

B.Sc Semester 3

Semester: 3	
Course : Microbiology	
Paper Title: Microbial physiology and metabolism	
Paper code: C2MB230312T/P	Credits: 4
Hours/week : 5 (6)	
Category: Core/MDC/SEC/VAC : Core	
Theory / Practical / Composite : Composite	
No of Modules : No modules	
<p>Course Overview: The course on microbial physiology and metabolism is divided into different units based on the hierarchical levels of understanding. The first level explores the environmental influence (both physical and chemical factors) on the growth of microbes, mechanism of microbial adaptations, different methods of nutrient uptake and mechanism of transport. The chapter includes nutritional classification of bacteria, modes of nutrition, chemolithotrophic pathways with focus on hydrogen oxidizing bacteria, methanogenesis, etc. The chemoheterotrophic metabolism and its relevance to energy yielding pathways as glycolysis, kreb's cycle, pentose phosphate pathway and an emphasis on the different fermentation pathways. The phototrophic metabolism with reference to the metabolism on anoxygenic and oxygenic photosynthesis. The microbial involvement in the nitrogen and sulphur metabolism, assimilatory and dissimilatory pathways with respect to metabolism are also discussed.</p> <p>The practical unit studies the effect of different physical and chemical factors on the bacterial growth curve and its measurement on the bacterial growth kinetics.</p>	
Course Outcome:	
<p>1. Remember: Nutritional classification of bacteria, the different enzymatic pathways of aerobic, anaerobic and fermentation pathways. The different modes of nutrition as chemolithotrophic, chemoheterotrophic and fermentation pathways.</p>	
<p>2. Understand: To understand, explain how environmental factors influence microbial growth and survival. The principles of microbial modes of nutrition as chemolithotrophic, heterotrophic and phototrophic metabolism.</p>	
<p>3. Apply: To apply and understand knowledge of microbial nutritional classification to categorize microorganisms based on energy, carbon, and electron sources. To apply the knowledge of microbial nutrition to interpret microbial energy strategies associated with different biogeochemical cycles.</p>	
<p>4. Analyze: To study, understand and examine mechanisms of nutrient uptake and transport systems including passive diffusion, facilitated diffusion, primary and secondary active transport, and group translocation. To describe and compare aerobic respiration, anaerobic respiration, and fermentation pathways in microorganisms. To study the biochemical pathways of glucose metabolism and their roles in energy production. Differentiate between oxygenic and anoxygenic photosynthesis and compare major phototrophic groups.</p>	
<p>5. Evaluate: To examine, compare the assimilatory and dissimilatory pathways of nitrogen and sulfur metabolism and assess their ecological significance. Evaluation, description and comparison the structure and function of the electron transport chain in bacteria and from the mitochondrial ETC, including the effects of inhibitors and uncouplers.</p>	

6. **Create:** To design, develop the modes of microbial nutrition based on different nutritional sources, their involvement in the nitrogen and sulfur cycles, the involvement of microbial physiology in the industries, clinical settings, food industry, etc.

Prerequisites: *Basic knowledge about any prior course*

SYLLABUS

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
I.	<p>Effect of Environment on Microbial Growth Microbial growth in response to environment -temperature, pH, oxygen, pressure, solute etc, water activity; the underlying mechanisms. Introduction to nutritional classes of bacteria with examples, nutrient uptake and transport (passive and facilitated diffusion, primary and secondary active transport, concept of uniport, symport, antiport, group translocation).</p>	8	CO1, CO2, CO4	K1, K2, K4
II.	<p>Chemoheterotrophic Metabolism Introduction to aerobic respiration, anaerobic respiration, and fermentation. Aerobic Respiration: Glycolysis i.e. EMP, ED, PPP, TCA cycle. Electron transport chain: composition, mechanism, comparison of mitochondrial and bacterial ETC, uncouplers and inhibitors. Anaerobic respiration Fermentation - Alcohol fermentation and Pasteur effect; Lactic acid fermentation, concept of linear and branched fermentation pathways.</p>	20	CO1, CO2, CO3, CO4, CO5, CO6	K1, K2, K3, K4, K5, K6
III.	<p>Chemolithotrophic and Phototrophic metabolism Concept to chemolithotrophy with examples (aerobic and anaerobic). 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.</p>	12	CO1, CO2, CO4, CO5	K1, K2, K4, K5
IV.	<p>Nitrogen and sulphur Metabolism Introduction to biological nitrogen and sulphur metabolism, Assimilatory and dissimilatory pathways.</p>	8	CO1, CO2, CO5, CO6	K1, K2, K5, K6

V.	Practical 1. Study and plot of 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 the growth of E. coli. 4. Effect of carbon and nitrogen sources on the growth of E. coli. 5. Effect of salt on the growth of E. coli.	32	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
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Text Books

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Stanier RY, Ingraham JI, Wheelis ML and Painter PR. (1987).
3. General Microbiology. 5th edition, McMillan Press.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013).

Suggested readings

1. Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
2. Lehninger's Biochemistry
3. Voet & Voet. Biochemistry

Web Resources

- 1.
- 2.
- 3.
- 4.

Evaluation Theory 60 (45+15) CIA-10+3+2; Practical 40 CA (38+2)

Paper Structure for Theory Semester Exam Module : Full Marks: 45

Short questions: 5 (each 1 mark) from 7 (5x1=5)

Long questions: 4 (each 10 marks) from 6 (4x10=40)

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
CO1	Remember: Define, identify, recognize the nature, structure and function of microbial diversity existing in nature and understanding the microbial diversity in relation to its environment.	K1
CO2	Understand: To understand microbial interactions from the foundations of microbial communities, shaping the	K2

	structure and function of communities and their different types of interactions i.e. both positive and negative.	
CO3	Apply: To understand the microbial interactions occurring in biogeochemical cycles, the diverse microbial metabolism, microbial role in nutrient recycling, maintaining a role in elemental flux thereby contributing to ecosystem dynamics.	K3
CO4	Analyze: Understanding the role of extremophiles, their nature, classification based on habitat, physiological and biochemical adaptation, and their application in industries.	K4
CO5	Evaluate: Remembering the core concepts of microbial diversity, their application in waste management systems (solid and liquid), physical, chemical and biological methods of waste treatment, engineering principles of waste treatment plant and their eco-friendly solutions.	K5
CO6	Create: To create and develop the foundation principles behind the waste management systems, concepts of indicator bacteria, formulate core concepts in terms of physical, chemical and microbiological parameters of potable water. Develop microbiological tests to study indicator bacteria.	K6