VANITA VISHRAM WOMEN'S UNIVERSITY

SCHOOL OF SCIENCES

DEPARTMENT OF MICROBIOLOGY

BACHELOR OF SCIENCE (B.Sc.) HONOURS MICROBIOLOGY PROGRAMME

under Learning Outcomes-based Curriculum Framework (LOCF) for Under Graduate (UG) Education

SEMESTERS 4

Core Courses (CC), Discipline Specific Elective (DSE), Skill Enhancement Course (SEC), Generic Elective Courses (GE), Ability Enhancement Compulsory Courses (AECC)

Syllabus applicable to the students seeking admission in the B.Sc.- Microbiology (Honours)

under LOCF

w.e.f. the Academic Year 2022-2023

CORE COURSE PAPER 8

MB11150 MICROBIAL GENETICS		
Course Objectives: Understanding genome organization, understanding mutation, methods of genetic material transfer among bacteria, understanding plasmid and its nature. Laboratory course is also designed in accordance with theory to affirm the understanding of concepts of microbial genetics.		
Course learning outcomes: By the conclusion of this course, the students have - **Outcome 1**. Understood genome organization of model organisms namely *E.coli* and *Saccharomyces,* and the molecular mechanisms that underlie mutations. **Outcome 2**. Developed a fairly good knowledge about the three well-known mechanisms by which genetic material is transferred among the microorganisms namely transformation, transduction and conjugation. **Outcome 3**. Can describe different types of the extrachromosomal elements or the plasmids; the nature of the transposable elements in the prokaryotic and the eukaryotic cells. **Outcome 4.** Hands-on skills of isolation of plasmid DNA from bacterial cells and its visualization by performing agarose gel electrophoresis.		
THEORY COURSE **(4 Credits)**		
Unit-1	Genome organization: *E. coli, Saccharomyces, Tetrahymena*. 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 Intergenic suppression; Ames test; Mutator genes. Concept of microbial epigenetics. Neurospora as model organism in study of genetics.	**15 Lectures**
Unit-2	Microbial Genetics: **Transformation**- discovery, Griffith's experiment, mechanism of transformation; Factors affecting transformation process, Competence and development of competence in *S. Pneumonia.* **Transduction** – discovery, Lederberg and Tatum's experiment, mechanism and types of transductions- Generalized transduction, Specialized transduction, Sexduction and abortive transduction.	**15 Lectures**
Unit-3	**Conjugation**- discovery, experimental evidence, F-factor, F^+ & Hfr, mechanism of conjugation, Cross between Hfr, F^+&F^-Conjugant and its application. Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda.	**15 Lectures**
Unit-4	**Types of plasmids** – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, Plasmid replication and partitioning, Host range, plasmid incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids. **Prokaryotic transposable elements** – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Eukaryotic	**15 Lectures**

	transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds).	

LAB. COURSE: MB11160 PRACTICAL VIII
(2 Credits)

1. Preparation of Master and Replica Plates.
2. Study the survival curve of bacteria after exposure to ultraviolet (UV) light.
3. Isolation of Plasmid DNA from *E.coli.*
4. Study different conformations of plasmid DNA through agarose gel electrophoresis (Demonstration).
5. Demonstration of bacterial conjugation.
6. Demonstration of bacterial transformation and transduction.

Reference Books

1. Benjamin Lewin, Gene VII, Oxford University Press, (2000).
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Molecular biology of the Cell, 4th Edition. Garland publishing Inc. (2002).
3. Darnel l, Lodish and Baltimore, Molecular Cell Biology, Scientific American Publishing Inc. (2000).
4. Watson. J.D, Baker. T.A, Bell. S.P, Gann. A. Levine. M. Losick. R, Molecular Biology of Gene, 5th Edition. The Benjamin/Cummings Pub. Co. Inc. (2003).
5. Brown T.A., Gene Cloning and DNA analysis. 2nd Edition, ASM press. (2004).
6. Sandy Primrose. Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers. (2006).
7. Gardner E J, Simmons M J and Snustad DP, Principles of genetics, 8th edition John Wiley & Sons, (2006).
8. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Angelika Amon; Kelsey C. Martin, Stephen C. Harrison. Molecular Cell biology. Macmillan Higher Education
9. David Freifelder. Essentials of molecular biology. Jones and Bartlett Publishers, 1998

CORE COURSE PAPER 9

MB11170 MICROBIAL PHYSIOLOGY & METABOLISM

Course Objectives: Objectives of the course include; understanding concepts related to microbial growth in vitro condition, nutritional types of microorganisms, extremophiles and their adaptations, nutrient transport in microorganisms, various metabolic pathways of aerobes and anaerobes, some of the characteristic aerobic and anaerobic metabolic reactions of microbes occurring in nature. Laboratory course is designed with objectives of studying the growth curve, effect of environmental conditions on bacterial growth & understanding concept of TDP & TDT.

Course learning outcomes: By the conclusion of this course, the students are capable of -

Outcome 1. Describing the growth characteristics of the microorganisms capable of growing under unusual environmental conditions of temperature, oxygen, and solute and water activity.

Outcome 2. Describing the growth characteristics of the microorganisms which require different nutrients for growth and the associated mechanisms of energy generation for their survival like autotrophs, heterotrophs, chemolithoautotrophs etc.

Outcome 3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms.

THEORY COURSE
(4 Credits)

Unit-1	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.	**15 Lectures**
Unit-2	Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake	**15 Lectures**
Unit-3	Overview of metabolism, Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain, phosphorylation, uncouplers and inhibitors. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways	**.15 Lectures**
Unit-4	Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Anaerobic respiration with special reference to assimilatory and dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Introduction to biological nitrogen fixation & ammonia assimilation. Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and Cyanobacteria.	**15 Lectures**

LAB. COURSE: MB11180 PRACTICAL IX
(2 Credits)

1. Preparation of growth curve of *E.coli* by turbidimetric method.
2. Preparation of growth curve of *E.coli* by standard plate count methods.
3. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
4. Effect of temperature on growth of *E.coli.*
5. Effect of pH on growth of *E.coli.*
6. Effect of carbon and nitrogen sources on growth of *E.coli.*
7. Effect of salt on growth of *E.coli.*
8. Demonstration of the thermal death time and decimal reduction time of *E.coli.*

Reference Books

1. Stanier, Ingraham, Wheelis and Painter. The Microbial world. McMillan Educational Ltd., London.
2. Moat and Foster, Microbial Physiology. Wiley.
3. Umbreit. Essentials of Bacterial Physiology.
4. Skokatch. Bacterial Physiology and Metabolism.
5. Kushner, D.J. Microbial life in Extreme Environments. Academic Press.
6. Pawar. C.B. Cell Biology.
7. Franklin and Snow, Biochemistry of Antimicrobial Action. Chapman and Hall, N.York.
9. Philipp. G. Manual of Methods for General Bacteriology.
10. David T. Plummer. An Introduction to Practical Biochemistry.
11. Subba Rao, N.S. Soil Microorganisms and Plant Growth.
12. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
13. Willey, Sherwood, Woolverton. Prescott, Harley, and Klein's Microbiology McGraw-Hill publication
14. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cummings.
15. JACQUELYN G. BLACK. Microbiology Principles and explorations. JOHN WILEY & SONS, INC.
16. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of Microorganisms. Pearson
17. Eugene W. Nester, Denise G. Anderson, C. Evans Roberts, Martha T. Nester. Microbiology, a Human Perspective, 6th Edition, McGRAW-HILL

CORE COURSE PAPER 10

MB11190 MICROBIAL ECOLOGY & ENVIRONMENTAL MICROBIOLOGY

Course Objectives: Students will be able to know about microbial ecology, biogeochemical cycling, several biological interactions of microbes, environmental microbiology, and microbial role in solid waste management, bioremediation, water potability and microbiological tests to determine the same. Lab course is designed with objectives of isolation of microbes from soil, rhizosphere, rhizoplane and root nodules, presence of microbial activity in by detecting enzymes, portability of drinking water and testing for the same and assessment of COD-BOD of

waste water.		
Course learning outcomes: By the completion of this course, the students - **Outcome 1**. Have developed a fairly good knowledge and understanding of different types of environments and habitats where microorganisms grow including the microbiomes of the human gut and animal gut. **Outcome 2**.Have understood the significant activities of microorganisms in sewage treatment plants and solid/liquid wastes management. **Outcome 3.** Have developed the practical skills for conducting experiments to assess the BOD/COD of wastewaters and their interpretation; practically assess the portability of drinking water by the use of standard microbiological tests		
THEORY COURSE **(4 Credits)**		
Unit-1	History, significance and developments in the field of microbial ecology. Microbial succession in decomposition of plant organic matter. Carbon cycle, Nitrogen cycle, Phosphorus cycle,. Sulphur cycle, Microbial role in mobilization of Iron and manganese.	**15 Lectures**
Unit-2	Biological Interaction: A. Microbe– Microbe Interactions- Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents. B. Microbe–Plant Interactions Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers) C. Microbe-Animal Interactions - Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont.	**15 Lectures**
Unit-3	**Environmental microbiology**: Soil profile and soil microflora. Aquatic Environment: Microflora of freshwater and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes. Animal Environment: Microbes in/on human body (microbiomics) & animal (ruminants)body. **Solid Waste management**: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). 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. Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants.	**15 Lectures**
Unit-4	Treatment and safety of drinking (potable) 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.	**15 Lectures**
LAB. COURSE: MB11200 PRACTICAL X **(2 Credits)**		
1. Isolation of microbes (bacteria & fungi) from soil (28ºC&45ºC).		

2. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
3. Isolation of *Rhizobium* from root nodules.
4. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease etc.) in soil.
5. Assessment of microbiological quality of water through detection of coliforms.
6. Determination of BOD & COD of wastewater sample.

Reference Books

1. Medigan, M.T., Martinko, J. M. and Parker, J. Brock Biology of Microorganisms. Pearson Education Inc. , New York
2. Pelczar, MJ Chan ECS and Krieg NR, Microbiology McGraw-Hill.
3. Willey,Sherwood,Woolverton. Prescott,Harley, and Klein's Microbiology McGraw-Hill publication
4. Tortora, Funke, Case. Microbiology. Pearson Benjamin Cummings.
5. JACQUELYN G. BLACK. Microbiology Principles and explorations. JOHN WILEY & SONS, INC.
6. Madigan, Martinko, Bender, Buckley, Stahl. Brock Biology of Microorganisms. Pearson