MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL
(Formerly West Bengal University of Technology)
Syllabus of B. Sc in Microbiology
(Effective from 2023-24 Academic Sessions)

Course Name: Diversity of Environmental Microflora

Mode: Offline **Credits: 5(3T+2P)**

BMMC 2101

Aim of the Course: To acquaint the students with basic concepts of microbial diversity and their significance as environmental microflora.

Course Objectives: The course is aimed to complement the students with the basic knowledge of the structural architecture and differences among Bacteria, Archaebacteria, Algae, Fungi, Protozoawith their significant roles. After successful completion of this course the students are expected to understand the basic morphological, physiological and ecological characteristics of prokaryotes and eukaryotes.The course also includes the structural similarities and differences among various physiological groups of Eubacteria, Archaea and Eukaryotes.

Sl	Graduate attributes	Mapped modules
CO1	The students will be able to get a brief idea on microbial taxonomy, classification and their applications.	**M1**
CO2	The students will be able to understand the morphological, physiological, and ecological diversity of Eubacteria and their economic importance.	**M2**
CO3	The students will be able to get well versed about the microbial aspects (morphological, Physiological, and ecological diversity) pertinent to Algae,Fungi andProtozoa.	**M3**
CO4	The students will be able to comprehend knowledge regarding the morphological,physiological and ecological features of microorganisms to adapt in extreme environment.	**M4**

Learning Outcome/ Skills:

The students should demonstrate fundamental knowledge about the systems of classification and the diverse groups of microorganisms as environmental microflora.Theyshould explain thevarious kinds of prokaryotic & eukaryotic microbes and their interactions.They should be able to discuss the ecological roles and explain the adaptations of Archaebacteria in extreme environments.The students should also assess how the subject emerge as new branch of biology by learning ancient view about life continuity.

Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Systems of Classification	**6**	**15%**	**1,2**	**NA**
M2	Bacterial diversity: Gram negative and Gram-positive Eubacteria,Cyanobacteria	**13**	**25%**	**1,2,3**	**NA**

M3	Diversity of Eukaryotes: Algae,Fungi,Protozoa	**14**	**35%**	**1,2,3**	**NA**
M4	Microbes in Extreme Environment: Archaebacteria	**12**	**25%**	**1,2,3**	**NA**
Total Theory		**45**	**100**		
Practical		**30**			
TOTAL		**75**			

Detailed Syllabus

Module 1: Systems of classification

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

(Total Hours :6)

Module 2:Bacterial diversity

Eubacteria: Morphology, ecological significance and economic importance of following groups:
Gram Negative:
Non proteobacteria: General characteristics with suitable examples.
Alpha proteobacteria: General characteristics with suitable examples.
Beta proteobacteria: General characteristics with suitable examples.
Gamma proteobacteria: General characteristics with suitable examples.
Delta proteobacteria: General characteristics with suitable examples.
Epsilon proteobacteria: General characteristics with suitable examples.
Zeta proteobacteria: General characteristics with suitable examples.
Gram Positive:
Low G+ C (Firmicutes): General characteristics with suitable examples.
High G+C (Actinobacteria): General characteristics with suitable examples.
***Cyanobacteria*:** An Introduction.

(Total Hours :13)

Module 3:Diversity of Eukaryotes

Algae:
History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic lifecycles.

Fungi:
Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements,fungal cell ultra-structure, thallus organization and aggregation, fungal wall structure and synthesis,asexual reproduction,

sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Protozoa:
General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

(Total Hours :14)

Module 4: **Microbes in Extreme Environment**

Archaebacteria: General characteristics, phylogenetic overview, economic importance of genera. Classification of Archea: Crenarchaeota (*Sulfolobus*, *Thermoproteus*) Euryarchaeota Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), Halophiles (*Halobacterium, Halococcus*) and Nanoarchaeota (*Nanoarchaeum*).

(Total Hours: 12)

PRACTICAL

Paper Name: Lab on Diversity of Environmental Microflora

BMMC 2191
Credit: 2

Total Hours: 30
BMMC-2191

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Preparation of different media: Nutrient agar, Complex media- McConkey agar, EMB agar. YEPD Agar, Sabouraud's Chloramphenicol agar, synthetic media BG-11
2. Isolation of pure cultures of bacteria by streaking, spreading, pore plate method.
3. Identification of bacteria through colony morphology.
4. Motility by hanging drop method.
5. Staining: Simple staining, Negative staining, Gram's staining, Acid fast staining-permanent slide only. Capsule staining, Endospore staining. Fungal staining by LCB.
6. Identification of fungus through microscopic observation.
7. Preservation of microbial cultures by various techniques.

Suggested Readings:

1. Atlas RM. (1997).Principles of Microbiology.2nd edition.WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and MartinkoJM.(2014). Brock Biology of Micro-organisms.14th edition. Parker J.Prentice Hall International, Inc.
4. PelczarJr MJ, Chan ECS, and Krieg NR.(2004). Microbiology.5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th editionMcMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition PearsonEducation.
8. Willey JM, Sherwood LM, and Woolverton CJ.(2013). Prescott's Microbiology.9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.PearsonEducation Limited

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Course Name: Microbial Physiology & Biochemistry

Mode: Offline **Credits: 5(3T+2P)**
BMCC 2102

Aim of the Course: To familiarize students with concepts of various physiological & biochemical aspects of microbial world.

Course Objectives: The course is intended to impart fundamental knowledge on different physiological and biochemical parameters in relation to microbial metabolisms. This course also encourage to complement the students with basic concepts of bioenergetics and enzyme kinetics for better understanding of energetically favorable biochemical reactions and their rate quantification. After successful completion of this course students are expected to develop better understanding on various microbial growth patterns and nutritional factors that diversify microbial metabolism and related physiology.

Sl. No.	Graduate attributes	Mapped modules
CO1	This course will help the students to develop basic concepts on the structures and functions of biomolecules of the living systems including Carbohydrates, Proteins, Lipids, Nucleic acids, Amino acids along with their metabolisms.	**M1**
CO2	This course will familiarize the students with the enzyme biochemistry of the living systems. This is essential to learn functional mechanism, kinetics, and regulation of microbial enzymes. It will help to evaluate and quantify the enzymatic activity related to microbial metabolism.	**M2**
CO3	This course will enable students to build the perception on thermodynamic principles relating to basic metabolic pathways of the living systems. It will help to learn student that how bioenergetics play critical role to maintain metabolic activity of organisms.	**M3**
CO4	This course will provide students in-depth knowledge on various growth patterns and related metabolic activities of microorganisms, growth quantification process through kinetics study and nutrition dependent metabolic diversification of microbes.	**M4**
CO5	This course will help students to understand the detail mechanisms of cellular transportation and nutrient uptake process in microbial system.	**M5**
CO6	This course will acquaint the students with diverse aerobic respiratory pathways of chemoheterotrophic microorganisms.	**M6**
CO7	This course will facilitate students with the detailed idea of different metabolic pathways related to anaerobic respiration and fermentation conducted by chemoheterotrophic microorganisms.	**M7**
CO8	This course introduce students with various mode of metabolic activity associated with chemolithotrophic and phototrophic microorganisms.	**M8**

Learning Outcome/ Skills:

The students should demonstrate fundamental knowledge about the structural, functional and metabolic aspects of macromolecules, significance of energy reach metabolic compounds and thermodynamics behind biochemical reactions. They should be able to quantify microbial growth parameters and solve problems related to enzyme kinetics. Moreover student should be able to develop better understanding on diverse biochemical pathways based on nutritional, metabolic and physiological pattern of microorganisms.

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Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Macromolecules: cellular building blocks and their metabolic role	**5**	**10**	**1,2**	**NA**
M2	Structure and function of enzymes and concepts related to enzyme kinetics	**6**	**10**	**1,2,3**	**NA**
M3	Concept of thermodynamics and energy rich compound related to microbial physiology	**5**	**10**	**2,3,4**	**NA**
M4	Microbial growth pattern and kinetics; Nutritional diversity of microorganism.	**4**	**15**	**1,2,3**	**NA**
M5	Diverse nutrient uptake and cellular membrane transport system	**3**	**10**	**1,2,3**	**NA**
M6	Aerobic respiratory pathways of chemoorganotrophic microorganisms.	**8**	**15**	**2,3,4**	**NA**
M7	Anaerobic respiratory pathways and fermentation of chemoorganotrophic microorganisms.	**6**	**15**	**2,3,4**	**NA**
M8	Metabolism pathways of diverse groups of chemo-lithotrophic and phototrophic microorganisms.	**8**	**15**	**2,3,4**	**NA**
Total Theory		**45**	**100**		
Practical		**30**			
TOTAL		**75**			

Detailed Syllabus:

Module 1: Biomolecules

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses.
Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure andfunctions. Essential fatty acids, Triacylglycerol structure, functions and properties. 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.

(**Total Hours: 5)**

Module 2:Microbial Enzymes

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, enzyme unit, specific activity and turnover number Km, and allosteric mechanism. Effect of pH and temperature on enzyme activity.

Total Hours: 6

Module 3: Bioenergetics

Definitions of Gibb's Free Energy, enthalpy, 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- Bis-phosphoglycerate, Thioesters, ATP.
Total Hours: 5

Module 4: Microbial Growth and Nutrition

Definitions of growth, measurement of microbial growth, Batch culture kinetics, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve.
Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, Photolithoautotroph, Photo-organoheterotroph.

Total Hours: 4

Module 5: Nutrient Uptake and Transport

Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation Iron uptake.
Total Hours: 3

Module 6: Metabolisms

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.

Total Hours: 8

Module 7: Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation

Anaerobic respiration with special reference to Nitrification, Denitrification, Dissimilatory nitrate reduction to ammonium.

Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Total Hours: 6

Module 8: Chemolithotrophic and Phototrophic Metabolism

Introduction to aerobic and anaerobic chemolithotrophywith an example each. Hydrogen oxidation (definition and reaction) and Methanogenesis - methanotrophy and methylotrophy (definition and reactions).Oxidation of reduced Sulphur compounds, Sulphate reduction.
Introduction to phototrophic metabolism - groups of phototrophic microorganisms,
Anoxygenic*vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and Cyanobacteria.
Total Hours: 8

PRACTICAL

Paper Name- Lab on Microbial Physiology & Biochemistry

Credit: 2

Total Hours: 30
BMCC 2192

(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Detection of amino acids- Ninhydrin reaction.
2. Estimation of protein by Folin Lowry method.
3. Qualitative analysis of carbohydrate by Molisch's test.
4. Study and plot the growth curve of *E. coli* by turbidometric method.
5. Estimation of CFU count by spread plate method/pour plate method.
5. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
6. Effect of carbon and nitrogen sources on growth of *E.coli.*
7. Effect of temperature, pH on growth of *E. coli.*
8. Effect of salt on growth of *E. coli.*
9. Estimation of Alkaline phosphatase from bacterial cell.
10. Study of lactic acid production by *Lactobacillus* sp.

Suggested Readings:

1. Madigan MT, and Martinko JM (2014).Brock Biology of Microorganisms.14th edition.PrenticeHall 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.
7. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.