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)

FOURTH SEMESTER

Course Name: Microbial Genetics

Mode: Offline **Credits: 4**

BMMC 4201

Aim of the Course: The aim is to achieve basic knowledge about mutations in DNA, different types of plasmids and their roles in genetic information exchange, transformation, conjugation and transduction of genetic material, Phage genetics and role of transposable elements in microbial genetics.

Course Objectives: The course is aimed to build knowledge in fundamentals of microbial genetics and the underlying mechanisms of it. To impart basic knowledge about mutations in DNA, different types of plasmids and their roles in genetic information exchange, Phage genetics and role of transposable elements in microbial genetics. To acquaint students with the procedure of gene mutation, conjugation, transformation.

Sl. No.	Graduate attributes	Mapped modules
CO1	The student will get an introduction to the discipline of microbial genetics with details of DNA mutation	**M1**
CO2	The student will get a concept of different types of plasmids and their roles in genetic information exchange	**M2**
CO3	The students will get a clear concept on DNA damage, repair, transformation, conjugation, transduction	**M3**
CO4	The students will get a clear concept on details about phage genetics in lytic and lysogenic cycles	**M4**
CO5	The students will get a clear concept on the procedure of transposition and mobile genetic materials	**M5**

Learning Outcome/Skills: To impart basic knowledge about the following

- mutations in DNA
- different types of plasmids
- transformation, conjugation and transduction
- Phage genetics
- transposable elements

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Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Mutations in DNA	**10**	**18**	**1,2,3**	**NA**
M2	Types of plasmids and their role in exchange of genetic material	**10**	**18**	**1,2,3,4**	**NA**
M3	Mechanism of genetic exchange by transformation, conjugation, transduction	**15**	**24**	**1,2,3,4**	**NA**
M4	Phage genetics in lytic and lysogenic cycle	**15**	**22**	**1,2,3,4**	**NA**
M5	Transposable elements	**10**	**18**	**1,2,3,4**	**NA**
Total Theory		**60**	**100**		
TOTAL					

Detailed Syllabus

Module 1:

Genome Organization and Mutations:

Structural organization: of E. coli, Saccharomyces, Archeal genome. Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of Mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.

(Total Hours: 10)

Module 2:

Plasmids

plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

(Total Hours:10)

Module 3:

Mechanisms of Genetic Exchange

DNA as a genetic material: Griffith experiment of Transformation, Avery, MacLeod and McCarty experiment, Hershey and Chase experiment to prove DNA carries the genetic information. Fraenkel-Conrat experiment to prove RNA as genetic material. Structure and organization of chromosomes in prokaryotes. Plasmid-types, Transposons in Prokaryotes.

Bacterial transformation: Principle and Types of transformation mechanisms found in prokaryotes. Bacterial Conjugation: U-tube experiment, properties of the F plasmid, F + x F - conjugation, F′ x F - conjugation, Hfr x F - conjugation, Transduction: Generalized and specialized transduction

(Total Hours: 15)

Module 4:

Genetics of Viruses and Fungi:

Genetics of viruses: Stages in the Lytic Life Cycle of a typical phage, Properties of a phage infected bacterial culture, Specificity in phage infection, E. coli PhageT4, T7, ϕX 174 E.coli phage lambda, Immunity to infection, Prophage integration, Induction of prophage, Induction & Prophage excision, Repressor, Structure of the operator and binding of the repressor and the Cro product, Decision between the lytic and lysogenic Cycles
Genetics of Fungi: Life cycle of Neurospora, Terad analysis, unordered tetrad analysis in yeast, ordered tetrad analysis in Neurospora, two point and three point test cross.

(Total Hours:15)

Module 5:

Transposable elements:

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition

(Total Hours:10)

Suggested Readings:

1. Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

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Course Name: Bio-analytical Tools

Mode: Offline **Credits: 4**

BMMC- 4202

Aim of the Course: To acquaint students with different essential bio-analytical tools

Course Objectives: To impart basic knowledge about the bio-analytical tools and principles of centrifugation, microscopy, spectroscopy, chromatography, X-ray crystallography and other different tools.

Sl	Graduate attributes	Mapped modules
CO1	The student will get an introduction to the Principle, types and applications of Different microscopy	**M1**
CO2	The students will get a clear concept on the Principle, types and applications of Absorption spectroscopy	**M2**
CO3	The student shall get a concept of the Principle, types and applications of centrifugation	**M3**
CO4	To acquaint students with the details about concepts of the Principle, types and applications of chromatography	**M4**
CO5	The student shall be master to know the Principle, types and applications of spectrometry	**M5**
CO6	The student will get an introduction to the Principle, and applications of X-ray crystallography	**M6**
CO7	The student shall get a concept of the Principle and applications of NMR spectroscopy	**M7**

Learning Outcome/Skills: To impart basic knowledge about the following

- Principle, types and applications of Different microscopy
- Principle, types and applications of Absorption spectroscopy
- Principle, types and applications of Centrifugation
- Principle, types and applications of Spectrometry
- Principle, types and applications of Chromatography
- Principle, and applications of X-ray crystallography
- Principle and applications of NMR spectroscopy

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Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Microscopy Techniques	**8**	**13**	**1,2, 3, 4**	**NA**
M2	Absorption spectroscopy	**9**	**16**	**1,2,3, 4**	**NA**
M3	Centrifugation	**8**	**13**	**1,2,3,4**	**NA**
M4	Chromatography	**9**	**16**	**1,2,3,4**	**NA**
M5	Spectrometry	**8**	**13**	**1,2,3,4**	**NA**
M6	X-ray crystallography	**9**	**15**	**1,2,3,4**	**NA**
M7	NMR spectroscopy	**9**	**14**	**1,2,3,4**	**NA**
Total Theory		**60**	**100**		
	TOTAL	**60**			

Detailed Syllabus

Module 1:

Microscopy Techniques

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter

(Total Hours: 8)

Module 2:

Absorption spectroscopy

Absorption Spectroscopy – Simple theory of the absorption of light by molecules, Beer-Lambert law, Instrumentation for measuring the absorbance of visible light, Factors affecting the absorption properties of a Chromophore. Principle of absorption fluorimetry,

(Total Hours: 9)

Module 3:

Centrifugation

Centrifugation – Basic Principle of Centrifugation, Instrumentation of Ultracentrifuge (Preparative, Analytical), Factors affecting Sedimentation, Standard Sedimentation Coefficient, Rate-Zonal centrifugation, sedimentation equilibrium Centrifugation. Cell fractionation techniques, isolation of sub-cellular organelles and particles.

(Total Hours: 8)

Module 4:

Chromatography

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC. Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting.

(Total Hours: 9)

Module 5:

Spectrometry

Mass spectrometry (MALDI, ESI) and Introduction to Biosensors and Nanotechnology and their applications. Radioactive labeling & counting, Autoradiography.

(Total Hours: 8)

Module 6:

X-ray crystallography

X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure [concept of rotating crystal method, powder method].

(Total Hours: 9)

Module 7:

NMR spectroscopy

NMR Spectroscopy – Basic principle of NMR spectroscopy, Experimental technique & instrumentation, Chemical shift, hyperfine splitting, Relaxation process.

(Total Hours: 9)

Suggested Readings:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E. D. P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM, Press & Sunderland, Washington, D. C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009
5. Uma Devi Koduru, General Biology, Khanna Publishing House, 2023.
6. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

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Course Name: Environment Microbiology

Mode: Offline **Credits: 3**

BMMC- 4203

Aim of the Course: To acquaint students with the concept of Environment Microbiology

Course Objectives: To impart basic knowledge and principles of Environment Microbiology and their interaction , Biogeochemical Cycling, Microbial bioremediation, Waste management & water portabability

Sl	Graduate attributes	Mapped modules
CO1	The student will get an introduction to the types and applications of Microbiology habitat	**M1**
CO2	The students will get a clear concept on the Microbial interaction	**M2**
CO3	The student shall get a concept of the Biogeochemical Cycling	**M3**
CO4	To acquaint students with the details about concepts and the types of Waste Management	**M4**
CO5	The student shall be master to know the principle, types and applications of Microbial bioremediation	**M5**
CO6	The student will get an introduction to the safety regulation of water portability	**M6**

Learning Outcome/Skills: To impart basic knowledge about the following

- Different types and applications of Microbiology habitat
- Different types and applications of Microbial interaction
- Principle, and application of Biogeochemical Cycling
- Principle, types and applications of Waste Management
- Principle, types and applications of Microbial Bioremediation
- Principle, and applications of Water Portability

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Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any
THEORY					
M1	Microorganism and their habitats	**16**	**19**	**1,2, 3, 4**	**NA**
M2	Microbial Interaction	**10**	**16**	**1,2,3, 4**	**NA**
M3	Biogeochemical Cycling	**14**	**14**	**1,2,3,4**	**NA**
M4	Waste Management	**7**	**16**	**1,2,3,4**	**NA**
M5	Microbial Bioremediation	**8**	**17**	**1,2,3,4**	**NA**
M6	Water portability	**5**	**18**	**1,2,3,4**	**NA**
Total Theory		**60**	**100**		
	TOTAL	**60**			

Detailed Syllabus

Module 1:

Microorganisms and their Habitats

Terrestrial Environment: Soil profile and soil microflora
Aquatic Environment: Microflora of fresh water and marine habitats
Atmosphere: Aeromicroflora and dispersal of microbes
Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.
Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter

(Total Hours: 16)

Module 2:

Microbial Interactions

Microbe interactions: Mutualism, synergism, commensalism, competition, predation
Microbe-Plant interaction: Symbiotic and non-symbiotic interactions
Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria.
(**Total Hours: 10)**

Module 3:

Biogeochemical cycling

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin
Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction.
Phosphorus cycle: Phosphate immobilization and solubilisation
Sulphur cycle: Microbes involved in sulphur cycle
Other elemental cycles: Iron and manganese.

(Total Hours: 14)

Module 4:

Waste management

Solid waste management: sources & types of solid waste, methods of solid waste disposal (Composting and sanitary landfill), Electronic Waste Source and Component, E-waste management strategy .
Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, Secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary Sewage treatment .
(Total Hours: 7)

Module 5:

Microbial Bioremediation

Principle and types of bioremediation.
Overview on microbial bioremediation of inorganic matter (metals) and biodegradation of common organic pollutants (pesticides, hydrocarbons, and, biosurfactants).

(Total Hours: 8)

Module 6:

Water potability

Treatment and safety of drinking water, methods to detect potability of water samples: a) Standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests **(Total Hours: 5)**

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA

2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings

3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press

4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York

5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.

9. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.

10. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.

11. Chakraborty S (2022)Electronic Waste :A growing Concern in Environment . New Delhi Publishers

BMMC- 4203: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)

TOTAL HOURS: 40 **CREDITS: 2**

1. Analysis of soil – pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of Rhizobium from root nodules.
8. Isolation of Phosphate solubilising Bacteria