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

2020-2021

Deccan Education Society's
Fergusson College (Autonomous), Pune

S.Y. B.Sc Microbiology (Pattern 2019)

From academic year2020-2021

Particulars	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
S.Y. B.Sc. 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

Subject Microbiology Paper -1(MIC2301): Paper title: Microbial Genetics

[Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Understand the fundamentals of microbial genetics with reference to evolution of DNA on earth and the experiments that led to the determination of DNA and RNA as genetic material in organisms.

CO2 Understand the structure of DNA, models of DNA replication in various systems and mechanisms underlying gene expression.

CO3 Gain knowledge about the extrachromosomal inheritance in bacteria and evidences towards establishment of the biological basis of origin of mutations.

CO4 Understand the mechanisms of different mutagenic agents including physical and chemical mutagens on bacteria.

Unit	Details	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	[18]

	d. Mechanism of DNA replication: enzymes and proteins involved in 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 **2. 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]**

Books-

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.

S.Y. B.Sc. Semester III

Subject Microbiology Paper -1 (MIC2302): Paper title: Microbial Metabolism

[Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Identify the different biomolecules based on their structures and the role of the biomolecules in different life forms

CO2 Understand the mechanisms underlying the enzyme-catalyzed reactions and appreciate the role of activators and inhibitors on the rate of enzyme-catalyzed reactions

CO3 Understand the pathways by which micro-organisms utilize the different substrates available to them and appreciate the role of a wide variety of enzymes in metabolism

CO4 Understand the interconnectivity between the different metabolic pathways

Unit	Details	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 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)	**[18]**

Books-

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.

S.Y. B.Sc. Semester III

Subject Microbiology Paper -1 (MIC2303): Paper title: Microbiology Practical -III [Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Perform some of the tests used to partially characterize micro-organisms
CO2 Perform the different methods for inducing mutations in bacteria
CO3 Perform the different ways of isolation of mutants
CO4 Identify the biomolecules present in different food items

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

S.Y. B.Sc. Semester IV

Subject Microbiology Paper -1 (MIC2401):Paper title: Environmental Microbiology

[Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Understand the role of air and water in the transmission of different micro-organisms

CO2 Understand the importance of sanitation of air in different indoor environmental settings

CO3 Understand the importance of different steps in the purification of raw water

CO4 Understand the different methods for treatment of waste water alongwith the ways of disposal of solid waste

Unit	Details	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	**[12]**
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 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	**[12]**

	(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)	

Books-

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

S.Y. B.Sc. Semester IV

Subject Microbiology Paper -1 (MIC2402): Paper title: Industrial Microbiology

[Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Understand the important characteristics of industrially important microorganisms, different methods of strain improvement.

CO2 Understand the basics of large scale fermentation processes with respect to constituents of media and types of crude media.

CO3 Study the design of industrial fermenters with respect to construction, sterilization of media, air and feed.

CO4 Understand the control and monitoring aspects in commercial bioprocess technology.

Unit	Details	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 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:	18

	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	

Books-

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

S.Y. B.Sc. Semester IV

Subject Microbiology Paper -1 (MIC2403): Paper title: Microbiology Practical-IV

[Credits-2]

Course Outcomes

At the end of this course, students will be able to

CO1 Understand the working of an air sampler

CO2 Determine the diversity of air in different indoor and outdoor environmental settings

CO3 Isolate and characterize the exopolysaccharide and endospore producing bacteria from soil

CO4 Perform primary and secondary screening methods for antibiotic producers and organic acid producers from soil.

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

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