



SEMESTER 3

BIOMOLECULES AND BIOENERGETICS (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 3 rd Sem
Course Title: BIOMOLECULES AND BIOENERGETICS (Theory)	Subject Code: TIU-UMB-MJ-T21201
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. To understand the fundamental principles of thermodynamics and their relevance in biological systems.
2. To classify monosaccharides based on their functional groups and carbon number.
3. To classify lipids and understand their structural and functional roles in biological systems and biomolecules

COURSE OUTCOME :

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

CO-1:	Be able to outline structure and function of monosaccharide, disaccharide and polysaccharide	K1
CO-2:	Be able to know about structure, properties and functions of essential fatty acids, Triacylglycerols, lipid	K2
CO-3:	Be able to apply different functions of proteins in different fields	K3
CO-4:	Able to arrange different levels of organization of proteins, primary, secondary (alpha helix and beta pleated sheet), tertiary and quaternary Forces holding the polypeptide together.	K4
CO-5:	Be able to explain the Enzyme kinetics, significance of hyperbolic, double reciprocal plots of enzyme activity and Km.	K2
CO-6:	Be able to explain functions of proteins, carbohydrates and enzyme kinetics	K2

COURSE CONTENT :

MODULE 1:	BIOENERGETICS	6 Hours
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<p>First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP</p>		
MODULE 2: CARBOHYDRATES		7 Hours
<p>Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin</p>		
MODULE 3: LIPIDS		7 Hours
<p>Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties, Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers</p>		
MODULE 4: AMINO ACIDS & PROTEINS		7 Hours
<p>Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and Dglutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. Biologically important peptides like glutathione, oxytocin-important functions. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary, structures of proteins, Forces holding the polypeptide together, Human haemoglobin structure, Quaternary structures of proteins</p>		
MODULE 5: ENZYMES		6 Hours
<p>General properties, Nomenclature and classification Structure of enzyme: Apoenzyme and cofactors (prosthetic group-TPP, coenzyme NAD, metal cofactors) Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis.</p>		

MODULE 6:	NUCLEIC ACIDS	7 Hours
Miescher to Watson and Crick- historic perspective Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA & RNA: Chargaff's rule, Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). Chemical Properties of DNA & RNA: Hydrolysis (acid, alkali), enzymatic hydrolysis		
MODULE 7:	Vitamins	5 Hours
Classification and characteristics with suitable examples, sources and importance		
TOTAL LECTURES		45 Hours**

Books:

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
7. Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	1	2	1	2	1	0	1	0	1	2	2	2	3	2
CO-2	3	2	2	2	2	1	0	1	0	1	2	2	2	3	2
CO-3	3	3	3	2	2	1	0	2	1	1	2	2	2	3	3
CO-4	3	3	3	2	2	1	0	1	1	1	2	3	2	3	3
CO-5	3	2	3	2	3	1	0	1	0	1	2	3	2	3	3
CO-6	3	2	3	1	2	1	0	2	1	1	3	3	2	3	3

BIOMOLECULES AND BIOENERGETICS (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 3 rd Sem
Course Title: BIOMOLECULES AND BIOENERGETICS (Practical)	Subject Code: TIU-UMB-MJ-L21201
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. To understand the unique properties of water and their significance in biological systems
2. To differentiate between reducing and non-reducing sugars using biochemical tests
3. To identify lipids using solubility tests, Salkowski reaction, and Sudan III/IV tests.
4. To understand the different levels of protein structure (α -helix, β -sheet, tertiary conformation).
5. To differentiate between various DNA conformations (A-DNA, B-DNA, Z-DNA).

COURSE OUTCOME :

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

CO-1:	Able to analyse and prepare pH, buffer, and their derivatives	K4
CO-2:	Able to analyse free energy	K4
CO-3:	Able to perform experiments of carbohydrates	K3
CO-4:	Able to perform experiments of lipids and proteins	K3
CO-5:	Able to analyse different protein structures	K4
CO-6:	Able to analyse DNA structures	K4

COURSE CONTENT :

MODULE 1:	QUANTIFICATION AND ESTIMATION OF BIOMOLECULES	15 Hours
1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts 2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant 4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars 5. Qualitative/Quantitative tests for lipids and proteins 6. Study of protein secondary and tertiary structures with the help of models 7. Study of different types of DNA with the help of models		
TOTAL LECTURES		15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)	PROGRAM SPECIFIC OUTCOMES (PSO)
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	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	2	3	2	2	1	1	1	1	1	2	3	2	3	2
CO-2	3	3	3	2	2	1	1	1	1	1	2	3	2	3	2
CO-3	2	2	2	2	3	1	1	2	2	1	3	2	2	3	3
CO-4	2	2	2	2	3	1	1	2	2	1	3	2	2	3	3
CO-5	3	3	3	2	3	1	1	2	1	1	2	3	2	3	3
CO-6	3	3	3	2	3	1	1	2	1	1	2	3	2	3	3

MICROBIAL PHYSIOLOGY AND METABOLISM (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 3 rd Sem
Course Title: MICROBIAL PHYSIOLOGY AND METABOLISM (Theory)	Subject Code: TIU-UMB-MJ-T21202
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. To understand the fundamental concepts of microbial growth, including different phases and growth kinetics.
2. To explore different mechanisms of nutrient transport, including passive diffusion, facilitated diffusion, and active transport.
3. To understand the principles of aerobic respiration, anaerobic respiration, and fermentation.
4. To introduce the concept of chemolithotrophy and Chemoheterotrophy and their significance in microbial ecology.

COURSE OUTCOME :

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

CO-1:	Define and explain the concept of microbial growth, including the different phases of a typical growth curve.	K2
CO-2:	Explain the mechanisms of transport systems, including uniport, symport, and antiport systems.	K2
CO-3:	Recall and describe the key metabolic pathways involved in aerobic respiration (EMP, ED, Pentose phosphate pathway, TCA cycle).	K4

CO-4:	Illustrate the Chemoheterotrophic Metabolism - Anaerobic Respiration and Fermentation	K3
CO-5:	Explain different Chemolithotrophic and Phototrophic Metabolism	K3
CO-6:	Illustrate Nitrogen Metabolism and what will be application on agriculture	K3

COURSE CONTENT :

MODULE 1:	MICROBIAL GROWTH AND EFFECT OF ENVIRONMENT ON MICROBIAL GROWTH	10 Hours
<p>Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph, Peptidoglycan biosynthesis pathway</p>		
MODULE 2:	NUTRIENT UPTAKE AND TRANSPORT	7 Hours
<p>Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake</p>		
MODULE 3:	CHEMOHETEROTROPHIC METABOLISM - AEROBIC RESPIRATION	8 Hours
<p>Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors</p>		
MODULE 4:	CHEMOHETEROTROPHIC METABOLISM- ANAEROBIC RESPIRATION AND FERMENTATION	7 Hours
<p>Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways</p>		
MODULE 5:	CHEMOLITHOTROPHIC AND PHOTOTROPHIC METABOLISM	8 Hours

Introduction to aerobic and anaerobic chemolithotrophy with an example each. 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		
MODULE 6:	NITROGEN METABOLISM - AN OVERVIEW	7 Hours
Introduction to biological nitrogen fixation, nitrogenase-mode of action and regulation, ammonia assimilation, assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.		
TOTAL LECTURES		45 Hours**

Books:

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
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CO-1	3	2	3	-	-	-	-	-	-	-	2	3	3	-	3
CO-2	3	2	2	-	-	-	-	-	-	-	2	2	3	3	2
CO-3	3	3	3	-	2	-	-	-	-	-	2	3	3	2	2
CO-4	3	3	2	-	2	-	-	-	-	-	2	3	3	2	2
CO-5	3	2	3	2	2	2	-	-	-	-	2	3	3	2	3
CO-6	3	3	3	2	2	3	-	-	-	-	3	3	3	2	3

Department of Microbiology, MICROBIAL PHYSIOLOGY AND METABOLISM (Practical)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 3 rd Sem
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Course Title: MICROBIAL PHYSIOLOGY AND METABOLISM (Practical)	Subject Code: TIU-UMB-MJ-L21202
Contact Hours/Week: 0-0-1 (L-T-P)	Credit: 1

COURSE OBJECTIVE :

Enable the student to:

1. To understand different methods of measuring bacterial growth.
2. To calculate the generation time and specific growth rate from experimental data.
3. To study how environmental factors influences microbial metabolism and growth.
4. To learn techniques for isolating phototrophic bacteria from environmental samples.

COURSE OUTCOME :

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

CO-1:	Study and plot the growth curve of <i>E. coli</i> by turbidometric and standard plate count methods.	K3
CO-2:	Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data	K3
CO-3:	Understand the effect of temperature and pH on growth of <i>E. coli</i>	K4
CO-4:	Evaluate the presence of carbon, nitrogen and salt sources on growth of <i>E.coli</i>	K3
CO-5:	Demonstration of alcoholic fermentation	K4
CO-6:	Demonstration of the thermal death time and decimal reduction time of <i>E. coli</i> .	K4

COURSE CONTENT :

MODULE 1:	STUDY OF ENVIRONMENTAL FACTORS AFFECTING GROWTH OF MICROBES	15 Hours
1.Study and plot the growth curve of <i>E. coli</i> 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 growth of <i>E. coli</i> 4. Effect of carbon and nitrogen sources on growth of <i>E.coli</i> 5. Effect of salt on growth of <i>E. coli</i> 6. Enrichment of phototrophic bacteria from natural sources		
TOTAL LECTURES		15 Hours**

Course Articulation Matrix:

	PROGRAM OUTCOMES (PO)	PROGRAM SPECIFIC
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													OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	3	3	-	3	-	-	-	2	-	3	2	3	3	2
CO-2	3	3	3	-	3	-	-	-	-	-	3	2	3	3	2
CO-3	3	2	3	-	2	2	-	-	-	-	2	2	3	3	3
CO-4	3	3	3	-	3	2	-	-	-	-	2	2	3	3	3
CO-5	3	2	2	2	3	-	-	-	-	-	2	2	2	3	3
CO-6	3	3	3	-	3	-	-	-	-	-	3	2	3	3	2

MICROBIAL QUALITY CONTROL IN FOOD & PHARMACEUTICAL INDUSTRIES (Theory)

Program: B. Sc. in Microbiology	Year, Semester: 2 nd Yr., 3 rd Sem
Course Title: MICROBIAL QUALITY CONTROL IN FOOD & PHARMACEUTICAL INDUSTRIES (Theory)	Subject Code: TIU-UMB-SEC-T2101
Contact Hours/Week: 2-1-0 (L-T-P)	Credit: 3

COURSE OBJECTIVE :

Enable the student to:

1. To understand Good Laboratory Practices (GLP) and Good Microbiological Practices (GMP) for safe handling of microorganisms.
2. To learn different methods for detecting and quantifying microbes in food and pharmaceutical products.
3. To understand the principles and applications of Hazard Analysis and Critical Control Points (HACCP) for food safety.
4. To study the enrichment culture techniques for isolating food- and waterborne pathogens.

COURSE OUTCOME :

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

CO-1:	Recall key microbial quality control terminology, safety rules, and standard laboratory techniques.	K2
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CO-2:	Explain the role of microbial testing methods and laboratory safety protocols in ensuring product quality.	K4
CO-3:	Demonstrate the ability to apply microbial testing techniques and safety rules in laboratory and industrial settings.	K3
CO-4:	Analyze microbial test results and assess the quality of food and pharmaceutical products.	K3
CO-5:	Evaluate the suitability of different microbial testing methods and laboratory protocols for various products.	K5
CO-6:	Design and implement a microbial quality control program for food or pharmaceutical products.	K6

COURSE CONTENT :

MODULE 1:	MICROBIOLOGICAL LABORATORY AND SAFE PRACTICES	10 Hours
Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets -Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration.		
MODULE 2:	DETERMINING MICROBES IN FOOD / PHARMACEUTICAL SAMPLES	10 Hours
Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products Molecular methods - Nucleic acid probes, PCR based detection, biosensors.		
MODULE 3:	PATHOGENIC MICROORGANISMS OF IMPORTANCE IN FOOD & WATER	15 Hours
Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)		
MODULE 4:	HACCP FOR FOOD SAFETY AND MICROBIAL STANDARDS	10 Hours
Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water		
TOTAL LECTURES		45 Hours**

Books:

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press

Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

Course Articulation Matrix: (to be generated using campus. technology)

	PROGRAM OUTCOMES (PO)												PROGRAM SPECIFIC OUTCOMES (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1	3	-	2	-	-	-	-	-	-	2	2	2	3	2	2
CO-2	3	2	3	-	2	-	-	-	-	3	2	3	3	3	3
CO-3	3	3	3	-	3	-	-	-	2	2	3	3	3	3	3
CO-4	3	3	3	-	3	-	-	-	-	-	2	3	3	3	3
CO-5	3	3	3	2	3	-	-	-	-	-	2	3	3	3	3
CO-6	3	3	3	3	3	-	-	-	2	3	3	3	3	3	3