

The New National Education Policy (NEP), 2020
Syllabus B. Sc. Microbiology
(Pursuant to inclusion as major subjects/ disciplines)
GENERAL COURSE OUTLINE

Course Description: Third Semester

Course Type 1

Course Type: Major/Minor

Course Code: MIC-23-301-CT1

Course Title: Fundamentals of Cell Biology and Biochemistry

Course Credits: 4+2

Course Objectives:

- This course has been designed to teach students about cell organization of eukaryotes, cell to cell interactions, transport of molecules, cell signaling and protein sorting.
- This course will provide students comprehensive information about the structural and functional diversity of biomolecules in the living system

Credit I: Cell Wall, Membrane Structure and Nucleus

- 1.1. Eukaryotic cell wall, Extracellular matrix, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions and plasmodesmata
- 1.2. Plasma membrane: Structure and transport of small molecules, Structure and physiology of membrane pumps, carriers and channels
- 1.3. Signal transduction and its mechanism
- 1.4. Nuclear envelope, nuclear pore complex, nuclear lamina, nucleolus
- 1.5. Chromatin – Molecular organization

Credit II: Cell Signaling and Protein Sorting

- 2.1. Signaling molecules and their receptors
- 2.2. Function of cell surface receptors
- 2.3. Pathways of intracellular receptors – Cyclic AMP pathway and cyclic GMP pathway
- 2.4. Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER
- 2.5. Protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids

Credit III: Carbohydrates and Lipids

- 3.1. Definition, classification, structure and functions of carbohydrates
- 3.2. Families of monosaccharides: aldoses and ketoses; Important classes of monosaccharide's and disaccharides
- 3.3. Stereoisomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose
- 3.4. Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid
- 3.5. Definition and classification of lipids. Nature of fatty acids. Role of triglycerides in energy storage and phospholipids in membrane formation, sterols

Credit IV: Proteins and Enzymes

- 4.1. Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins
- 4.2. 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
- 4.3. Secondary, Tertiary and Quaternary structure of proteins
- 4.4. Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors
- 4.5. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis

Credit V: Practical I

- 5.1. Differential isolation of chloroplast by differential centrifugation
- 5.2. Differential isolation of mitochondria by differential centrifugation
- 5.3. Study a representative plant cell by microscopy
- 5.4. Study a representative fungal cell by microscopy
- 5.5. Demonstration of the presence of cheek epithelial cell using vital stain Janus Green B

Credit VI: Practical II

- 6.1. Qualitative tests for carbohydrates
- 6.2. Qualitative tests for reducing and non-reducing sugars
- 6.3. Qualitative tests for lipids and proteins
- 6.4. Study of protein secondary and tertiary structures with the help of models.
- 6.5. Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values

Learning outcome:

- Students will get knowledge about eukaryotic cell structure, cell signaling and protein sorting
- They will acquire knowledge about the significance of various bio-molecules in cell structure and physiology

Recommended Books

1. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Kelsey C. Martin, Michael Yaffe, Angelika Amon (2021) Molecular Cell Biology, Ninth Edition, W.H Freeman and Company.
2. Alberts Bruce, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2015) Molecular biology of the Cell. Garland publishing Inc.
3. David L. Nelson, Albert L. Lehninger, Michael M. Cox (2021) Lehninger Principles of Biochemistry. WH Freeman and company, 8th Edition.
4. Biochemistry (Seventh Edition) JM Berg and JL Tymoczko and L. Stryer (international Edition) W.H. Freeman & Company (2003)
5. Practical Biochemistry Principles and Technology, K. Wilson and John Walker, Cambridge University Press (2004)
6. Andreas Hofmann, John M. Walker, Keith Wilson, Samuel Clokie (2018) Principles and Techniques of Biochemistry and Molecular Biology. Andreas Hofmann, John M. Walker, Keith Wilson, Samuel Clokie, 8th Edition.

Course Description: Fourth semester

Course Type 1

Course type: Major/Minor

Course code: : MIC-23-401-CT1

Course title: Microbial Diversity and Ecology

Course Credits: 3+1

Course objectives:

- The course has been designed to give a basic understanding of the diversity , occurrence, habitat, and classification of Microorganisms
- The students will be introduced to the characteristics, ultrastructure of some important microorganisms
- This course is framed to understand the isolation, and preservation of some important microorganisms

Credit I. Microbial Diversity and Classification

- 1.1. Microbial diversity, habitat distribution of microorganisms and microbial succession
- 1.2. Binomial Nomenclature, Whittaker's five kingdom Classification
- 1.3. Carl Woese's three kingdom classification systems and their utility
- 1.4. Association of microbes with eukaryotes, Aquatic habitats: Marine and fresh water
- 1.5. Terrestrial habitats; key nutrient cycles: Carbon, Nitrogen, Sulphur and Nitrogen.

Credit II: Ecology, Acellular and Cellular Microbes

- 2.1. Principles of microbial ecology, nutrient acquisition, microbial competition and antagonism
- 2.2. Difference between prokaryotic and eukaryotic microorganisms
- 2.3. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, and Prions)
- 2.4. General characters and economic importance of Bacteria (Lactic acid bacteria, *Rhizobium* spp, *Mycobacterium* spp)
- 2.5. General characters and economic importance of Archaea (Methanogens, *Thermus aquaticus*)

Credit III: Characteristics, habitat and economic importance of some microbes

- 3.1. General characters, distribution, occurrence, economic importance and ultrastructure of Algae with reference to *Chlamydomonas*, *Volvox* and *Gelidium*
- 3.2. General characters, distribution, occurrence, economic importance and ultra-structure of Fungi with reference to *Penicillium* spp, *Trichoderma* spp and *Agaricus bisporus*
- 3.3. General characters, distribution and occurrence, economic importance, ultrastructure of cyanobacteria with reference to *Spirulina*, *Anabaena* and *Nostoc*.
- 3.4. General characters, distribution and occurrence, economic importance, ultrastructure of protozoa with reference to *Leishmania* and *Giardia*.
- 3.5. Microorganisms in modern science.

Credit IV: Practical-1

- 4.1. Preparation of culture media (Nutrient Agar) for bacterial isolation - forest soil sample
- 4.2. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air
- 4.3. Preparation of culture media (potato dextrose agar-PDA) for fungi (*Penicillium* spp) - from spoiled food samples
- 4.4. Staining (Fungi)-*Penicillium* spp
- 4.5. Preservation of microbes using Mineral oil

Learn Learning outcome:

- Students will understand diversity and occurrence of microorganisms
- Awareness about classification and associations of microorganisms
- The students will develop the concept of the basic microbiology including the occurrence, cell structure and importance of various microbes.

Recommended Books

1. Brock Biology of Microorganisms by Madigan and Martinko, 14th edition, Pearson Education International.
2. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, 11th edition, McGraw Hill Publisher Companies, Inc edition, Cambridge University Press.
4. Microbiology by Michael J. Pelczar JR, E.C. S. Chan, Noel R. Krieg, 5th edition, McGraw Hill Publisher Companies, Inc.
5. Microbiology: A Laboratory Manual by James Cappuccino and Chad T. Welsh 11th Global Edition, Pearson Benjamin Cummings Publishers.
6. Practical Microbiology by D K Maheshwari and R C Dubey, 3rd edition, S Chand & Company Publishers.
7. Laboratory Fundamentals of Microbiology by Jeffrey C. Pommerville 12th edition, Jones and Bartlett Publishers.

Course Description: Fourth Semester
Course Type 2

Course type: Major/Minor

Course code: MIC-23-402-CT2

Course title : Fundamentals of Immunology

Course credits : 4 + 2

Course Objectives:

- The major objective of this course is to develop a clear understanding about the host immune system and advances in the field of Immunology
- The student will become familiar with the cells, tissues, and organs constituting the immune system and the various mechanisms used to defend host against microorganisms
- The course will further the student's understanding of how advances in immunology have changed the face of modern medicine

Credit-1: History and basic concepts of Immunology

- 1.1. Contributions of the following scientists in the field of Immunology: Edward Jenner, Karl Landsteiner, Paul Ehrlich, Elie Metchnikoff, MacFarlane Burnet and Rodney Porter
- 1.2. Infections and source of infections
- 1.3. Epidemic, Pandemic and Endemic diseases
- 1.4. Immunity, types of Immunity- Innate immunity and acquired immunity
- 1.5. Immune response- primary and secondary immune response. Mechanism of immune response

Credit-2: Immune cells and organs

- 2.1. Structure, functions and properties of immune cells – Stem cell and hematopoiesis
- 2.2. Lymphoid lineage cells (T cell, B cell, NK cell)
- 2.3. Myeloid lineage cells (macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell)
- 2.4. Central and peripheral immune organs.
- 2.5. Complement system and activation pathways (classical, alternate and lectin pathways)

Credit-3: Antigens and antibodies

- 3.1. Antigens, structure and types of antigens-endogenous and exogenous & super antigens
- 3.2. Haptens, adjuvants and its types
- 3.3. Antibodies, structure, types, functions and properties of antibodies
- 3.4. Antigenic determinants on antibodies (isotypic, allotypic, idiotypic)
- 3.5. Concept of VDJ rearrangement

Credit-4: Immunological Techniques

- 4.1. Brief introduction to antigen and antibody reactions- complement fixation, neutralization, agglutination reactions
- 4.2. Precipitation reactions and its types
- 4.3. Immunoassays of diagnostic importance-ELISA, R1A, VDRL and WIDAL test
- 4.4. Flow cytometry and Fluorescence immunoblotting – Hypersensitivity
- 4.5. Production of monoclonal and polyclonal antibodies and its applications

Credit-5: Practical I

- 5.1. Demonstration of different blood cells
- 5.2. Blood grouping and Rh typing
- 5.3. Latex agglutination test (WIDAL slide test for typhoid fever)
- 5.4. Perform Total Leukocyte Count of the given blood sample
- 5.5. Separate serum from the blood sample (demonstration)

Credit-6: Practical II

- 6.1. Demonstration of Urine sampling
- 6.2. Demonstration of medically important bacterial media (any two)
- 6.3. Demonstration of ELISA
- 6.4. Single radial immuno assay (SRID)
- 6.5. Demonstration of RT-PCR for COVID-19

Learning outcome:

- Will be acquainted with the emergence of immunology and how the immune system protects us from infection through various lines of defence
- Will have gained an indepth knowledge of characteristics and functions of the cells of the immune system and the organization of organs of the immune system
- Can understand the molecules that can act as antigens and also the antibodies that are made against the antigens. Will be able to outline the production and use of monoclonal antibodies

Recommended Books:

1. Kuby Immunology by J. Punt, S. Stranford, P. Jones and J. Owen. 8 th edition. W.H. Freeman and Company, USA. 2018.
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman and S. Pillai. 9th edition. Elsevier, USA. 2017.
3. Roitt's Essential Immunology by P. Delves, S. Martin, D. Burton and I.M. Roitt. 13th edition. Wiley- Blackwell Scientific Publication, UK. 2017.
4. Immunobiology: A short course by R. Coico and G. Sunshine. 7th edition. Wiley- Blackwell Scientific Publication, UK. 2015.
5. Basic and Clinical Immunology by M. Peakman and D. Vergani. 2nd edition. Churchill Livingstone, UK. 2009.
6. Immunology by C. Richard and S. Geoffrey. 6th edition. Wiley- Blackwell Scientific Publication, UK. 2009.
7. Janeway's Immunobiology by K. Murphy, P. Travers and M. Walport. 7th edition. Garland Science Publishers, USA. 2007.

Course Description: Fourth Semester
Course Type 3

Course type: Major/Minor

Course code: MIC-23-403-CT3

Course title: Instrumentation and Bio-techniques

Course credits: 4 + 2

Course Objectives:

- To develop practical skills and impart laboratory knowledge among students along with the collection and interpretation of scientific data to contribute the science.
- The course has been designed to equip students with advance microbiology laboratory equipment's and techniques.
- The students will be introduced to recent bio-techniques having potential applications in different fields.

Credit I: Basic Microbiology Laboratory Equipment's

- 1.1. Common microbiology laboratory equipment's – Incubators, Biosafety Cabinet & Laminar-air flow, hot plate, heating mental, Bunsen burner, vortex, pipettes
- 1.2. Principle and working: pH meter, autoclave, hot air oven, water bath, colony counter, lyophilizer
- 1.3. Principal and applications of microscopy, Different types of microscopes: Phase contrast, Bright Field, Dark Field microscopes
- 1.4. Principal and applications of Fluorescent and Confocal microscopes
- 1.5. Principal and applications: Scanning and Transmission Electron Microscopes, Scanning Probe Microscopy

Credit II: Centrifugation and Chromatography

- 2.1. Centrifugation: Basic principles of centrifugation, operation and its applications
- 2.2. Types of centrifugation techniques
- 2.3. Chromatography: Basic principles of chromatography and its applications
- 2.4. Working principle of paper chromatography, thin layer, gel filtration, ion exchange chromatography
- 2.5. GLC and HPLC and its applications

Credit III: Electrophoresis and PCR

- 3.1. Electrophoresis: Basic principles and applications
- 3.2. Principle and applications: Polyacrylamide gel electrophoresis and agarose gel electrophoresis
- 3.3. Working principle of PCR and its applications
- 3.4. Types of PCR (Brief overview): Conventional (Qualitative) PCR, Multiplex PCR, RT-PCR and qRT-PCR
- 3.5. Blotting techniques: Southern, Northern and Western blotting

Credit IV: Radio Isotopic Techniques and Spectroscopy

- 4.1. Use of radioisotopes in life sciences, Radioactive isotopes and radioactive decay
- 4.2. Principle and application of tracer techniques
- 4.3. Detection and measurement of radioactivity using different techniques
- 4.4. Spectroscopic techniques: principal and applications of UV-Visible spectrophotometer
- 4.5. Basic understanding: FT-IR, NMR, Atomic Absorption spectrophotometer and MALDI-TOF

Credit V: Practical I

- 5.1. Usage and maintenance of basic equipment's of microbiology lab: Principles, calibrations, and SOPs of weighing balance, pH meter, autoclave, incubator, laminar air flow and biosafety cabinet.
- 5.2. Usage and maintenance of basic equipment's of microbiology lab: Principles, calibrations, and SOPs of microscope, hot air oven, water bath, colony counter
- 5.3. Demonstration of electron microscope
- 5.4. Separation of bacterial lipids/amino acids/sugars/organic acids by TLC or Paper Chromatography
- 5.5. Demonstration of HPLC / GLC

Credit VI: Practical II

- 6.1. Isolation of bacterial DNA
- 6.2. Study of UV absorption spectra of macromolecules (protein/nucleic acid/bacterial pigments)
- 6.3. Demonstration of SDS-PAGE
- 6.4. Demonstration of PCR
- 6.5. Demonstration of FT-IR and NMR

Learning outcome:

- Students will be familiarized with the common and advanced equipment's of microbiology laboratory.
- The students will develop basic as well as advanced understanding about laboratory equipment's along with their working principles and applications.

Recommended Books:

1. Brock Biology of Microorganisms by Madigan and Martinko, 14th edition, Pearson Education International.
2. Microbiology: A Laboratory Manual by James Cappuccino and Chad T. Welsh 11th Global Edition, Pearson Benjamin Cummings Publishers.
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann, 8th edition, Cambridge University Press.
4. The Cell: A Molecular Approach by Geoffrey M. Cooper, Robert E. Hausman, 6th edition, Sinauer Associates Inc.
5. Instrumental Methods of Chemical Analysis. 1989 by Chatwal G and Anand, S. Himalaya Publishing House, Mumbai