

**SYLLABUS FOR B.Sc. MICROBIOLOGY (HONOURS) DEGREE PROGRAM UNDER CBCS w.e.f. 2017-18
OF SEM I & II**

Course Structure for B.Sc. Microbiology (Honours) degree program				
PAPER CODE	TITLE		CREDITS	TOTAL
SEMESTER I				
MIC DSC 1	Introduction to Microbiology and Microbial Diversity	Theory	4	6
		Practical	2	
MIC DSC 2	Bacteriology	Theory	4	6
		Practical	2	
MIC DSC 3	Biochemistry	Theory	4	6
		Practical	2	
MIC GE-1	Introduction and Scope of Microbiology	Theory	3	4
		Practical	1	
AECC 1	English / EVS / MIL communication	Theory	4	4
SEMESTER II				
MIC DSC 4	Virology	Theory	4	6
		Practical	2	
MIC DSC 5	Microbial Physiology and Metabolism	Theory	4	6
		Practical	2	
MIC DSC 6	Cell Biology	Theory	4	6
		Practical	2	
MIC GE-2	Industrial and Food Microbiology	Theory	3	4
		Practical	1	
AECC 2	English / EVS / MIL communication	Theory	4	4

PAPER CODE	TITLE		CREDITS	TOTAL
SEMESTER III				
MIC DSC 7	Microbial Genetics	Theory	4	6
		Practical	2	
MIC DSC 8	Environmental Microbiology	Theory	4	6
		Practical	2	
MIC DSC 9	Immunology	Theory	4	6
		Practical	2	
MIC GE-3	Microbes in Environment	Theory	3	4
		Practical	1	
SEC 1	Microbial Analysis of Air and Water	Theory		4
		Practical		
SEMESTER IV				

MIC DSC 10	Molecular Microbiology	Theory	4	6
		Practical	2	
MIC DSC 11	Food and Dairy Microbiology	Theory	4	6
		Practical	2	
MIC DSC 12	Industrial Microbiology	Theory	4	6
		Practical	2	
MIC GE-4	Health and Nutrition	Theory	3	4
		Practical	1	
SEC 2	Microbial Quality Control in Food and Pharmaceutical Industries	Theory		4
		Practical		
SEMESTER V				
MIC DSC 13	Medical Microbiology	Theory	4	6
		Practical	2	
MIC DSE 1	Microbial Biotechnology	Theory	4	6
		Practical	2	
MIC DSE 2	Instrumentation and Biotechniques	Theory	4	6
		Practical	2	
SEC 3	Microbial Diagnosis in Health Clinics	Theory		4
		Practical		
SEMESTER VI				
MIC DSC 14	Recombinant DNA Technology	Theory	4	6
		Practical	2	
MIC DSE 3	Microbes in Sustainable Agriculture and Development	Theory	4	6
		Practical	2	
MIC DSE 4	Project	Theory	4	6
		Practical	2	
SEC 4	Food Fermentation Techniques	Theory		4
		Practical		

SEMESTER –I

MIC DSC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 History of Development of Microbiology

No. of Hours: 15

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Fleming.

Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Beijerinck, Winogradsky, Waksman. Establishment of fields of medical microbiology and immunology through the work of Ehrlich, Metchnikoff, Jenner.

Unit 2 Diversity of Microbial World

No. of Hours: 35

Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

General characteristics of different groups

Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Algae

History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algal cell ultra structure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction. Applications of algae in agriculture, industry, environment and food.

Fungi

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, 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.

Protozoa

General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania* and *Giardia*

Unit 3 An overview of Scope of Microbiology

No. of Hours: 05

Role of microbes in the field of health, pharmaceuticals, food, agriculture, environment and industries.

Unit 4 Microbial Associations

No. of Hours: 05

Types of associations: mutualism, commensalism, synergism, syntrophism, competition, antagonism, parasitism, predation.

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Microbiology Good Laboratory Practices (GLP) and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using autoclave and assessment for sterility.
5. Sterilization of glassware using hot air oven and assessment for sterility.
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility.
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts.
9. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary mounts.
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*.

SUGGESTED READING (Latest editions)

- Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology. McGrawHill International.
- Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company.
- [Salle](#) A.J. Fundamental Principles of Bacteriology. Tata McGraw-Hill Education.
- Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan Publishers.
- Modi H.A, Elementary Microbiology Vol I, Fundamentals of Microbiology
- Cappucino J and Sherman N. Microbiology: A Laboratory Manual. Pearson Education Limited
- Atlas RM. Principles of Microbiology. WM.T.Brown Publishers.
- Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction. Pearson Education
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. Pearson International Edition.

MIC DSC-2: BACTERIOLOGY

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 Cell organization

No. of Hours: 12

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.

Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms.

Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids.

Endospore: Structure, formation, stages of sporulation.

Unit 2 Bacteriological techniques

No. of Hours: 05

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.

Unit 3 Microscopy

No. of Hours: 09

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Unit 4 Growth and nutrition

No. of Hours: 08

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

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

Chemical methods of microbial control: disinfectants, types and mode of action

Unit 5 Reproduction in Bacteria

No. of Hours: 03

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Unit 6 Bacterial Systematics

No. of Hours: 08

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 7 Important archaeal and eubacterial groups

No. of Hours: 15

Archaeobacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and

Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

Non proteobacteria: General characteristics with suitable examples

Alpha proteobacteria: General characteristics with suitable examples

Beta proteobacteria: General characteristics with suitable examples

Gamma proteobacteria: General characteristics with suitable examples

Delta proteobacteria: General characteristics with suitable examples

Epsilon proteobacteria: General characteristics with suitable examples

Zeta proteobacteria: General characteristics with suitable examples

Gram Positive:

Low G+ C (Firmicutes): General characteristics with suitable examples

High G+C (Actinobacteria): General characteristics with suitable examples

Cyanobacteria: An Introduction

PRACTICAL

CREDITS: 2

TOTAL HOURS: 60

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

SUGGESTED READING (Latest Editions)

- Stanier RY, Ingraham JL, Wheelis ML and Painter PR. General Microbiology. McMillan.
- Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. McGraw Hill Higher Education.
- Pelczar Jr MJ, Chan ECS, and Krieg NR. Microbiology. Tata McGraw Hill.
- Atlas RM. Principles of Microbiology. W.M.T. Brown Publishers.
- Black JG. Microbiology: Principles and Explorations. Prentice Hall
- Madigan MT, and Martinko JM. Brock Biology of Micro-organisms. Parker J. Prentice Hall International, Inc.
- Cappucino J and Sherman N. Microbiology: A Laboratory Manual. Pearson Education Limited.
- Tortora GJ, Funke BR, and Case CL. Microbiology: An Introduction. Pearson Education.
- Srivastava S and Srivastava PS. Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.

MIC DSC-3: BIOCHEMISTRY

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 Bioenergetics

No. of Hours: 08

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and entropy and mathematical relationship among them, Standard free energy change and equilibrium constant.

Coupled reactions and additive nature of standard free energy change, Energy rich compounds: phosphoenolpyruvate, 1, 3- bisphosphoglycerate, thioesters, ATP

Unit 2 Carbohydrates

No. of Hours: 12

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose, chair and boat forms of glucose; sugar derivatives; glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, polysaccharides: storage polysaccharides, starch and glycogen, structural polysaccharides; cellulose, peptidoglycan and chitin

Unit 3 Lipids

No. of Hours: 10

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acid structure and functions. Essential fatty acids. Triacyl glycerol structure, functions and properties. Saponification

Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties.

Lipid functions: Lipid micelles, monolayers, bilayers, prostaglandins, cofactors, cell signals.

Unit 4 Proteins

No. of Hours: 12

Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. 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 hydrolysine, cystine, hydroxyproline, selenocysteine. Non protein amino acids: gramicidin, beta-alanine, D-alanine and D- glutamic acid.

Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame,

Protein structure: Primary structure - Peptide unit and its salient features. Secondary structure – alpha helix, beta pleated sheet, random coil; Tertiary and quaternary structures of proteins; Forces holding the polypeptide together. Human haemoglobin structure.

Unit 5 Nucleic acids

No. of Hours: 04

Structure of nucleotides, DNA and RNA; brief concept of central dogma of molecular biology.

Unit 6 Enzymes**No. of Hours: 10**

Classification of enzymes. Apoenzyme, coenzyme, prosthetic group, cofactors.

Structure of enzyme.

Mechanism of action of enzymes: active site, activation energy, transition state complex.

Lock and key hypothesis, and Induced Fit hypothesis.

Significance of hyperbolic, double reciprocal plots of enzyme activity, K_m , and allosteric mechanism

Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase, Isozyme: lactate dehydrogenase.

Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive, non-competitive.

Unit 7 Vitamins**No. of Hours: 04**

Classification and characteristics with suitable examples, sources and importance

PRACTICAL**CREDITS: 2****TOTAL HOURS: 60**

1. Properties of water, concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts.
2. Numerical problems on calculations of Standard free energy change and Equilibrium constant.
3. Standard free energy change of coupled reactions.
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars.
5. Qualitative/Quantitative tests for lipids and proteins.
6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values.
8. Study effect of temperature and pH on enzyme activity.
9. Vitamin estimation.

SUGGESTED READING (Latest editions)

- Campbell, MK; Biochemistry, Published by Cengage Learning.
- Campbell, PN and Smith AD; Biochemistry Illustrated, Published by Churchill Livingstone.
- Berg JM, Tymoczko JL and Stryer L; Biochemistry, W.H. Freeman and Company.
- Nelson DL and Cox MM; Lehninger Principles of Biochemistry, W.H. Freeman and Company.
- Willey MJ, Sherwood, LM & Woolverton C J; Prescott, Harley and Klein's Microbiology, McGrawHill.
- Voet, D. and Voet J.G; Biochemistry, John Wiley and Sons.
- Conn E and Stumpf P, Outlines of biochemistry.
- Cappucino J and Sherman N; Microbiology: A Laboratory Manual. Pearson Education Limited.
- Plummer Mu, Plummer David T. An Introduction to Practical Biochemistry.
- Jayaraman; Laboratory Manual in Biochemistry, Published by New Age International (P) Limited.

MIC GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY

THEORY

CREDITS: 3

TOTAL HOURS: 45

Unit 1 History of Development of Microbiology

No. of Hours: 07

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Fleming.

Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Beijerinck, Winogradsky, Waksman. Establishment of fields of medical microbiology and immunology through the work of Ehrlich, Metchnikoff, Jenner.

Unit 2 Diversity of Microorganisms

No. of Hours: 07

Systems of classification: Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility.

General characteristics of different groups: Acellular microorganisms (viruses, viroids, prions) and cellular microorganisms (Prokarya: Archaea and bacteria, Eukarya: Algae, fungi and protozoa) giving definitions and citing examples.

Unit 3 Microscopy

No. of Hours: 05

Bright Field Microscope, Electron Microscope.

Principle of stains and staining techniques (Gram staining, monochrome staining, negative staining).

Unit 4 Sterilization

No. of Hours: 05

Autoclave (moist heat), hot air oven (dry heat), Tyndallization, membrane filtration.

Unit 5 Microbes in Human Health & Environment

No. of Hours: 07

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types, vaccines.

Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism.

Application of microorganisms for bio-pesticides and bio-fertilizers, biodegradation, bio-deterioration and bioremediation (e.g. hydrocarbons in oil spills).

Unit 6 Industrial Microbiology

No. of Hours: 07

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters, microbes producing important industrial products through fermentation. Biofuels.

Unit 7 Food and Dairy Microbiology

No. of Hours: 07

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non-dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

PRACTICALS

CREDITS: 1

TOTAL HOURS: 30

1. Microbiology Good Laboratory Practices (GLP) and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter, colorimeter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using autoclave and assessment for sterility.
5. Sterilization of glassware using hot air oven and assessment for sterility.
6. Sterilization of heat sensitive material by filtration and assessment for sterility.
7. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of different shapes of bacteria by monochrome staining.
9. Differentiation of bacteria by Gram staining.
10. Study of *Rhizopus* and *Penicillium* slides.
11. Study of *Spirogyra* and *Chlamydomonas* slides.

SUGGESTED READING (Latest editions)

- Pelczar MJ, Chan ECS and Krieg NR. Microbiology. McGraw Hill Book Company.
- Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. General Microbiology. McMillan.
- Tortora GJ, Funke BR and Case CL. Microbiology: An Introduction. Pearson Education
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. Brock Biology of Microorganisms. Pearson International Edition
- Cappucino J and Sherman N. Microbiology: A Laboratory Manual. Pearson Education Limited
- Wiley JM, Sherwood LM and Woolverton CJ. Prescott's Microbiology. McGraw Hill International.
- Atlas RM. Principles of Microbiology. W.M.T. Brown Publishers.

SEMESTER - II

MIC DSC-4: VIROLOGY

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 Nature and Properties of Viruses

No. of Hours: 15

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 2 Bacteriophages

No. of Hours: 10

Diversity, classification, one step multiplication curve, lytic and lysogenic phages; lambda phage, T4 phage and M13.

Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication

No. of Hours: 20

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal

Salient features of viral Nucleic acid: unusual bases (TMV, T4 phage), overlapping genes (ϕ X174, Hepatitis B virus), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV).

Viral multiplication and replication strategies: interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (ϕ X 174, Retroviridae, Vaccinia, Picorna), assembly, maturation and release of virions.

Unit 4 Viruses and Cancer

No. of Hours: 03

Introduction to oncogenic viruses

Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit 5 Prevention & control of viral diseases

No. of Hours: 08

Antiviral compounds and their mode of action

Interferon and their mode of action

General principles of viral vaccination

Unit 6 Applications of Viruses

No. of Hours: 04

Use of viral vectors in cloning and expression, gene therapy and phage display

PRACTICAL

CREDITS: 2

TOTAL HOURS: 60

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 X 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Study of cytopathic effects of viruses using photographs
6. Perform local lesion technique for assaying plant viruses.

SUGGESTED READING (Latest Editions)

- Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. McGraw Hill Higher Education.
- Dimmock, NJ, Easton, AL, Leppard. KN Introduction to Modern Virology. Blackwell Publishing Ltd.
- Carter J and Saunders V. Virology: Principles and Applications. John Wiley and Sons.
- Flint SJ, Enquist LW, Krug RM, Racaniello VR, Skalka AM. Principles of Virology, Molecular biology, Pathogenesis and Control. ASM press Washington DC.
- Levy JA, Conrat HF, Owens RA. Virology. Prentice Hall publication, New Jersey.
- Wagner EK, Hewlett MJ. Basic Virology. Blackwell Publishing.
- Mathews. Plant Virology. Hull R. Academic Press, New York.
- Nayudu MV. Plant Viruses. Tata McGraw Hill, India.
- Bos L. Plant viruses-A text book of plant virology. Backhuys Publishers.
- Versteeg J. A Color Atlas of Virology. Wolfe Medical Publication.

MIC DSC-5: MICROBIAL PHYSIOLOGY AND METABOLISM

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth No. of Hours: 12

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 (psychrophiles, psychrotrophs, mesophiles, thermophiles, thermotolerants), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophiles), oxygen (aerobes, anaerobes, microaerophilic, facultative aerobe, facultative anaerobe), hydrostatic pressure (barophiles).

Microbial growth in response to nutrition and energy – autotroph/phototroph, heterotroph; photoorganoheterotroph, chemolithotroph: chemolithoautotroph, chemolithoheterotroph, chemoheterotroph, photolithoautotroph.

Unit 2 Nutrient uptake and Transport

No. of Hours: 08

Passive and facilitated diffusion

Primary and secondary active transport, concept of uniport, symport and antiport

Group translocation

Concept of iron uptake

Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration

No. of Hours: 16

Concept of aerobic respiration, anaerobic respiration and fermentation

Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway

TCA cycle

Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors

Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

No. of Hours: 08

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 5 Chemolithotrophic and Phototrophic Metabolism

No. of Hours: 10

Introduction to aerobic and anaerobic chemolithotrophy with an example 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.

Unit 6 Nitrogen Metabolism - an overview

No. of Hours: 06

Introduction to biological nitrogen fixation.

Ammonia assimilation.

Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

PRACTICAL

CREDITS: 2

TOTAL HOURS: 60

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
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*.
7. Demonstration of alcoholic fermentation.
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READING (Latest Editions)

- Stanier RY, Ingraham JI, Wheelis ML and Painter PR. General Microbiology. McMillan Press
- Willey JM, Sherwood LM, and Woolverton CJ. Prescott's Microbiology. McGraw Hill Higher Education
- Madigan MT, and Martinko JM . Brock Biology of Microorganisms. Prentice Hall International Inc.
- Moat AG and Foster JWMicrobial Physiology. John Wiley & Sons
- Gottschalk G. Bacterial Metabolism. Springer Verlag
- Reddy SR and Reddy SM. Microbial Physiology. Scientific Publishers India

MIC DSC-6: CELL BIOLOGY

THEORY

CREDITS: 4

TOTAL HOURS: 60

Unit 1 Structure and organization of Cell

No. of Hours: 20

Cell Organization: Prokaryotic and Eukaryotic (Plant and animal cells).

Plasma membrane: Structure and transport of small molecules.

Cell Wall: Eukaryotic cell wall, extracellular matrix and cell matrix interactions.

Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

Endomembrane system: Endoplasmic reticulum, golgi complex, mitochondria, chloroplasts, peroxisomes, lysosomes.

Nucleus: Nuclear envelope, nuclear pore complex, nuclear lamina, nucleolus, chromatin organization.

Cell-Cell Interactions: Types of cellular junctions - adhesion junctions, tight junctions, gap junctions and plasmodesmata.

Unit 2 Protein Sorting and Transport

No. of Hours: 15

Ribosomes, Endoplasmic reticulum (ER) – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids.

Golgi apparatus – Organization, protein glycosylation, protein sorting and export from golgi apparatus.

Lysosomes.

Unit 3 Cell Signalling

No. of Hours: 10

Signalling molecules and their receptors.

Functions of cell surface receptors.

Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

Unit 4 Cell Cycle, Cell Death and Cell Renewal

No. of Hours: 15

Eukaryotic cell cycle and its regulation, mitosis and meiosis.

Development of cancer, causes and types.

Programmed cell death.

Stem cells and underlying principles of stem cell engineering.

PRACTICALS

CREDITS: 2

TOTAL HOURS: 60

1. Study of a plant cell using microscopy.
2. Study of an animal cell using micrographs.
3. Study of the structure of cell organelles through electron micrographs
4. Cytochemical staining of DNA – Feulgen stain.

5. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using micrographs.
6. Study of polyploidy in onion root tip by colchicine treatment.
7. Identification and study of cancer cells by photomicrographs.
8. Study of different stages of Mitosis.
9. Study of different stages of Meiosis.

SUGGESTED READING (Latest editions)

- Hardin J, Bertoni G and Kleinsmith LJ. Becker's World of the Cell. Pearson.
- Karp G. Cell and Molecular Biology: Concepts and Experiments. John Wiley and Sons. Inc.
- De Robertis, EDP and De Robertis EMF. Cell and Molecular Biology. Lipincott Williams and Wilkins, Philadelphia.
- Cooper, GM and Hausman, RE. The Cell: A Molecular Approach. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
- Lodish H, Berk, Kaiser C, Krieger M, Scott M, Bretscher A, Ploegh H, Matsudaira P. Molecular cell biology, W H Francis and company, New York.
- Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Molecular Biology of The Cell. Garland science, Taylor and Francis group.

MIC GE-2: INDUSTRIAL AND FOOD MICROBIOLOGY

THEORY

CREDITS: 3

TOTAL HOURS: 45

Unit 1 Introduction to Industrial Microbiology

No. of Hours: 08

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

Unit 2 Isolation of Industrial Strains and Study of Fermentation Media

No. of Hours: 07

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

Unit 3 Microbial fermentation processes

No. of Hours: 08

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

Unit 4 Food as a substrate for microbial growth

No. of Hours: 07

Intrinsic and extrinsic parameters affecting microbial growth in food.
Microbial spoilage of food - milk, eggs and canned foods.

Unit 5 Principles and methods of food preservation and food sanitation

No. of Hours: 07

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.

Unit 6 Dairy products, probiotics and Food-borne Diseases

No. of Hours: 08

Butter, Fermented dairy product – cheese and yoghurt.
Probiotics definition, examples and benefits.
Food intoxication by *Clostridium botulinum* and *Staphylococcus aureus*.
Food infection by *Salmonella*.

PRACTICALS

CREDITS: 1

TOTAL HOURS:30

1. Microbial fermentation for the production and estimation of amylase.
2. Microbial fermentation for the production and estimation of citric acid.
3. Determination of the microbiological quality of milk sample by MBRT.
4. Isolation of fungi from spoilt foods.
5. Preparation of Yogurt.

SUGGESTED READING (Latest editions)

- Crueger W and Crueger A. Biotechnology: A textbook of Industrial Microbiology. Panima Publishing Company, New Delhi.
- Patel AH. Industrial Microbiology. MacMillan India Limited Publishing Company Ltd. New Delhi, India.
- Tortora GJ, Funke BR and Case CL. Microbiology: An introduction. Pearson Education.
- Willey JM, Sherwood LM. and Woolverton CJ. Prescott, Harley and Klein's Microbiology. McGraw Hill Higher education.
- Casida LE. Industrial Microbiology. Wiley Eastern Limited.
- Stanbury PF, Whitaker A and Hall SJ. Principles of Fermentation Technology. Elsevier Science Ltd.
- Adams MR and Moss MO. Food Microbiology. New Age International (P) Limited Publishers, New Delhi, India.
- Banwart JM. Basic Food Microbiology. CBS Publishers and Distributors, Delhi, India.
- Frazier WC and Westhoff DC. Food Microbiology. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
- Jay JM, Loessner MJ and Golden DA. Modern Food Microbiology. CBS Publishers and Distributors, Delhi, India.