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

CREDIT BREAKUP OF COURSES FOR EACH SUBJECT OFFERED AS MAJOR AS WELL AS MINOR

SEMESTER	COURSE TYPE 1	COURSE TYPE 2	COURSE TYPE 3	TOTAL	STATUS
I.	4 + 2 Credits Fundamentals of Microbiology	-	-	**6 Credits**	AVAILABLE
II.	4 + 2 Credits Microbiological Techniques	-	-	**6 Credits**	AVAILABLE
III.	4 + 2 Credits Cell Biology and Biochemistry	-	-	**6 Credits**	AVAILABLE
IV.	3 + 1 Credits Microbial Diversity and Ecology	4 + 2 Credits Immunology	4 + 2 Credits Instrumentation and Bio-techniques	**16 Credits**	AVAILABLE
V.	3 + 1 Credits Bacteriology	4 + 2 Credits Microbial Genetics and Genomics	4 + 2 Credits Mycology and Phycology	**16 Credits**	AVAILABLE
VI.	3 + 1 Credits Virology	4 + 2 Credits Microbial Physiology and Metabolism	4 + 2 Credits Molecular Microbiology and Recombinant DNA Technology	**16 Credits**	AVAILABLE
VII.	3 + 1 Credits Industrial and Pharmaceutical Microbiology	4 + 2 Credits Food and Dairy Microbiology	4 + 2 Credits Biostatistics and Bioinformatics	**16 Credits**	AWAITED
VIII.	3 + 1 Credits Environmental and Agricultural Microbiology	4 + 2 Credits Medical Microbiology	4 + 2 Credits Microorganisms and IPR	**16 Credits**	AWAITED
TOTAL	**38 Credits**	**30 Credits**	**30 Credits**	**98 Credits**	

Description: Fifth Semester

Course Type: 1
Course type: Major/ Minor
Course code: MIC-24-501-CT1
Course Title: Bacteriology
Course credits: 3 + 1

Course Objectives:

- This course deals with characteristics, significance, classification and economic importance of different classes of archaeal and eubacterial groups
- The students will be introduced to the growth and nutritional requirements of bacteria

Credit-I: Important archaeal groups

1.1. General Characteristics, ecological significance, classification and economic importance of thermophiles with special reference to *Thermococcus*
1.2. General Characteristics, ecological significance, classification and economic importance of Nanoarchaeota (Nanoarchaeum)
1.3. General Characteristics, ecological significance, classification and economic importance of Halophiles (*Halobacterium)*
1.4. General Characteristics, ecological significance, classification and economic importance of Crenarchaeota (*Thermoproteus)*
1.5. General Characteristics, ecological significance, classification and economic importance of Methanogens (*Methanobacterium)*

Credit-II: Important eubacterial groups

2.1. General Characteristics, ecological significance, classification and economic importance of Non proteobacteria (*Chlamydia)*
2.2. General Characteristics, ecological significance, classification and economic importance of Alpha proteobacteria (*Agrobacterium*)
2.3. General Characteristics, ecological significance, classification and economic importance of Beta proteobacteria (*Thiobacillus*)
2.4. General Characteristics, ecological significance, classification and economic importance of Gamma proteobacteria (*Pseudomonas*)
2.5. General Characteristics, ecological significance, classification and economic importance of Delta protobacteria (Myxobacteria)

Credit-III: Nutrition and Growth in Bacteria

3.1. Nutritional requirements and nutritional categories in bacteria
3.2. Culture media: With reference to thermophiles, psychrophiles and mesophiles
3.3. Quantitative aspects of bacterial growth and growth cycle
3.4. Continuous culture, measuring bacterial growth, calculation of generation time and specific growth rate
3.5. Physical and chemical methods of control of bacteria

Credit IV. Practical

4.1. Isolation of bacteria from soil / water sample
4.2. Enumeration of CFU count by spread plate method
4.3. To study growth curve of bacteria (OD/ McFarland Scale)
4.4. Acid Fast Staining of bacteria
4.5. Spore staining of bacteria

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learning outcome:

- Students will develop basic knowledge about different groups of archaeal and eubacteria.
- Students will understand how bacteria grows under different nutritional requirements

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.
3. Microbiology by Michael J. Pelczar JR, E.C. S. Chan, Noel R. Krieg, 5th edition, McGraw Hill Publisher Companies, Inc.
4. Medical Microbiology by Michael R Baber, Will Irving Andrew Swann, Neuun Perera, Elsevier, 19 th edition, 2018
5. Laboratory Fundamentals of Microbiology by Jeffrey C. Pommerville 12th edition, Jones and Bartlett Publishers.

Course Description: Fifth Semester

Course Type: 2
Course type: Major/Minor
Course code: MIC-24-502-CT2
Course Title: Microbial Genetics and Genomics
Course credits: 4 + 2

Course Objectives:

- This course deals with the structure and function of DNA and also students will understand the mechanism of replication, transcription and translation
- They will also acquire knowledge about types of plasmids and their structure
- The students will be introduced to the mechanism of gene transfer and role of transposable elements in the process of transposition

Credit-I: DNA and Replication

1.1. DNA Double helix, size and shape of DNA
1.2. Different forms of DNA
1.3. Genome organization in prokaryotes, DNA supercoiling
1.4. Gene concept and structure of gene
1.5. Mechanism of Prokaryotic DNA replication

Credit-II: Transcription and Translation

2.1. RNA and its types
2.2. Functions of RNAs.
2.3. Transcription: mechanism of transcription in prokaryotes
2.4. Mechanism of translation in Prokaryotes
2.5. Concept of protein targeting and sorting

Credit-III: Plasmids

3.1. Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids and Ti-plasmids
3.2. Plasmid replication and partitioning
3.3. Host range, plasmid-incompatibility
3.4. Plasmid amplification
3.5. Regulation of copy number and curing of plasmids

Credit- IV: Genetic Exchange and Transposable elements

4.1. Transformation: Discovery, mechanism of natural competence
4.2. Conjugation - Discovery, mechanism, Hfr and F' strains
4.3. Transduction – Discovery, Generalized transduction and specialized transduction
4.4. Transposable elements: IS elements, bacterial transposons
4.5. Mechanism and types of transposition

Credit V: Practical I

5.1. Demonstration on the effect of chemical (HNO_2) mutagen on bacterial cells
5.2. Demonstration on the effect of physical (UV) mutagen on bacterial cells
5.3. Demonstration on the survival curve of bacteria after exposure to ultraviolet (UV) light
5.4 Demonstration on the Isolation of mutants
5.5 Characterization of mutants

Credit VI: Practical II

6.1. Isolation of genomic DNA from bacteria
6.2. Qualitative and quantitative estimation of DNA (gel/ spectrophotometric)
6.3. Isolation of Plasmid DNA from *E.coli.*
6.4. Detection of isolation of plasmid DNA by agarose gel electrophoresis
6.5. Demonstration of SDS PAGE

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learning outcome:

- Students will develop basic knowledge about DNA and its replication
- Students will understand transcription and protein synthesis
- Students will understand plasmids and its types, they will know how bacteria will transfer genes and the role of transposable elements in transposition

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. 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.
4. Lewin's Genes XII by Elliott S. Goldstein, Stephen T. Kilpatrick, Jocelyn E. Krebbs, Jones & Bartlett, 12th edition, 2017
5. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology by Andreas Hofmann, John M. Walker, Keith Wilson, Samuel Clokie, Andreas Hofmann, John M. Walker, Keith Wilson, Samuel Clokie, 8th edition, 2018

Course Description: Fifth Semester
Course Type: 3
Course type: Major/ Minor
Course code: MIC-24-503-CT3
Course title: Mycology and Phycology
Course credit: 4 + 2

Course Objectives:

- The major objective of this course is to develop a clear understanding about the algae and fungi
- The student will become familiar with the diverse economic applications of algae and fungi.
- This course will also familiarize students with utility of fungi in production of different industrial products; moreover, it will also highlight pathogenic characteristics of fungi.

Credit-I: An introduction to fungi

1.1. Historical prospective of Mycology
1.2. Morphology and reproduction of fungi
1.3. Classification and taxonomy of fungi (overview)
1.4. Occurrence, general characteristics and significance of Lichen and Mycorrhiza
1.5. Fungi as bio-pesticides (*Trichoderma)*

Credit-II: Mycotechnology and Medical Mycology

2.1. Fermentation: Solid substrate fermentations (SSF) & Submerged fermentation (SmF)
2.2. Fungi as a source of antibiotics, organic acids, vitamins and alcohols
2.3. Mushrooms: cultivation and their economic importance
2.4. Major fungal diseases: Humans (Candidiasis), Plants (Apple scab)
2.5. Mycotoxins: Types and economic impact

Credit-III: An introduction to Algae

3.1. Introduction to algae and its significance in ecosystem
3.2. General Classification and comparative morphology
3.3. Physiological Aspects: Fresh water algae, soil algae, marine algae (sea weeds), aerial algae (elemental idea)
3.4. Role of algae in nutrient cycling and oxygen production
3.5. Overview of reproduction in algae

Credit-IV: Economic importance of Algae

4.1. Algae: Photosynthesis and light absorbing pigments
4.2. Algae as bio-fertilizer, biofuel, SCP and fodder
4.3. Algae as a source of agar, alginate, diatomic and iodine
4.4. Antibiotics from algae, Algae as pollution indicator (water pollution)
4.5. Importance of algae in sewerage treatment

Credit-V: Practical I

5.1. Microscopic observation of pathogenic and nonpathogenic fungi
5.2. Preparation of media for isolating fungi (PDA)
5.3. Field visit for algae and fungi
5.4 Extraction and estimation of chlorophyll from algae
5.5. Quantification of phycobillins proteins

Credit- VI: Practical II

6.1. To examine the amylolytic activity of fungi
6.2. Extraction and quantification of Carotenoids in given algal sample using spectrophotometry
6.3. Study of bread mold by LCB method
6.4 Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus*
6.5. Study of the following genera through temporary and permanent slides: *Spirogyra and Chlamydomonas*

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learning outcome:

- Will have gained an in-depth knowledge of characteristics and functions of the algae and fungi
- Student will acquire knowledge about the applications and economic importance of both algae and fungi

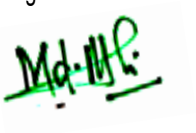
Recommended books:

1. Dube HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
2. Alexopoulos CJ, Mims CW and Blackwell M. (1996). Introductory Mycology. 4th edition. John Wiley and Sons, Inc.
3. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group, New York
4. Graham LE, Graham JM and Wilcox LW. (2009). Algae. 2nd edition. Benjamin Cumming, New York.
5. Lee RE. (1999). Phycology. 4th edition. Cambridge Press.
6. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press

Course Description: Sixth semester
Course Type: 1
Course type: Major/Minor
Course code: MIC-24-601-CT1
Course title: Virology
Course Credits: 3+1

Course Objectives:

- The course has been designed to give a basic understanding of the viruses their characteristics, composition, cultivation and classification
- The students will be introduced to the Bacteriophages
- Students will be introduced to features and replications of different viruses
- Students will be introduced to interferons, viral vaccines and antiviral agents



Credit I. History and Cultivation of viruses

1.1. Discovery of viruses
1.2. General characters of viruses, Viroids, virusoids and Prions
1.3. Structural organization of viruses
1.4. Cultivation of viruses
1.5. Lifecycle of viruses: general concepts

Credit II. Structure, classification and nomenclature

2.1. Taxonomy of viruses: classification and nomenclature as per ICTV
2.2. Baltimore classification system
2.3. Plant viruses (TMV)
2.4. Animal viruses (Adeno virus)
2.5. Oncogenic Viruses (HPV)

Credit III General Characteristics & replication of viruses

3.1. Brief account on Bacteriophages and its types
3.2. General features and replication of T4 and Apple Mosaic Virus
3.3. General features and replication of influenza virus
3.4. Antiviral agents (Interferons and Antiviral drugs)
3.5. Viral vaccines

Credit IV. Practical - I

4.1. Demonstration of biosafety cabinet
4.2. Performance of sterilization of glassware's
4.3. Demonstration of *pfu* in viral cultures and demonstration of viruses in cell cultures
4.4. Diagnostic techniques in viral detection (RT-PCR)
4.5. ELISA

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learn Learning outcome:

- Students will understand History and composition of Viruses.
- Awareness about Taxonomic classification
- The students will develop the concept of the basic virology including the occurrence, structure and importance of plant and animal viruses.
- Students will develop the concept of practical aspects of viral studies

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.
3. Microbiology: A Laboratory Manual by James Cappuccino and Chad T. Welsh 11th Global Edition, Pearson Benjamin Cummings Publishers.
4. Practical Microbiology by D K Maheshwari and R C Dubey, 3rd edition, S Chand & Company Publishers.
5. Laboratory Fundamentals of Microbiology by Jeffrey C. Pommerville 12th edition, Jones and Bartlett Publishers.

Course Description: Sixth Semester
Course Type: 2
Course type: Major/Minor Course code: MIC-24-602-CT2
Course title: Microbial Physiology & Metabolism
Course credits: 4 + 2

Course Objectives:

- To develop basic understanding about nutritional requirements and effect of different environmental parameters on microbial growth
- The course has been designed to provide students sound knowledge about nutrient transport and respiration in microorganisms
- The students will get equipped with fundamental knowledge of macromolecules and metabolism

Credit-I: Microbial growth and Nutritional requirements

1.1. Microbial growth, nutritional requirements, macro and micronutrients
1.2. Classification of organisms based on nutritional requirements
1.3. Factors affecting microbial growth (temperature, pH, solute, water activity and oxygen concentration)
1.4. Chemotrophs and Methanotrops: Characteristics, types and importance
1.5. Sulphur oxidizing microbes

Credit-: Nutrient transport and respiration

2.1. Types of cellular transport: passive, facilitated, active transport
2.2. Primary and secondary active transport, group translocation
2.3. Membrane bound protein transport system, carrier models
2.4. Concept of aerobic and anaerobic respiration and
IIFermentation (types) and Pasteur effect

Credit- III: Aerobic respiration and phototropic metabolism

3.1. Glycolysis and TCA cycle.
3.2. Electron transport chain
3.3. Oxidative photophorsphorylation
3.4. Groups of phototrophic microorganisms, anoxygenic and oxygenic photosynthesis
3.5. Photosynthetic pigments, photophosphorylation, Calvin cycle

Credit-IV: Macromolecules

4.1. Carbohydrates and classification
4.2. Lipids: definition, classification and structure
4.3. Amino acids: General formula, classification, structure
4.4. Proteins: structures of proteins, functions of proteins
4.5. Enzymes: classification, nomenclature and application of enzymes

Credit-V: Practical I

5.1. Demonstration of nutritional requirements of microorganisms (bacteria) by charts and models
5.2. To study the effect of temperature on growth of bacterial isolates (qualitative assay)
5.3. To study the effect of pH on growth of bacterial isolates (qualitative assay)
5.4. To study the fermentation of carbohydrates (qualitative assay)
5.5. Demonstration of TCA cycle by charts and models

Credit-VI: Practical II

6.1. Demonstration of Electron transport chain using charts and models
6.2. Estimation of photosynthetic pigments (Chlorophyll)
6.3. Qualitative tests for carbohydrates
6.4. Estimation of proteins by Lowry/Biuret method
6.5. Qualitative tests for lipids

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learning outcome:

- Students will be familiarized with nutritional requirements and class of microorganisms on basic of nutrient demand
- The students will develop basic as well as advanced understanding about respiration, fermentation, nutrient transport, macromolecules and much more

Recommended Books:

1. Lehninger Principles of Biochemistry by Lehninger by David L. Nelson and Michael M Cox, W.H Freeman and company.
2. Biochemistry by Stryer WH et al., W.H Freeman and company.
3. Physiology and Biochemistry of Prokaryotes by White David, Oxford University Press.
4. Brock Biology of Microorganisms by Madigan and Martinko, 14th edition, Pearson Education International.
5. Prescott's Microbiology by Joanne Willey, Linda Sherwood and Christopher J. Woolverton, 11th edition, McGraw Hill Publisher Companies, Inc

Course Description: 6th Semester
Course Type: 3
Course Type: Major/Minor
Course Code: MIC-24-603-CT3
Course Title: Molecular Microbiology and Recombinant DNA Technology
Course Credits: 4+2

Course Objectives:

- This course has been designed to teach students about DNA and RNA of eukaryotes and prokaryotes.
- This course will provide students comprehensive information about the mutation and different types of mutation
- This course will provide students comprehensive information about the Recombinant DNA technology and its applications

Credit I: The nature of Genetic material and mutations

1.1. The structure, function and properties of DNA, semi-conservative replication of DNA, the central dogma
1.2. hnRNA, mRNA, snRNA, capping and polyadenylation
1.3. Organization of DNA in Prokaryotes
1.4. Organization of Eukaryotic Genomes.
1.5. Extrachromosomal genetic elements

Credit II: Repair of DNA, Recombination and blotting techniques

2.1. DNA repair mechanism
2.2. Recombination as a molecular biology tool.
2.3. Transcription machinery of eukaryotes
2.4. Blotting techniques (Southern and Northern blotting)
2.5. Mutation and its types

Credit III: Basics of Recombinant DNA technology

3.1. Milestones in genetic engineering.
3.2. Restriction enzymes: Types I, II and III.
3.3. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering
3.4. DNA modifying enzymes and their applications: DNA polymerases, DNA ligases, kinases and phosphatases.
3.5. Vectors and types of vectors

Credit IV: Tools, Strategies and applications

4.1. Construction of recombinant DNA and its screening
4.2. Applications of Recombinant DNA Technology: Products of human therapeutic interest-insulin, and HGH
4.3. cDNA and genomic DNA libraries
4.4. *Agrobacterium* - mediated delivery.
4.5. Bt transgenic-cotton and Brinjal

Credit V: Practical-I

5.1. Study of different types of DNA and RNA using micrographs and model/schematic representations.
5.2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
5.3. Isolation of genomic DNA from *E. coli.*
5.4. Estimation of RNA using colorimeter (orcinol reagent) and UV spectrophotometer (A260 measurement).
5.5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

Credit VI: Practical-II

6.1. Preparation of competent cells for transformation.
6.2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
6.3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
6.4. Demonstrration of Ligation of DNA fragments.
6.5. Demonstration of Amplification of DNA by PCR

Note: Those experiments which can't be performed in laboratory, should be conducted via Virtual lab

Learning outcome:

- Students will get knowledge about eukaryotic and prokaryotic genome organization, mutations
- They will acquire knowledge about the recombinant DNA technology and its significance

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. David L. Nelson, Albert L. Lehninger, Michael M. Cox (2021) Principles of Biochemistry. WH Freeman and company, 8th Edition.
3. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Practical Biochemistry Principal and Technology, K. Wilsone and John Walker, Cambridge University Press (2004)