DEPARTMENT OF MICROBIOLOGY				*CLASS: I M.Sc. Microbiology*				
Sem	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Contact Hours/week**	**CIA**	**Ext**	**Total**
I	Major Core - 3	21P1RMC3	Microbial Physiology	4	5	25	75	100

Nature of Course				
Knowledge and skill	✓		Employability oriented	
Skill oriented			Entrepreneurship oriented	

Course Objectives

1. To understand microbial growth and nutrition
2. To understand the concept of photosynthesis and bioluminescence
3. To know the concept of catabolism and catabolic pathways in microbes
4. To gain knowledge about the microbial anabolic pathways and nitrogen metabolism
5. To know about anaerobic respiration and microbial stress response

Course Learning Outcomes

On successful completion of the programme, the students will be able to

1. Outline the concept of microbial growth and nutrition.
2. Define the basic concept of photosynthesis and bioluminescence.
3. Summarize the concept of catabolism and catabolic pathways in microbes
4. Interpret the microbial anabolic pathways and nitrogen metabolism
5. Illustrate anaerobic respiration and microbial stress response

Unit	Description	Hours	K- level	CLO
I	**Unit- I Microbial Growth and Nutrition** Growth of Bacteria - phases of growth, batch culture, continuous culture, diauxic growth and synchronous culture - induction of synchrony and growth kinetics. Factors affecting microbial growth. Classification of organisms based on carbon, energy and electron sources. Microbial nutrition – Nutritional requirements and types of bacteria – phototrophs and chemotrophs, autotrophs and heterotrophs, organotrophs and lithotrophs - photoorganotrophs and chemolithotrophs (ammonia, nitrate sulphur, hydrogen, iron oxidizing bacteria). Nutrient transport mechanisms- Passive diffusion, facilitated diffusion, active transport, group translocation and specific transport system.	15 hrs	Up to K2	1

II	**Unit- II Bacterial Photosynthesis** Bacterial Photosynthesis- general types of microbial photosynthesis - oxygenic and anoxygenic. Structure of photosynthetic pigments – chlorophylls, bacteriochlorophyll, carotenoids and phycobilins. Photosynthetic bacteria - green sulphur and purple bacteria. Light reaction in aerobic oxygenic phototrophic bacteria. Light reaction in anaerobic anoxygenic phototrophic bacteria (Green and Purple bacteria). CO_2 fixation – Calvin cycle. Bioluminescence - Process and application.	15 hrs	Up to K3	2
III	**Unit –III Metabolism** Basic concepts of metabolism, oxidation – reduction reactions, Energy generation by anaerobic metabolism – glycolysis, pentose phosphate pathway, Entner- Doudoroff (ED) pathway, Fermentation - alcoholic and lactic acid fermentation – homolactic, heterolactic and mixed acid fermentation with examples. Energy generation by aerobic metabolism - TCA cycle, glycoxylate pathway and electron transport chain, mechanism of ATP synthesis – chemiosmosis, Pasteur effect.	15 hrs	Up to K3	3
IV	**Unit –IV Anabolism and Nitrogen metabolism** Glycogenesis, gluconeogenesis and amphibolic nature of TCA cycle -production of biosynthetic products. Biosynthetic pathway of peptidoglycan. Nitrogen Metabolism- Sources of nitrogen, Nitrogen fixation - non symbiotic and symbiotic nitrogen fixation. Nitrification, denitrification, Nitrate and ammonia assimilation pathways, Nitrogen cycle. Diazotrophs of nitrogen fixation, structure of nitrogenase complex. Regulation of nitrogenase complex by oxygen and combined nitrogen sources. Nif genes and their regulation.	15 hrs	Up to K4	4
V	**Unit- V Anaerobic respiration and microbial stress response** Anaerobic respiration. Nitrogen, sulphur, iron and hydrogen oxidation. Methanogenesis. Microbial stress responses (extremophiles) - osmotic stress and osmoregulation, aerobic to anaerobic transitions, oxidative stress, pH stress and acid tolerance, thermal stress and heat shock response, nutrient stress and starvation stress, stringent response.	15 hrs	Up to K4	5

Total 75 Hours

Books for Study:

1. Moat, A.G. and Foster, J.W. (2009). Microbial Physiology. 4th Edition. John Wiley & Sons, New York.
2. Atlas, R.M. (1997). Principles of Microbiology. 2nd Edition. WCB/McGraw-Hill Co., USA.

Books for Reference:

1. Hall, D.O. and Rao, K.K. (1994). Photosynthesis. 5th Edition. Cambridge University press, UK.
2. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, P.R. (1986). General Microbiology. 5th Edition. Macmillan Education Ltd., London.
3. Dubey, R.C. and Maheswari, D.K. (2005). A Text book of microbiology. S. Chand & Company Ltd., New Delhi.
4. Salle, A.J. (1992). Fundamentals Principles of Bacteriology. 7th Edition. McGraw Hill Publishing Co. Ltd., New York.
5. Sundararajan, S. (2003). Microbial Physiology. Anmol Publication, New Delhi.

Web Resources:

1. http://www.chris-anthony.co.uk/pdf_files/presentations/IntroductionWeb.pdf
2. https://www.youtube.com/watch?v=NYMTeqpr6JI
3. https://www.youtube.com/watch?v=ei6Z7orCpPk

Rationale for nature of the course

Microbial physiology provides information on sources of energy and its utilization by microorganisms. Microorganisms play important role in environment as producers, consumers and decomposers. These are the only group of organisms which takes part in all three important stages of ecosystem. Understanding microbial physiology has greater application in industry, developing medicine and even in agriculture.

Activities having direct bearing on skill development/employability/entrepreneurship:

Microbial physiology has traditionally played a very important role in both fundamental research and in industrial applications of microorganisms.
The classical approach in microbial physiology is to analyze the role of individual components (genes or proteins) in the overall cell function.
It is possible to optimize industrial fermentations through introduction of directed genetic modification - an approach referred to as metabolic engineering.

Pedagogy

Chalk and talk, PPT, Group discussion, Seminar, Screening of educational videos and quiz

Course Learning Outcomes (CLO)

On the completion of the course the student will be able to

	Course Learning Outcome	Knowledge Level
CLO1	Outline the concept of microbial growth and nutrition.	Up to K2
CLO2	Define the basic concept of photosynthesis and bioluminescence.	Up to K3
CLO3	Summarize the concept of catabolism and catabolic pathways in microbes	Up to K3
CLO4	Interpret the microbial anabolic pathways and nitrogen metabolism	Up to K4
CLO5	Illustrate anaerobic respiration and microbial stress response	Up to K4

K1 –Remembering and recalling facts with specific answers

K2 – Basic understanding of facts and stating main ideas with general answers

K3 – Application oriented – Solving Problems

K4 – Examining, analyzing, presentation and make interferences with evidences

Mapping of Course Learning Outcome with Programme Specific Outcome

	PSO1	PSO2	PSO3	PSO4	PSO5
CLO1	1	1	1	1	3
CLO2	1	1	1	2	2
CLO3	1	2	1	1	3
CLO4	2	2	2	1	2
CLO5	2	2	2	2	2

Advance application–3 Intermediate level –2 Basic level –1

Mapping of Course Outcome with Programme Outcome

	PO1	PO2	PO3	PO4	PO5
CLO1	1	1	1	1	1
CLO2	1	1	1	1	1
CLO3	1	1	1	1	1
CLO4	1	2	2	2	2
CLO5	2	2	2	2	2

Advance application–3 Intermediate level –2 Basic level –1

Learning Outcome Based Education & Assessment (LOBE)

Blue Print

Articulation Mapping – K Levels with Courses Learning Outcomes (CLOs)

S. No.	CLOs	K-Level	Section A		Section B		Section C (Either / or Choice)	Section D (Open Choice)
			MCQs		Short Answers			
			No. of Questions	K-Level	No. of Questions	K-Level		
1.	CLO 1	Up to K2	2	K2 & K2	1	K1	2 (K1&K1)	1(K2)
2.	CLO 2	Up to K3	2	K3 & K3	1	K1	2 (K3&K3)	1(K3)
3.	CLO 3	Up to K3	2	K3 & K3	1	K2	2 (K2&K2)	1(K3)
4.	CLO 4	Up to K4	2	K4& K4	1	K2	2 (K4&K4)	1(K4)
5.	CLO 5	Up to K4	2	K1& K1	1	K3	2 (K4&K4)	1(K4)
No. of Questions to be asked			10		5		10	5
No. of Questions to be answered			10		5		5	3
Marks for each Question			1		2		5	10
Total Marks for each Section			10		10		25	30

K1 –Remembering and recalling facts with specific answers
K2 – Basic understanding of facts and stating main ideas with general answers
K3 – Application oriented – Solving Problems
K4 – Examining, analyzing, presentation and make interferences with evidences

Distribution of Section-wise Marks with K Levels

K Levels	Section A (No Choice)	Section B (No Choice)	Section C (Either/or)	Section D (Open Choice)	Total Marks	% of Marks without choice	Consolidated
K1	2	4	10	-	**16**	13.33	**35 %**
K2	2	4	10	10	**26**	21.67	
K3	4	2	10	20	**36**	30	**30%**
K4	2	-	20	20	**42**	35	**35%**
Total Marks	10	10	50	50	**120**	100.00	**100%**

K1 –Remembering and recalling facts with specific answers
K2 – Basic understanding of facts and stating main ideas with general answers
K3 – Application oriented – Solving Problems
K4 – Examining, analyzing, presentation and make interferences with evidences

LESSON PLAN

UNITS	DESCRIPTION	STAFF	HOURS	MODE
I Microbial Growth and Nutrition	a) Growth of Bacteria: phases of growth, growth kinetics - batch culture, continuous culture, diauxic growth and synchronous culture - induction of synchrony and growth kinetics		3	Chalk and Talk
	b) Factors affecting microbial growth		3	
	c) Classification of organisms based on carbon, energy and electron sources		3	
	d) Nutrition – nutritional requirements and types of bacteria – phototrophs and chemotrophs, autotrophs and heterotrophs, organotrophs and lithotrophs - photoorganotrophs and chemolithotrophs (ammonia, nitrate sulphur, hydrogen, iron oxidizing bacteria).		3	
	e) Nutrient transport mechanisms- Passive diffusion, Facilitated diffusion, Active transport, Group translocation and Specific transport system.		3	
II Bacterial Photosynthesis	a) Bacterial Photosynthesis- General types of microbial photosynthesis - oxygenic and anoxygenic		2	Chalk and Talk
	b) Structure of photosynthetic pigments – chlorophylls, bacteriochlorophyll, carotenoids and phycobilins		2	
	c) Photosynthetic bacteria - green sulphur and purple. Light reaction in aerobic oxygenic phototrophic bacteria		2	
	d) Light reaction in anaerobic an-oxygenic phototrophic bacteria (Green and Purple bacteria)		3	
	e) CO_2 fixation – Calvin cycle		3	
	f) Bioluminescence - Process and application		3	

III Metabolism	a) Basic concepts of metabolism, Oxidation – reduction reactions		3	Chalk and Talk & PPT
	b) Energy generation by anaerobic metabolism – glycolysis, pentose phosphate pathway, Entner- Doudoroff (ED) pathway		4	
	c) Fermentation-alcoholic-lactic acid fermentation-Homolactic and Heterolactic and Mixed acid fermentation with examples		4	
	d) Energy generation by Aerobic metabolism - TCA cycle, glycoxylate pathway and electron Transport chain, Mechanism of ATP synthesis – Chemiosmosis, Pasteur effect		4	
IV Anabolism and Nitrogen metabolism	a) Glycogenesis, Gluconeogenesis and Amphibolic nature of TCA cycle - production of biosynthetic products		3	PPT & Chalk and Talk
	b) Biosynthetic pathway of peptidoglycan		3	
	c) Nitrogen Metabolism- Sources of nitrogen, Nitrogen fixation: Non symbiotic and symbiotic nitrogen fixation. Nitrification, denitrification, Nitrate and ammonia assimilation pathways		4	
	d) Nitrogen cycle. Diazotrophs of nitrogen fixation, Structure of nitrogenase complex. Regulation of nitrogenase complex by oxygen and combined nitrogen sources. Nif genes and their regulation		5	
V Anaerobic respiration and microbial stress response	a) Anaerobic Respiration. Nitrogen, sulphur, iron and hydrogen oxidation.		3	PPT
	b) Methanogenesis.		2	
	c) Microbial stress responses (extremophiles)- Osmotic stress and osmoregulation, Aerobic to anaerobic transitions, oxidative stress, pH stress and acid tolerance		5	
	d) thermal stress and heat shock response, nutrient stress and starvation stress, stringent response		5	
Total			**75 Hours**	

Course designers

1. Dr.P.N.Rajarajan