systems, quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses.

SUGGESTED READINGS

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bio prospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCHVerlag
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley andSons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, 1st edition, Garland Science

B. Sc. (Honours) Microbiology
Semester –VI
MIC400: Medical Microbiology [Credits: 6(4+2)]

UNIT I: Normal micro-flora of the human body and Host Pathogen Interaction **12 Hours**

Importance of normal micro-flora, normal human microbial flora of skin, throat, gastrointestinal tract, urogenital tract and its significance, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection.

UNIT II: Diagnostic Microbiology **12 Hours**

General principles: Collection, transport and culturing of clinical samples, principles of different diagnostic tests - ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, and PCR.

UNIT III: Bacterial diseases & viral diseases **12 Hours**

List of diseases of various organ systems and their causative agents (bacterial & viral). Causative agents, symptoms, mode of transmission and control of diseases caused by *Mycobacterium tuberculosis*, *Salmonella typhi*, *Clostridium tetani*, Polio, Hepatitis, Rabies, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

UNIT IV: Protozoan diseases & Fungal diseases **12 Hours**

List of various diseases in the different organ systems with their causative agents for Protozoan - Malaria, Kala-azar & Fungal - Cutaneous mycoses: Tinea pedis, Systemic mycoses: Histoplasmosis, Opportunistic mycoses: Candidiasis.

UNIT V: Antimicrobial agents **12 Hours**

General characteristics and mode of action Antibacterial agents: Five modes of action with one example each. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin, Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1

PRACTICAL

1. Identify bacteria using laboratory strains on the basis of cultural, morphological and biochemical characteristics.
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS.
3. Study of bacterial flora of skin by swab method.
4. Perform antibacterial sensitivity by Kirby-Bauer method.
5. Study of various stages of malarial parasite in RBCs using permanent mounts.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms).

SUGGESTED READINGS

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

B. Sc. (Honours) Microbiology
Semester –VI
MIC410: Immunology [Credits: 5(3+2)]

UNIT I: Introduction of Immunity, Immune cells and Organs

9 Hours

Concept of Innate and Adaptive immunity, Structure, Functions and Properties: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs-Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

UNIT II: Antigens and Antibodies

9 Hours

Antigens: Characteristics of an antigen, Haptens, Epitopes, T-dependent and T-independent antigens, Adjuvants, Antibodies: Structure, Types, Functions and Properties of antibodies, Antigenic determinants on antibodies, VDJ rearrangements, Monoclonal and Chimeric antibodies.

UNIT III: Generation of Immune Response

9 Hours

Primary and Secondary Immune Response, Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response - Self MHC restriction, T cell activation, Co- stimulatory signals, Mechanisms of CTL and NK cells, Introduction to tolerance.

UNIT IV: Major Histocompatibility Complex

9 Hours

Organization of MHC locus (Mice & Human): Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).

UNIT V: Immunological disorder and techniques

9 Hours

Autoimmunity and Hypersensitivity with examples, Immuno deficiencies- Di George syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, Introduction to immunodiagnostics – Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA.

PRACTICAL

1. Total leucocyte count
2. Differential leucocytes count
3. Separation of serum from blood
4. Double immune diffusion test using specific antibody and antigen.
5. Radial immune diffusion test
6. ELISA.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinburgh.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

B. Sc. (Honours) Microbiology
Semester –VI
MIC420: Plant pathology [Credits: 6(4+2)]

UNIT I: Introduction and History of Plant pathology

12 Hours

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

UNIT II: Stages in development of a plant disease & epidemiology

12 Hours

Infection, invasion, colonization, dissemination of pathogens and perennation, Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

UNIT III: Microbial Pathogenicity

12 Hours

Virulence factors of pathogens: enzymes, toxins (host specific and nonspecific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes.

UNIT IV: Genetics of Plant Diseases & Defense Mechanisms

12 Hours

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance, Concepts of constitutive defense mechanisms in plants, inducible structural defenses, inducible biochemical defenses-hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plant antibodies, phenolics, quinones, oxidative bursts.

UNIT V: Control of Plant Diseases

12 Hours

Principles & practices involved in the management of plant diseases by different methods, viz. regulatory-quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material, Cultural-host eradication, crop rotation, sanitation, polyethylene traps and mulches, Chemical- protectants and systemic fungicides, Biological- suppressive soils, antagonistic microbes-bacteria and fungi, trap plants. Genetic engineering of disease resistant plants with plant derived genes and pathogen derived genes.

PRACTICAL

1. Study of important diseases of crop plants- Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.
2. Isolation of causal agent from plant leaf lesion.
3. Isolation of causal agent from root of plant.
4. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.
5. Molecular detection of any one important plant virus.
6. Study of antibiotics against plant pathogen.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

B. Sc. (Honours) Microbiology
Semester –VI
MIC431: Bioinformatics [Credits: 3(3+0)]

UNIT I: Introduction of Bioinformatics **9 Hours**
History of Bioinformatics, the notion of Homology, sequence Information Sources - EMBL, GENBANK, Entrez, and Unigene, understanding the structure of each source and using it on the web.

UNIT II: Protein Databases **8 Hours**
Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web.

UNIT III: Data Generating Techniques **9 Hours**
Introduction of Data Generating Techniques: Restriction Digestion, Chromatograms, Blots, PCR, Microarrays, Mass Spectrometry.

UNIT IV: Phylogenetics **10 Hours**
Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

UNIT V: DNA Databases **9 Hours**
Searching Databases: SRS, Entrez, Sequence Similarity Searches - BLAST, FASTA, and Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

PRACTICALS

1. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource(PIR)
2. Understanding and using: PDB, Swissprot, TREMBL
3. Using various BLAST and interpretation of results.
4. Retrieval of information from nucleotide databases.
5. *In silico* PCR demonstration.
6. Multiple sequence alignment using Clustal W.

SUGGESTED READING

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings

B. Sc. (Honours) Microbiology
Semester –VI

MIC432: Biosafety and Intellectual Property Rights [Credits: 3(3+0)]

UNIT I: Biosafety

8 Hours

Introduction; Biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

UNIT II: Biosafety Guidelines

10 Hours

Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol. AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

UNIT III: Introduction to Intellectual Property

9 Hours

Patents, Types, Trademarks, Copyright & Related Rights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO).

UNIT IV: Grant of Patent and Patenting Authorities

9 Hours

Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.

UNIT V: Agreements and Treaties

9 Hours

GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

SUGGESTED READINGS

1. Bare Act, 2007. Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., New Delhi.
2. Kankanala C (2007). Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd. New Delhi.
3. Mittal, D.P. (1999). Indian Patents Law, Taxmann, Allied Services (p) Ltd.
4. Singh K K (2015). Biotechnology and Intellectual Property Rights: Legal and Social Implications, Springer India.
5. Goel D & Prashar S (2013). IPR, Biosafety and Bioethics .Pearson
6. Senthil Kumar Sadhasivam and Mohammed Jaabir, M. S. 2008. IPR, Biosafety and biotechnology Management. Jasen Publications, Tiruchirappalli, India.