

**DISCIPLINE SPECIFIC CORE COURSE –8:  
MICROBIAL PHYSIOLOGY AND METABOLISM- I**

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
<b>MICROB-DSC302:  MICROBIAL PHYSIOLOGY AND METABOLISM- I</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>1</b>	<b>Class XII pass with Biology/ Biotechnology/ Biochemistry</b>	<b>NIL</b>

**Learning Objectives**

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable students to understand the underlying mechanisms governing various physiological and metabolic features of prokaryotes. These include transport mechanisms for the uptake of nutrients, bacterial growth, and the diversity of prokaryotes due to (i) adaptations to the different habitats in which they grow and (ii) metabolic pathways for energy production and carbon and nitrogen assimilation.
- The course will build the strong foundation needed by the students for further studies in the advanced fields of microbiology including metabolic engineering.

**Learning outcomes**

The Learning Outcomes of this course are as follows:

- Student will be able to discuss the diverse nutritional categories of bacteria/archaea and mechanisms of transport of nutrients across membranes of microbes.
- Student will be able to describe the physiology of bacterial growth, calculation of generation time and specific growth rate, and the effects of physicochemical factors on microbial growth.
- Student will be able to describe the metabolic pathways used by bacteria for energy generation and conservation during growth on glucose and other carbon sources under aerobic and anaerobic conditions.
- Student will be able to discuss energy production processes in microbes.

- Student will be able to analyse growth kinetics of bacteria, and evaluate the impact of external factors on bacterial growth kinetics.

## SYLLABUS OF DSC-8

### UNIT – I (10 hours)

#### **Nutritional diversity amongst bacteria and mechanisms of nutrients transport:**

Classification of bacteria based on carbon, electron and energy sources. Nutrient transport across membrane: passive transport (diffusion- simple and facilitated), active transport (primary and secondary with suitable examples, concept of uniport, symport, antiport) and group translocation. Electrogenic and electroneutral transport. Transport of iron in bacteria through concerted action of primary and secondary active transport.

### UNIT – II (12 hours)

**Microbial growth patterns, kinetics and physiological adaptations:** Batch, continuous, diauxic and synchronous growth. Bacterial growth kinetics: growth curve, generation time and specific growth rate. Physiological adaptations by microbes for growth under different environmental conditions: effect of temperature, pH, oxygen concentration, solute and water activity.

### UNIT – III (12 hours)

**Chemoheterotrophic metabolism under aerobic conditions:** Concept of metabolism and energy production. Glucose degradation/catabolism by microbes via: glycolysis, Entner-Doudoroff (ED) pathway, Pentose phosphate pathway (PPP). The pyruvate dehydrogenase reaction, Krebs Cycle, anaplerotic reactions, Glyoxylate cycle. Utilization of fructose, lactose and pentose

### UNIT – IV (11 hours)

**Electron transport and energy production:** Redox potentials of the electron carriers, organization of electron carriers in mitochondria, coupling sites, mechanisms of proton translocation, chemiosmotic hypothesis, oxidative phosphorylation and ATP generation, uncouplers and inhibitors of respiratory chain, comparison of mitochondrial and bacterial electron transport, branched respiratory chain in *E. coli* under high and low levels of O<sub>2</sub>.

## Practical component

**30 Hours**

### UNIT 1: (20 hours)

**Microbial growth:** Study of various methods of measurement of microbial growth. Collection of data and plotting of bacterial growth curve of *E. coli* using turbidometric method (using optical density as the indirect method of measurement of bacterial growth). Understanding bacterial growth kinetics by calculation of generation time and specific growth rate of bacteria from the graph. Study of radial growth of *Aspergillus niger* using point inoculation method

### Unit 2: (10 hours)

**Effect of environmental factors on microbial growth:** Study of the effect of physicochemical factors like temperature and pH variations on the growth of *E.coli*. Understanding the physiological importance of catalase and oxidase in protecting bacteria from the harmful effects of oxidizing environment: detection and assay of their activity in bacteria.

### **Essential/recommended readings**

#### **Theory:**

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman Fundamentals of Bacterial Physiology and Metabolism by Rani Gupta and Namita Gupta. Springer Nature Singapore Pvt. Ltd., Singapore. 2021.
2. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.
3. Brock Biology of Microorganisms by M.T. Madigan, J. Aiyer, D. Buckley, W. Sattley and D. Stahl. 16th edition. Pearson, USA. 2021.
4. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
5. Microbial Biochemistry by G.N. Cohen. 2nd edition. Springer, Germany. 2014.
6. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond and C. Fuqua. 4th edition. Oxford University Press, UK. 2011.
7. Microbial Physiology by S.R. Reddy and S.M. Reddy. Scientific Publishers India. 2007.
8. Microbial Physiology by A.G. Moat, J.W. Foster and M.P. Spector. 4th edition. John Wiley & Sons, USA. 2002.

#### **Practicals:**

1. Essentials of Practical Microbiology by A. Sastry and S. Bhat. 2nd edition. Jaypee Brothers Medical Publishers, India. 2021.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Laboratory Experiments in Microbiology by T. Johnson and C. Case. 12th Edition. Pearson Education, USA. 2019.
4. Microbiology Practical Manual edited by A. Jain, J. Agarwal, V. Venkatesh. Elsevier, India. 2018.
5. Applied Microbial Physiology: A Practical Approach by P. M. Rhodes and P. F. Stanbury. IRC Press. 1997.

**Note:** Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.