Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Syllabus

for

S.Y.B.Sc. (Microbiology)

[Pattern 2019]

(B.Sc. Semester-III and Semester-IV)

From Academic Year

2020-21

Programme Structure

Year	Name of Paper	Paper Code	Title of Paper	No. of Credits
S.Y. B.Sc.	**Semester III**			
	Theory Paper - 1	MIC2301	Microbial Genetics	2
	Theory Paper - 2	MIC2302	Microbial Metabolism	2
	Practical Paper - 1	MIC2303	Microbiology Practical-III	2
	Semester IV			
	Theory Paper - 3	MIC2401	Environmental Microbiology	2
	Theory Paper - 4	MIC2402	Industrial Microbiology	2
	Practical Paper - 2	MIC2403	Microbiology Practical-IV	2

S.Y. B.Sc. Semester III		
Title of the Course and Course Code	**Microbial Genetics - (MIC2301)**	**Number of Credits : 02**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall the RNA world theory and outline the key events in evolution of life on earth.	
CO2	Illustrate, differentiate and contrast between the structures of DNA and also discuss the DNA replication process.	
CO3	Infer the experiments that led to the discovery of DNA, RNA as genetic material and apply the concepts in understanding the basics of genetics.	
CO4	Explain the mechanism of gene expression in bacteria.	
CO5	Compare different types of mutations and appraise the methods of isolation of spontaneous or induced mutants from bacterial population. Review fluctuation test, different types of mutagenic agents and their action on functioning of a cell.	
CO6	Develop concepts about different types of plasmid DNA. Specify the differences between chromosomal DNA, plasmid DNA.	

Unit	Details	No. of Lectures
I	**1. Understanding Molecules of Heredity** a. RNA world and shift to DNA world with time b. Evidence for nucleic acid as genetic material in bacteria - i. Discovery of transforming material (hereditary material): Griffith's experiment. ii. Avery and MacLeod experiment c. Evidence for nucleic acid as genetic material in viruses - i. Gierer and Schramm / Fraenkel-Conrat & Singer experiment (TMV virus) ii. Hershey& Chase experiment (T2 phage) **2. Prokaryotic genome organization** a. Bacterial nucleoid structure, Concept of gene b. Basic structure of B form of DNA, Properties of nucleotides related with DNA stability c. Comparative account of different forms of DNA d. DNA topology – linking number, topoisomerases **3. Prokaryotic DNA replication** a. J. Cairn's experiment b. Messelson and Stahl's experiment (semiconservative) c. Various models of DNA replication: Theta model (semi-discontinuous), D- loop (mitochondrial), Θ (theta) mode of replication, rolling circle model d. Mechanism of DNA replication: enzymes and proteins involved in	**18**

	DNA replication –DNA polymerases, DNA ligase, primase **4. Concepts of Gene expression** a. Properties of genetic code b. Transcription c. Translation	
II	**Plasmids and mutation** 1. Plasmids- Structure and properties of plasmids 2. Extra-chromosomal inheritance in algae, protozoa and yeast **Mutations** **a. Spontaneous mutations** i. Occurrence and Mechanisms ii. Fluctuation test **b. Mechanisms of induced mutations** **i. Types of mutations:** Base pair substitution (transitions, transversions), frame shift mutations (Insertions and deletions), nonsense, missense, silent, null, leaky& non leaky, conditional lethal mutants (temperature sensitive, amber) **ii. Chemical mutagens:** Base analogues (2amino purine, 5bromo uracil), HNO_2, alkylating agents (ethyl methyl sulphonate), Intercalating agents (EtBr, acridine orange) **iii. Physical mutagens:** UV rays, X rays **iv. Biological mutagens:** (bacteriophages, transposons) **c. Isolation of Mutants:** Replica plate technique **d. Reversion mutations** i. True reversion ii. Suppression (intragenic and intergenic)	**18**

References:

1.Benjamin Lewin (1994) Genes I. Oxford University Press
2.Russel Peter. Essential Genetics. 2nd Edn, Blackwell Science Pub.
3.Watson J.D. (1987) Molecular Biology of the Gene, 4th Ed. The Benjamin Cummings Publishing Company Inc.

Title of the Course and Course Code	Microbial Metabolism - (MIC2302)	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Identify the biomolecules from the given structures and label the linkages. Recall the different techniques used in the detection of radioisotopes during the use of radioisotopic tracers in the elucidation of metabolic pathways.	
CO2	Differentiate between reversible and irreversible inhibitors of enzymes. Explain the different metabolic pathways used by the microorganisms.	
CO3	Classify naturally occurring substances into the class of biomolecules they belong to and the enzymes occurring in different metabolic pathways into the six classes of enzymes.	
CO4	Integrate the different metabolic pathways to understand the metabolism of a particular microorganism well.	
CO5	Evaluate the roles of different biomolecules in a microbial cell.	
CO6	Construct a hypothetical pathway based on the given intermediates.	

Unit	Details	No. of Lectures
I	**Biomolecules:** **1. Carbohydrates** – Structure and types, biological role: storage polysaccharides – starch, structural polysaccharides – cellulose, complex polysaccharides - peptidoglycan **2. Proteins** – amino acids – general formula and concept of zwitterions, primary structures of proteins, secondary structure of proteins- peptide unit and its salient features, alpha helix and beta pleated sheets and their occurrence in proteins, tertiary and quaternary structure of proteins (fibrous and globular proteins). Proteins as enzymes - Nature of active site, Coenzymes, Apoenzymes, Prosthetic group, Cofactors and Isoenzymes; Structure of active site and common amino acids at the active site, Models of catalysis i. Lock and key model ii. Induced fit hypothesis iii. Transition state hypothesis, Activators and inhibitors of enzymes **3. Lipids** – Difference between oils and fats, Definitions and major classes of storage and structural lipids, structure and biological role of fatty acids, essential fatty acids, structure, function and properties of triacylglycerols, special lipids- sphingolipids, gangliosides	**18**
II	**Utilization of nutrients:** 1. Radioisotopes in the study of metabolic pathways, Autoradiography, Pulse chase experiment (tracer studies) 2. Metabolic pathways i. Definitions: Metabolism, catabolism, anabolism, respiration, fermentation ii. Glycolysis iii. Hexose monophosphate pathway iv. Entner- Duodoroff pathway v. Glyoxylate	**18**

	bypass vi. Krebs Cycle (with emphasis on Amphibolism) vii. Homofermentative pathway viii. Heterofermentative pathway, High energy compounds, electron transport chain, oxidative phosphorylation and substrate level phosphorylation, chemiosmotic hypothesis of ATP formation, concept of standard redox potential (Nernst Equation)	

References:

1.Nelson D. L. & Cox M. M. (2005). Lehninger's Principles of Biochemistry, 4th Edition, W. H. Freeman & Co. NY.

2. Trevor Palmer and Philip Bonner (2007). Enzymes- Biochemistry, Biotechnology, Clinical Chemistry, 2nd Edition, Woodhead Publishing.

Title of the Course and Course Code	Microbiology Practical- III - MIC2303	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Show different ways of isolation of bacterial mutants.	
CO2	Differentiate microorganisms on the basis of biochemical characteristics.	
CO3	Carry out mutations in bacteria using different inducing methods.	
CO4	Identify the biomolecules present in different food items.	
CO5	Justify the effect of U.V. light on death rate of bacteria.	
CO6	Perform some of the tests that can be used to partially characterize microorganisms.	

List of practicals (Compulsory 10 + 2 Activity)

I.

1. Biochemical characterization of bacteria: (*E. coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus aureus*)

a. Sugar utilization test
b. Sugar fermentation test
c. Enzyme detection tests– Amylase, Gelatinase, Catalase, Oxidase
d. Oxidative-fermentative test

2.Diagnostic biochemical tests:

a. IMViC test

II.

1. Induced mutationsand Isolation of Mutants

a. Induction of mutations by using physical mutagen (e.g. UV rays)
b. Isolation of mutants by any suitable method such as replica plate technique
c. Demonstration of UV survival curve

2. Qualitative tests for:

a. Carbohydrates
b. Proteins

Title of the Course and Course Code	Microbiology Practical- III - MIC2401	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Define the primary, secondary pollutants of air. List the airborne, waterborne diseases. Outline the steps involved in the purification of raw water.	
CO2	Compare and contrast between the different methods of secondary treatment of wastewater. Explain the different methods used for sampling and sanitation of air.	
CO3	Calculate the values of different parameters such as BOD, COD, MPN, etc. based on given values.	
CO4	Relate the industrial processes to environmental pollution.	
CO5	Evaluate the quality of different water samples based on the values given for different parameters.	
CO6	Propose eco-friendly ways and means for disposal of waste water.	

Unit	Details	No. of Lectures
I	**Air Microbiology** 1. i. Air flora – Transient nature of air flora ii. Droplet, droplet nuclei, and aerosols iii. Transmission of air-borne pathogens 2. Air pollution: Chemical pollutants, their sources in air and effects on human health 3. Principles of air sampling for microbial load i. Impaction on solids ii. Impingement in liquid iii. Sedimentation 4. Air sanitation: Physical and chemical methods	**18**
II	**Water Microbiology** 1. Types of water: natural and processed- surface, ground, stored, distilled, mineral and de-mineralized water 2. Steps in the purification of raw water 3. Bacteriological standards of potable water Maharashtra pollution control board (MPCB), Central pollution control board (CPCB), Bureau of Indian standards (BIS) World health Organization (WHO) 4. Indicators of faecal pollution; i. *Escherichia coli* ii. *Bifidobacterium* iii. *Streptococcus faecalis* iv. Bacteriophages v. *Clostridium perfringens* 5. Water borne Infections	**18**

	6. Bacteriological analysis of water for potability i. Multiple tube fermentation test ii. Confirmed test iii. Completed test iv. Eijkman test v. Membrane filter technique **Sewage and Waste Water Microbiology** Analysis of waste water – Physico- chemical parameters: pH, temperature, total solids, suspended solids, Chemical Oxygen Demand (C.O.D.); Biological parameters: B.O.D., Toxicity (Fish bioassay); Industrial water pollutants, their ecological effects and health hazards (Biomagnification and eutrophication) Methods of effluent treatment – Primary, secondary, tertiary treatment methods iii. Recycling and reuse of waste water Treatment of sludge – sludge thickening and dewatering and its disposal; biochemical mechanisms of Biomethanation, Types of anaerobic digesters, Applications of biogas (Methane)	

References:

1. Andrew D Eaton; American Public Health Association.; American Water Works Association.; Water Environment Federation. (2005). Standard methods for the examination of water and wastewater 21st Edition.

2. Prescott, Lancing M., John, P. Harley and Donald, A. Klein (2006). Microbiology, 6th Edition, McGraw Hill Higher Education

Title of the Course	Industrial Microbiology – MIC2402	Number of Credits : 02
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Recall basics concepts of industrial microbiology including constituents of fermentation media and different types of industrial fermenters.	
CO2	Compare between different types of industrial fermentations. Explain the process control and monitoring of fermentation parameters.	
CO3	Examine the characteristics of industrial microorganisms and different strain improvement methods.	
CO4	Explain the importance of sterilization in fermentation processes and different sterilization methods.	
CO5	Justify the use of media for specific fermentation processes.	
CO6	Plan different screening methods for isolating desired microorganism from environment. Devise inoculum development steps in industrial fermentations.	

Unit	Details	No. of Lectures
I	**Basic industrial microbiology** 1. Strains of industrially important microorganisms: a. Desirable characteristics of industrial strain b. Different methods of strain improvement i. feedback control mechanisms ii. auxotrophic mutants iii. analogue resistant mutants iv. revertants 2. Screening – Principles and methods of primary and secondary screening 3. Master, working and seed culture, development of inoculum 4. Media for industrial fermentations: a. Constituents of media: Carbon source, nitrogen source, amino acids and vitamins, minerals, water, buffers, antifoam agents, precursors, inhibitors and inducers b. Crude media components: molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates	**18**
II	**Fermentation equipment and process control** 1. Types of fermentation – Batch, continuous and dual	**18**

	fermentation 2. Design of a fermenter (typical CSTR Continuous stirred tank Reactor): different parts and their operation. 3. Different types of fermenter: Laboratory, pilot- scale and production fermenters, constantly stirred tank reactors and air-lift fermenters 4. Contamination and sterilization: a. Sources, precautions, and consequences of contamination b. Sterilization of media-batch and continuous sterilization c. Sterilization by filtration: feed, air and heat labile supplements 5. Process control and monitoring of different fermentation parameters: temperature, pH, aeration, agitation, foam	

References:

1. Casida LE. (1984) Industrial Microbiology. Wiley Easterbs, New Delhi
2. Ingraham J. L. and Ingraham C.A. (2004) Introduction to Microbiology. 3nd Edition. Thomson Brooks / Cole.
3. Patel A.H. (1985) Industrial Microbiology, Macmillan India Ltd

Title of the Course	Practicals based on 'Environmental Microbiology & Industrial Microbiology' - MIC2403	Number of Credits : 02
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the process for spore staining and demonstrate the capsule presence.	
CO2	Discuss the functioning and design of waste-water treatment plant	
CO3	Demonstrate air sampling techniques and evaluate different sampling parameters.	
CO4	Classify the organisms capable of producing antibacterial substances and polysaccharides.	
CO5	Measure different diversity indices and interpret the data in terms of probability.	
CO6	Perform different water potability tests and compare them.	

List of practicals (Compulsory 10 + 2 Activity)

I. Air Microbiology

1. Demonstration of the working of an air sampler
2. Determination of the diversity of air flora and calculation of Simpson's index

Water Microbiology

1.Bacteriological tests of potability of water
   i. MPN, Confirmed and Completed test.
   ii. Membrane filter technique (Demonstration)
2. Determination of B.O.D. of water sample
3. Determination of total solids and total suspended solids in sewage water

Compulsory visit to waste water treatment plant/ water purification plant

II. Industrial microbiology

1. Isolation and checking characters of bacteria producing antibacterial substance from soil by crowded plate technique
2. Giant colony inhibition spectrum
3. Screening of organic acid producing bacteria from soil
4. Isolation and checking characters of exopolysaccharide – producing bacteria from soil
5. Demonstration of presence of capsule and spores in bacteria