VANITA VISHRAM WOMEN'S UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF MICROBIOLOGY

MASTER OF SCIENCE (M.Sc.) MICROBIOLOGY PROGRAMME
under Learning Outcomes-based Curriculum Framework (LOCF)
for Post Graduate (PG) Education

SEMESTERS 1
Core Courses (CC)

Syllabus applicable to the students seeking admission in the M.Sc.- Microbiology
under LOCF
w.e.f. the Academic Year 2023-2024

1. Preamble – VVWU

Vanita Vishram Women's University (VVWU) is the First-ever Women's University of Gujarat approved by the Government of Gujarat under the provisions of the Gujarat Private Universities Act, 2009. It is a University committed to achieve Women's Empowerment through Quality Education, Skill Development, and by providing employment opportunities to its girl students through its model curriculum, integration of technology in pedagogy and best-in-class infrastructure. The focus is on prioritizing practical component and experiential learning supported through academia-industry linkages, functional MoUs, skill development training, internships etc. It aims at providing opportunities to the girl students for holistic development and self-reliance.

VISION

Empowerment of women through quality education and skill development, so as to make them strong pillars of stability in the society.

MISSION

To provide Education & Professional Training to all women for their all-round development, so as to enable them to become economically independent and socially empowered citizens.

2. Introduction of the Programme:

The M.Sc. Microbiology programme offered by VVWU is of two years' duration and is divided into four semesters. The various courses of the programme are designed to include classroom teaching and lectures, laboratory work, project work, viva, seminars, assignments and field trips.

Three categories of courses are being offered in this programme: Core Courses (twelve mandatory courses offered by the Department) and Department specific Elective Courses (student must opt for three out of four Elective Courses offered by the Department). One general elective paper is offered in semester 2 which student. It could be a Core Paper from other departments or could be a General Elective Paper like IPR or some General Component. The Core Courses are of five/eight credits and include classroom as well as laboratory courses. Whereas, the Elective Courses are of four credits. In all the courses one credit is devoted to self leaning outside classroom. A separate research-based course that leads to a dissertation and is worth twelve credits is also one of the Core Courses. The student is required to accumulate different credits as shown in table in each semester, a

total of 116 credits, to fulfil the requirements for a Master of Science degree in Microbiology.

Thirty percent of the total marks for each course will be awarded through Internal Assessment. Final examinations for four credit courses will be of three hours duration while examinations for each laboratory-based course will be held over two days of eight hours each or four hours each for eight credits or four credit courses respectively.

The curriculum is designed to train the students in basic and advanced areas of Microbiology, keeping in mind the latest advances in the field. Particular emphasis is laid on the practical aspects of the field. Students are taught how to plan experiments, perform them carefully, analyze the data accurately, and present the results both, qualitatively and quantitatively. To enable them to develop speaking and presentation skills they are encouraged to deliver seminars on a wide range of topics covering the different areas of Microbiology. This also leads them into reading about different themes and enhances their assimilation abilities. A major component of their course is a research project they work on in their final semester. The student is guided in choosing a research problem, executing experiments related to it, collecting data and analyzing it, and presenting the results in the form of an oral presentation as well as a dissertation. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently. At the end of the programme the student will be well-versed in basic microbiology as well as be familiar with the most recent advances in microbiology, and will have gained hands-on experience in microbiology, including fermentation technology and molecular biology techniques. The student will be able to design a short research problem and plan and execute experiments to investigate the problem, as well as analyze and present the results obtained both qualitatively and quantitatively. The student will be able to take up a suitable position in academia or industry, and will be equipped to pursue a career in research if so desired.

3. Programme Specific Objectives:

1. **Major objectives of this program for students are:**

a. **Knowledge acquisition and probing the future**: gathers in-depth knowledge of basic and applied areas of microbiology acquiring which students may opt for higher studies or join industry, academia, public health etc. and play their role as microbiologists in a useful manner contributing their role in the development and welfare of the society

b. **Core microbiology laboratory skills attainment**: understands various methods of safe handling, culturing and storage of microorganisms in the laboratory.

c. **Realization of Interdisciplinary approach of Microbiology**: becomes aware of the role of microbiology in interdisciplinary research as well as in daily life.

d. **Apprehending Environmental literacy**: develops a basic understanding of the microbiological principles that that have environmental implications and gains an awareness of regulatory requirements and their compliance in biotechnology and microbiological research.

e. **Field Exposure & awareness of Ethics**: acquires an awareness of work environment through training placements, field trips, expert talks, interaction with entrepreneurs etc. and be familiarized with ethics and ethical issues in scientific research, biosafety, Intellectual Property Rights etc.

4. Programme Specific Outcomes:

2. A candidate who is conferred a M.Sc. degree in microbiology needs to have acquired/developed following competencies during the programme of the study:

a. Acquired knowledge and understanding of the microbiology concepts as applicable to diverse areas such as medical, industrial, environment, genetics, agriculture, food and others.

b. Demonstrate key practical skills /competencies in working with microbes for study and use in the laboratory as well as outside, including the use of good microbiological practices.

c. Explain why microorganisms are ubiquitous in nature; inhabiting a multitude of habitats and occupying a wide range of ecological habitats, their role in these ecological niches, influence of microbiome on our health, environmental clean-up, variety of industrial product development, and their significance in human wellbeing.

d. Competent enough use microbiology knowledge and skills to analyze problems involving microbes, learning use of microbes as a model-organisms to understand facts about living systems, analyze the genetic makeup of different types of microbes, articulate these with peers/ team members/other stakeholders through effective communication, and undertake remedial measures /studies etc.

e. Developed a broader perspective of the discipline of Microbiology to enable him to identify challenging societal or global, economical, environmental, energy related and other problems and plan his professional career to develop innovative solutions for such problems.

5. Structure of the Programme:

CREDITSTRUCTURE FOR PG PROGRAMMES (M.Sc.)

Semester 1	Credits	Semester 2	Credits	Semester 3	Credits	Semester 4	Credits
CC1 MB21200	4	CC 5 MB21260	4	CC9 MB21320	4	CC 11 MB21360	4
CC2 MB21210	4	CC 6 MB21270	4	CC10 MB21330	4	CC 12 MB21370	4
CC3 MB21220	4	CC 7 MB21280	4			DE 3 (Group 2) MB24050/ MB24060	4
CC4 MB21230	4	CC 8 MB21290	4	DE 1 (Group 1) MB24010/ MB24020	4	Dissertation MB21380	16
CC Practical MB21240	4	CC Practical MB21300	4	DE 2 (Group 1) MB24030/ MB24040	4		
CC Practical MB21250	4	CC Practical MB21310	4	CC Practical MB21340	4		
				CC Project MB21350	4		
Total Credits	24		24		24		28
Total Credits of Four semester			100				

- 1 Credit Theory = 1 hour
- 1 Credit Practical = 2 hours
- Theory Credits = 4

- ✓ **Class Hours = 4**
- ✓ **Expected Learning Hours by students outside the class hours = 2**

- **Practical = 4**
  - ✓ **Class (Lab) Hours = 8**
- **Semester 1 and 2 will have core and practical papers common for all enrolled students.**
- **Semester 3 and 4 will offer subjects of selected specialization as core and elective papers.**
- **Semester 3 offers project and 4 will offer Dissertation for all enrolled students.**

DEPARTMENT ELECTIVES

- **Department of Microbiology offers 3 electives out of which students will choose 1 electives in Semester 3 and 2 elective in Semester 4 to promote choice-based learning of the said specialization through the programme.**

Sr.No.	Name of Papers	Total No. of Papers	Credits	Total Credits
1	Core Course	12	4	48
2	Elective Course (Specialization)	3	4	12
3	Practical/FieldWork/Seminar/Workshop/SDP*	6	4	24
4	Dissertation	--	16	16
Total Credits				100

***Student Development Programme (SDP) & Research Methodology component should be incorporated.**

6. Structure of the Course

Semester I				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
MB21200: Fundamental of Bacteriology	4	0	0	4
MB21210: Microbial Physiology and Metabolism	4	0	0	4
MB21220: Fundamentals of Immunology	4	0	0	4
MB21230: Microbial Pathogenicity	4	0	0	4
MB21240: Practical I	0	4	0	4
MB21250: Practical II	0	4	0	4
Core course 'n' (total number)=4T+2P	16	8	0	24
Total credits in Core Course	**24**			

Semester II				
Number of Core Courses	**Credits in each Core Course**			
Course	Theory	Practical	Tutorial	Credits
MB21260: Environmental Microbiology	4	0	0	4
MB21270: Fermentation Technology	4	0	0	4
MB21280: Industrial Microbiology	4	0	0	4
MB21290: Microbial Genetics	4	0	0	4

MB21300: Practical III	0	4	0	4
MB21310: Practical IV	0	4	0	4
Core course ‘n’ (total number) = 4T+ 2P	16	8	0	24
Total credits in core course	**24**			

Semester III				
Number of core courses	**Credits in each core course**			
Course	Theory	Practical	Tutorial	Credits
MB21320: Molecular Biology	4	0	0	4
MB21330: Recombinant DNA Technology	4	0	0	4
MB21340: Computational Biology	4	0	0	4
MB21350: Practical V	0	4	0	4
MB21360: Project		4		4
Core course ‘n’ (total number) = 3T+2P	12	8	0	20
Total credits in Core Course	**20**			
Number of Department Elective Courses	**Credits in each Elective Course**			
Course	Theory	Practical	Tutorial	Credits
MB24010: Biophysical and Biochemical Methods	4	0	0	4

MB24030: Plant-Pathogen Interactions**	4	0	0	4
Elective course ‘n’(total no) = 1	4	0	0	4
Total credits in Elective Courses	**4**			
** **Student must opt for any One of the Two Elective Courses**				

Semester IV				
Number of Core Courses	**Credits in each Core Course**			
Course	Theory	Practical	Tutorial	Credits
MB21370: Molecular Virology	4	0	0	4
MB21380: Dissertation		16		16
Core course ‘n’ (total number) = 2T+1P	8	16	0	24
Total credits in Core Course	**24**			
Number of Department Elective Courses	**Credits in each Elective Course**			
Course	Theory	Practical	Tutorial	Credits
MB24020: Advance Instrumental Microbiology	4	0	0	4
MB24040: Food Microbiology	4	0	0	4
MB24050: Research Methodology	4	0	0	4

MB24060: Scientific Writing	4	0	0	4
Elective Course ‘n’(total no) = 2T	8	-	-	8
Total credits in Elective Courses	**8**			
Elective will be Two from list of Four subjects				

List of Elective Courses

Department Elective (DE)

1. MB24010: Biophysical and Biochemical Methods
2. MB24020: Advance Instrumental Microbiology
3. MB24030: Plant-Pathogen Interactions
4. MB24040: Food Microbiology
5. MB24050: Research Methodology
6. MB24060: Scientific Writing

MASTER OF SCIENCEMICROBIOLOGY

SEMESTER 1
CORE COURSE PAPER 1

MB21200: Fundamentals of Bacteriology

Course Objectives:

The main objective of the course is to build a strong foundation in the area of bacterial cell structure, reproduction & cell division and bacterial secretion system.

Course learning outcomes: At the conclusion of this course the students -

CO1: Will be able to describe the morphological features, cell arrangement and structural components of bacterial cell.

CO2: Will have learned difference between gram positive and gram negative bacterial cell envelope.

CO3: Will have gathered detailed information about bacterial cell division and endospore formation.

CO4: Understands different secretion systems existing in bacteria for toxins and biomolecules secretion, and their role in bacterial survival and pathogenesis.

THEORY COURSE
(4 Credits)

Unit-1	**Bacterial cell structure and appendages:** Overview of eubacterial cell organization**:** nucleoid, ribosomes, intracytoplasmic membranes and cell inclusions. Detailed account of biogenesis and function of various cell structure appendages: flagella- structure, assembly and mechanism of movement; pili and fimbriae- types, structure and their role. External cell surface structures: capsule, glycocalyx, slime layer and S-layer	**15 Lectures**
Uni-2	**Bacterial cell wall and cell membrane:** Overview of gram negative and gram-positive bacterial cell wall, outer membrane lipopolysaccharide (LPS). Detailed account of cell wall synthesis and its inhibitors including different antibiotics	**15 Lectures**
Unit-3	**Bacterial cell division and reproduction:** Binary fission and other forms of reproduction in bacteria, bacterial cell cycle, assembly, maintenance and disassembly of Z ring, endospore structure and stages involved in endospore development in *Bacillus subtilis.*	**15 Lectures**
Unit-4	**Bacterial secretion system:** Introduction. Sec secretion pathway, SecB secretion pathway, SRP pathway, Tat pathway. Protein secretion in Gram-negative bacteria: Type I TypeVI. Protein secretion in Gram-positive bacteria: Type VII, Sec A2, Sortases and Injectosome. Introduction to Type VIII and Type IX secretion systems. Quorum Sensing.	**15 Lectures**

Reference Books

1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
4. Archaea Molecular and Cellular Biology by Ricardo Cavicchioli. American Society of Microbiology. 2007.
5. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.

SEMESTER 1
CORE COURSE PAPER 2

MB21210: MICROBIAL PHYSIOLOGY AND METABOLISM

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of microbial growth & cell division, nutrient transport mechanism, enzymes & kinetics of enzyme activity, Physiological Adaptation and Intracellular signalling. To develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation.

Course learning outcomes: After completing this course, the students-

CO1: Will be acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.

CO2: Will have gained an in-depth knowledge of primary, secondary and group translocationtransport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.

CO3: Will have learnt basic concepts of enzyme biochemistry, its kinetics and regulation.

CO4: Is conversant with intracellular signalling in bacteria in response to various nutritional and physiological stresses. CO1: Will have gained an in-depth knowledge of central metabolic pathway and their regulation. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.

CO5: Will understand details of lipid and nucleotide metabolism in microorganisms.

CO6: Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also known the role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.

THEORY COURSE
(4 Credits)

Unit-1	**Growth and cell division:** Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.	**18 Lectures**

	Solute Transport: Introduction, primary and secondary transport, kinetics. Membrane transport proteins: porins and aquaporins, mechanosensitive channels, ABC transporter, group translocation PEP-PTS system.	
Uni-2	**Enzymes:** Introduction, activation energy, enzyme kinetics, significance of K_m, catalytic efficiency, turnover number. Methods of plotting enzyme kinetics data: Lineweaver –Burk plot, saturation kinetics. Enzyme inhibition, models and type of inhibition	**12 Lectures**
Unit-3	**Central Metabolic Pathways and Regulation:** Glycolysis and its regulation, Gluconeogenesis, Pentose-Phosphate Pathway, Entner-Doudoroff Pathway, Citric Acid Cycle, alternate TCA, Glyoxylate Pathway and its regulation. **Metabolism of lipids:** Biosynthesis of Lipid, degradation/oxidation of lipids and its regulation in *E. coli*, lipid accumulation in yeast.	**15 Lectures**
Unit-4	**Metabolism of nucleotides:** Purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis. **Nitrogen metabolism:** Inorganic nitrogen assimilation- nitrate and ammonia assimilation, regulation of glutamate synthetase, General reaction of amino acid and Stickland reaction. Glutathione: distribution in bacteria, biosynthesis and role in redox regulation. Outline of amino acid biosynthesis, protein utilization, detailed account of biochemistry of glutamate producing strains.	**15 Lectures**

Reference Books

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA. 1999. 2. Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002

3. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6th Edition. W. H. Freeman. 2012

4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.

5. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.

6. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013

7. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.

8. Understanding Enzymes by T. Palmer, E.Horwood. 3rd Edition. Wiley. 1991.

SEMESTER 1
CORE COURSE PAPER 3

MB21220: FUNDAMENTALS OF IMMUNOLOGY

Course Objectives:

After completing this course, the students can -

The objective of this course is to understand the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body. It would also make the students understand the operational mechanisms which underlie the host defense system, allergy and organ transplantation.

Course learning outcomes:

Upon successful completion of the course, the student:

CO1: Willbe able to understand the fundamental bases of immune system and immune response

CO2: Will be able to gather information about the structure and organization of various components of the immune system

CO3: Will be able to understand the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity

CO4: Will be able to understand the operation and the mechanisms which underlie the immune response

CO5: Will be able to apply the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

THEORY COURSE
(4 Credits)

Unit-1	**Three fundamental concepts in immunology:** Specificity, discrimination of self from non-self and memory. **Immune cell receptors:** Detailed structure and development of B cell (Ig) and T cell (TcR) receptors; Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules; Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); Markers of suppressor / regulatory cells - $CD4^+$ $CD25^+Foxp3^+T_{reg}$, iNKT.	**16 Lectures**
Uni-2	**Genetic organization:** Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2). Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors. Peptide loading and expression of MHC-I and MHC-II molecules; Hybridoma technology and monoclonal antibodies, antibody engineering including bispecific antibodies. **Immune response and signalling:** Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; Important cytokines and their role in immune mechanisms: TNF, IFN-γ, IL 1, IL-2, IL-4, 1L-6, 1L-12, IL-17, TGFβ;	**14 Lectures**

	Cell signalling through MAP kinases and NF-κB.	
Unit-3	**Tolerance and autoimmunity:** Central and peripheral tolerance, and their mechanism; Mechanisms of autoimmunity; Immune checkpoints, Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), pernicious anemia; Infections leading to autoimmune diseases. **Immunological disorders and hypersensitivity:** Deficiencies / defects of T cells, B cells, and phagocytic cells; Comparative study of Type I-V hypersensitivities with examples.	**15 Lectures**
Unit-4	**Transplantation and tumor immunology:** Alloreactive response; Graft rejection and GVHD; HLA-matching; Tumor antigens, immune response to tumors and immunotherapy of tumors. **Immunological Techniques:** ELISA, RIA, Immunodiffusion, Precipitation, Agglutination, complement Fixation.	**15 Lectures**

Reference Books

1. Kuby Immunology by J.A. Owen, J. Punt, S.A. Stranford. 7th edition. WH Freeman. 2013.
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman, S. Pillai. 9th edition. Saunders Elsevier. 2018.
3. Janeway's Immunobiology by K. Murphy, W. Casey. 9th edition. Garland Science Publishing. 2017.
4. Review of Medical Microbiology and Immunology by W.Levinson. 15thedition. Lange Publication. 2018.
5. Fundamental Immunology by W.E. Paul. 7th edition. Lippincott Williams and Wilkins. 2013.
6. Roitt's Essential Immunology by P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt. 13th edition. Blackwell Publishing. 2017.

SEMESTER 1
CORE COURSE PAPER 4
MB21230: MICROBIAL PATHOGENICITY

Course Objectives:

The objective of this course is to make the students understand various attributes which make the microbes pathogenic or disease-causing, the emergence of newer pathogens with relevance to India and the various tools for their local or global spread. The students would also learn the mechanisms of resistance of bacteria to antibiotics and role of newer vaccines in controlling infectious diseases. The course would also enable students to describe the molecular diagnostic methods and automated equipment which may be used for diagnosis of diseases caused by microorganisms.

Course learning outcomes:

Upon successful completion of the course, the student will be able:

CO1: To understand classical and molecular determinants of disease-causing microbes
CO2: To describe the characteristics of newer disease-causing bacteria and viruses

CO3: To study and critique the various molecular tools available to work on the molecular epidemiology of disease-causing microorganisms

CO4: To study and evaluate mechanisms underlying resistance of bacteria to antibiotics, spread of resistance and the use of newer vaccines to control infectious diseases

CO5: To gather information as to how the infectious diseases may be diagnosed using newer diagnostic tools and what automated equipment are available for use in diagnostic microbiology laboratories.

THEORY COURSE
(4 Credits)

Unit-1	**Classical and modern view of microbial pathogenicity**: Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD_{50}, ID_{50}, $TCID_{50}$. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative/ obligate intracellular pathogens, recent concepts – multidrug efflux pumps, extended spectrum β-lactamases (ESBL).	**15 Lectures**
Uni-2	**Molecular microbial pathogenicity:** Molecular Koch's postulates, multiplicity of virulence determinants, coordinated regulation of virulence genes, and environmental regulation of virulence determinants by two component signal transudation systems, antigenic variation; clonal and panmictic nature of microbial pathogens, type three secretion system (TTSS, T3SS), Role of biofilms and quorum sensing in microbial pathogenicity.	**15 Lectures**
Unit-3	**Emerging and re-emerging pathogens:** Illustrate emerging and re-emerging pathogens using *V. cholerae*0139, X-MDR *M. tuberculosis, Helicobacter pylori,* Enterohaemorrhagic *E. coli* (EHEC), *Cryptosoridium parvum*, Bird/swine flu, AIDS and dengue hemorrhagic fever, opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: horizontal gene transfer (HGT) and pathogenicity islands (PAI). X-MDR *M. tuberculosis*, methacillin-resistant *S. aureus* (MRSA), role of integrons.	**15 Lectures**
Unit-4	**Environmental change and infectious diseases and diagnostics:** Global warming-led increase in vector borne and water-borne infectious diseases; Impact of increasing urbanization, international travel and trade on infectious diseases, Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, real-time PCR, lateral flow assays, diagnostic sequencing and mutation detection, automated instruments for detection / diagnosis of infectious agents (BACTAC and Vitek-2, GeneXpert).	**15 Lectures**

Reference Books

1. Jawetz, Melnick, &Adelberg's Medical Microbiology by Carroll KC, Hobdon JA, Miller S,

Morse SA, Mietzner TA. 27th edition. Lange Publication, 2016.

2. Beginner's guide to comparative genome analysis using next generation sequence data by Edward DJ and Holt KE in Microbial Informatics and Experimentation, 3:2, https://doi.org/10.1186/2042-5783-3-2, 2013.

3. Bacterial Pathogenesis: A molecular approach by Wilson BA, Salyers AA, Whitt DD, Winkler ME. 3rd edition. American Society for Microbiology Press, Washington, DC USA, 2011.

4. Bacterial Pathogenesis: Molecular and Cellular Mechanisms by Locht C, Simonet M, Caister Academic Press, 2012.

5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Hayden R, Leven M, Miller MB, Nolte FS, Tang YW, Belkum AAV. 3rd edition. Washington, American Society for Microbiology Press, 2016

6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM. 4th edition. Jones and Bartlett, 2019.

MB21240: Practical I

Marks: 100 Duration: 60 hours (4 credits)

Course Objectives:

The major objective of the course is to impart hands-on training in basic microbiological, biochemical and immunological techniques. Students will be trained in basic bacterial culturing and identification methods, as well as working in a biosafety cabinet. Students will become familiar with sterilization techniques when handling bacterial as well as virus-infected mammalian cells. Students will be trained in basic enzyme and immunological assays and be taught to present the results both, qualitatively and quantitatively.

Course Learning Outcomes: The Student:

CO1. Is able to use different sterilization procedures and learn handling of micropipette. CO2. Is able to work in the Biosafety Cabinet for culturing cells, virus infection and study of viral cytopathic effects.

CO3. Can use Fluorescence Microscopy for live cell imaging and intracellular localization of viral proteins in different subcellular compartments.

CO4. Is versed with identification and classification of given bacterial isolate by performing a variety of cultural, biochemical and molecular tests. Is able to construct phylogenetic tree using bioinformatic techniques.

CO5. Can determine pI of amino acids by titration method

CO6. Is able to determine concentration of sugar and protein in a given sample after drawing a standard curve. Is able to study glucose uptake by *E.coli.*

CO7. Is able to perform TLC for separating a mixture of amino acids, lipids, and sugars. CO8. Is able to study ammonium uptake by *E.coli*.

Contents:

1. To train students in handling, upkeep and calibration of micropipette for measuring small volumes
2. To give hands-on training in sterilization techniques & their application in microbiology lab
3. To train student in working with a biosafety cabinet in a BSL2.5 lab
4. To purify and identify the given bacterial sample by determining their: Colony morphology, staining characteristics and biochemical characteristics
5. To perform DNA extraction of the given bacterial culture and to carry out PCRamplification of the isolated DNA using universal 16S rRNA gene primers.
6. To analyze the given 16srRNA sequences by using BLAST and construct a phylogenetic tree based on the comparison results.
7. To draw the titration curve of amino acid and determine its pI.
8. To study glucose uptake by *E.coli*.
9. To prepare a standard curve of BSA and determine the concentration of unknown protein samples using Bradford method using regression equation.
10. To separate amino acids, sugars and lipids using Thin Layer Chromatography (TLC)
11. To prepare standard curve of ammonia and determine its uptake by bacterial cells with respect to time and temperature

Suggested Readings:

1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11th Ed. Pearson. 2017.
2. Biochemistry Lab Manual by D.A. Thompson. 3rd edition. Create Space Independent Publishing Platform. 2013.
3. Biochemical calculations: how to solve mathematical problems in general biochemistry by Irwin H. Segel, Wiley, 2nd Edition 2004

MB21250: Practical II

Marks: 100 Duration: 60 hours (4 credits)

Course Objectives:

The major objective of the course is to impart hands-on training in basic microbiological, biochemical and immunological techniques. Students will be trained in basic bacterial culturing and identification methods, as well as working in a biosafety cabinet. Students will become familiar with sterilization techniques when handling bacterial as well as virus-infected mammalian cells. Students will be trained in basic enzyme and immunological assays and be taught to present the results both, qualitatively and quantitatively.

Course Learning Outcomes: The Student:

CO1. Is able to determine the specific growth rate of *E.coli* in different media.

CO2. Can draw a diauxic growth curve in lactose and glucose medium and learn to perform β galactosidase assay.

CO3. Understands the techniques of enzyme assay to determine its specific activity, pH optima, pH stability, temperature optima and temperature stability and calculate inactivation constant (Kd) and $t_{1/2}$ of the enzyme reaction based on the temperature stability curve.

CO4. Can determine K_m, V_{max} and K_{cat} of a purified enzyme and determine its activation energy by plotting Arrhenius curve.

CO5. Is able to perform immune-electrophoresis, immunodiffusion assay. CO6. Is able to perform rocket immune-electrophoresis.

CO7. Is able to stain a tissue by immune-histochemical reaction

CO8. Is able to perform quantitative precipitation assay

CO9. Is able to perform dot-ELISA.

CO10. Is able to perform latex agglutination test

CO11. Is able to perform western blotting.

CO12. Can differentiate lymphocytes, neutrophils, monocytes, eosinophils, and basophils based on morphological and staining characteristics.

Contents:

1. To determine the specific growth rate of *E.coli* in different media.
2. To study the diauxie growth curve of *E.coli* in media containing glucose and lactose and perform β-galactosidase assay.
3. To determine activity and specific activity of the enzyme sample provided.
4. To study the pH optima, pH stability, temperature optima and temperature stability of the given enzyme sample and to calculate inactivation constant (Kd) and $t_{1/2}$ of the enzyme reaction.
5. To determine K_m, V_{max} and K_{cat} of a purified enzyme.
6. To calculate activation energy (Ea) of the given enzyme sample using Arrhenius plot.
7. To perform immune-electrophoresis.
8. To perform radial immunodiffusion assay.
9. To perform rocket immune-electrophoresis.
10. To study quantitative precipitation assay
11. To perform dot-ELISA.
12. To perform latex agglutination test
13. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

8. Teaching Methodology

In order to achieve the objectives of the teaching-learning process and holistic development of the students, faculty may incorporate a variety of modes for teaching and a regular use of ICT. Few of them which will be included in this course are; Classroom Lectures, Classroom Discussions, Power Point presentations, Video Displaying, Laboratory Practical, Model Making, Problem Solving, Group Activity, Presentations by the Students, Presentation by Experts, Interaction with Experts, Visit to Industries/Laboratories.

1. **Classroom Teaching** for topics which are intensely information-based. This a very regular feature of all the courses in Microbiology
2. **Flip Classrooms** video lectures are shared prior to classroom teaching and based on concept discussed, classroom discussions initiated.
3. **Classroom Discussions** are a regular feature while teaching. The students are drawn into impromptu discussions by the teacher during the process of teaching.
4. **Power Point presentations** for topics which involve information related to intricate biological pathways such as metabolic pathways in bacteria and other microorganisms. Use of Power Point presentations are also made whenever the lectures are to be summarized in a crisp and pointwise manner to highlight salient / important conclusions from the topics.
5. **Video Displaying**, both real-time and animations, are used for topics which require 3D dimensional viewing of the biological mechanisms to drive the point home. These have proved to be very helpful while teaching concepts of molecular biology like DNA replication, transcription and translation. These are also used to convey complexities of antigen-antibody interactions and generation of antibody diversity during the teaching of Immunology.
6. **Model Making** is an exercise where students are prompt to learn some structures by preparing 3D structure. It used especially for understanding and building a perception of the students for the structures of viruses, DNA etc. which cannot be seen by a light microscope and can be seen only under expensive equipment like electron microscopes.
7. **Laboratory Practical** are an integral part of every course included in UG programme in Microbiology. In these sessions UG students of Microbiology will get hands on experience of microbiological tests and techniques.
8. **Problem Solving** is an exercise where students will try to solve problems related to microbiology experiments. It is encouraged during the laboratory work.
9. **Group Activity** as well as discussions with the laboratory supervisor/ among the students themselves/ Mentor is also encouraged during laboratory work.
10. **Presentations by the Students** can be regularly done. The students are mentored in presentation of data, interpretation of data and articulation with the students/teachers/Research Scholars during their presentation.
11. **Presentation by Experts** in different specialties of Microbiology can be arranged to broaden the horizons of the students.

12. **Interaction with Experts** can also be encouraged during/after presentations to satisfy/ignite curiosities of the students related to developments in the different areas of Microbiology.
13. **Visit to Industries/Laboratories** related to Microbiology like fermentation, food, diagnostics etc. can be organized to acquaint the students with real-life working environments of the professional microbiologists with a view to broaden their perspective of the subject of Microbiology

9. Keywords