MICROBIOLOGY

Course Objective:

The aim of this course is to familiarize the students with the elementary history of the subject Microbiology and the various theories proposed for Microbial existences which are used in understanding the basics of Microbiology in general. The core course will also help to describe the world-changing scientific contributions of pioneering scientist of the 17^{th} to 18^{th} century. The core course will help the students to understand the importance of morphological distinctness with respect to species diversity of Algae, Fungi and Protozoa and their Evolutionary relationship that exist in between them. They will try to critically think why algae, fungi and protozoa are studied in Microbiology. Moreover, core course will also provide a comprehensive understanding of the origin of various techniques used in Microbiology and development of ideas to exhibit the techniques origin and development of ideas to exhibit the techniques for isolation of pure culture.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe the contributions of eminent pioneer microbiologist, Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky and Selman A. Waksman in the establishment of the field of Microbiology.
- Describe the evidence that support the Germ theory of disease.
- Define microbes in the words of Leeuwenhoek and as we know them today.
- Explain why protozoa, algae, and non-microbial parasitic worms are studied in microbiology.
- List and answer four questions that propelled research in what is called the "Golden Age of Microbiology."
- Identify the scientists who argued in favour of spontaneous generation.
- Compare and contrast the investigations of Redi, Needham, Spallanzani, and Pasteur concerning spontaneous generation.
- List four steps in the scientific method of investigation.
- Discuss the significance of Pasteur's fermentation experiments to our world today.
- Explain why Pasteur may be considered the Father of Microbiology.
- Identify the scientist whose experiments led to the field of biochemistry and the study of metabolism.
- List at least seven contributions made by Koch to the field of microbiology
- List four groups of algae, and describe the distinguishing characteristics of each

- List the four steps that must be taken to prove the cause of an infectious disease.
- Describe the contribution of Gram to the field of microbiology.
- Identify six health care practitioners who did pioneering research in the areas of public health microbiology and epidemiology.
- Name two scientists whose work with vaccines began the field of immunology.
- List four major questions that drive microbiological investigations today.
- Identify the field of microbiology that studies the role of microorganisms in the environment.
- Name the fastest-growing scientific disciplines in microbiology today.
- List the economically important group of Algae, Fungi and Protozoa
- Describe the ultrastructure of viruses
- List several economic benefits derived from algae.
- List four ways in which water moulds differ from true fungi
- Describe the five kingdom system of classification

BSc. MICROBIOLOGY (CBCS)

Course Objective:

The objective of the Bacteriology paper is to acquaint the student with the basic concepts of bacteriology for the development of the right attitudes by the Microbiology students to better understand the theoretical aspects of Bacteriology. The course is also intended to provide a thorough background on the anatomical and cellular organisation of the basic fundamental unit of all living organisms called cell. The course will also help the student to understand thebasic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also understand the structural similarities and differences among various physiological groups of bacteria/archaea. The student will be able to understand various physical and chemical means of sterilization, historical background of culture growth media and their applications. Know more about various microbial techniques for the isolation of pure cultures in an artificial growth media along with the safe laboratory practices. Moreover, the topics also provide an opportunity to understand the importance of three distinct Domain system of life (Eubacteria, Archaebacteria and Eukaryotes). The coverage of important archaeal and eubacterial groups has been expanded and updated for coherent understanding.

Learning Outcome:

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe the cellular organisation of prokaryotic and eukaryotic cells
- Differentiate the cell wall characteristics of Gram Positive and Gram Negative Bacteria

- Describe the importance of differential staining procedure: Gram and Acid fast staining
- Describe the importance of differential staining procedure in medical microbiology
- Describe the importance of Archaebacteria
- List two structures that are unique to Gram-negative and to Gram-positive cells, and provide the function of each.
- List two structures that both Gram-negative and Gram-positive cells have in common, and provide the function of each.
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- Comment on the cell wall characteristics of Archaebacteria
- Describe the effect of antibiotic on the growth of prokaryotic organisms with respect to cell wall architecture
- Differentiate the plasma membrane structure of archaea and prokaryotic organism
- Comment on the Ribosome of Prokaryote and Eukarya
- Describe the process of sporulation in Gram positive bacteria
- State two unique structures present in Eukaryotes, but not in Bacteria and Achaea.
- Describe the structure of endospore
- List the various stages of endospore formation
- List the methods of pure culture isolation
- Describe the various methods of pure culture isolation
- List the important technique available for maintaining the pure culture for short term and long term preservations
- How can anaerobic bacteria be brought into culture growth
- State the difficulties faced by microbiologist in isolating pure culture
- Describe the various methods available in determining non-cultural bacteria.
- List the various types of Microscope used in the field of Microbiology
- Describe the mechanical part and functioning of Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope
- Explain why microscope is used in Microbiology
- Describe the nutritional requirements in bacteria
- List the various type of media used in microbiology
- What is a culture and culture media
- Classify various types of media based on function and composition
- How can bacterial growth be enriched
- Describe the physical and chemical methods of sterilization
- Explain the mode of action biocides for controlling microorganisms
- Describe the general process of asexual reproduction
- Explain the logarithmic increase in growth
- Describe the various phases of growth
- Calculate the mean generation time and specific growth rate constant
- List the three Domains of the phylogenetic tree of life. State a unique characteristic of each Domain
- List two features of a useful molecular/evolutionary clock.
- Explain what features of 16S rRNA make it useful to compare the evolutionary relationship between organisms.
- Determine the two most related and two least related organisms from a short list of 16S rRNA sequences.
- Draw inferences about evolutionary relatedness of organisms based on phylogenetic trees.

- Describe the general characteristics of the different members of Archaebacteria
- Describe the overall features related to alpha, beta and gamma proteobacteria
- Describe extensively the features of low G+C Firmicutes
- Describe extensively the features of high G+C Actinobacteria
- Briefly describe the important cellular features associated with cyanobacteria
- Explain the role of heterocyst in nitrogen fixation

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-II

Objective:

Biochemistry is an evolving science where researchers are making new discoveries every day. The purpose of this course is to teach students the fundamentals concepts in biochemical chemistry and thermodynamics. Enable student to understanding the laws of thermodynamics, concepts of entropy, enthalpy and free energy changes and their application to biological systems and various biochemical studies and reactions. The student will be able to incorporate these concepts into their basic learning of chemical structures needed for understanding of chapter in other courses where basic chemical are used as a precursor forthe generation of biological macromolecules i.e., integration of metabolism with biochemistry. The biochemistry course has been designed to meet up the fundamentalsrequired for understanding the chemical biology of microbes and human health. Finally to give an overview of major biomolecules – carbohydrates, lipids, proteins, amino acids, nucleic acids, vitamins, enzymes, their classification, structure, and function will be dealt in details. The fundamental and conceptual knowledge of properties, structure, and function of enzymes, enzyme kinetics and their regulation will be covered using models.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Explain the two laws of Thermodynamics
- Define Gibb's Free Energy, enthalpy, and Entropy and establish mathematical relationship among them.
- Describe standard free energy change and equilibrium constant and Coupled reactions and additive nature of standard free energy change
- Describe the structure and importance of energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters andATP
- Give a concise account on the classification of carbohydrates
- Describe the various types of isomerism exhibited by the carbohydrates
- Describe mutarotation with respect to monosaccharides
- Contrast reducing and non-reducing sugars
- Explain Haworth projection formulae for glucose

- Describe the chair and boat forms of glucose
- List the different types of monosaccharides
- Describe the structure of sugar derivatives
- Explain the concept of reducing and non-reducing sugars
- Describe the structural and storage polysaccharides citing biological examples
- Define major classes of lipids
- Classify lipids on the basis carbon chain
- Explain saponification with respect to hydrolysis of triglycerides
- Comment on structural lipids
- Give few examples of saturated and unsaturated fatty acids
- Describe the functions of lipids
- Define amino acids and proteins
- Explain the concept of Zwitterions
- Describe the titration curve of amino acids and its significance
- Classify amino acids on the basis of side groups
- Classify the different level of organisation of protein structure
- Describe the structure and functions of naturally occurring glutathione and insulin and synthetic Aspartame
- Describe in details the structure of Human Haemoglobin
- List the different types of forces that hold the protein structure
- Define enzyme
- Classify enzymes according to enzyme commission number
- Explain the following: Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD,metal cofactors
- Describe the mechanism of action of enzymes: active site, transition state complex and activation energy.
- Explain the Lock and key hypothesis, and Induced Fit hypothesis
- Describe the significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism
- Give a definitions of terms – enzyme unit, specific activity and turnover number,
- Describe multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase
- Explain the effect of pH and temperature on enzyme activity
- Describe enzyme inhibition: through competitive- sulfa drugs; non-competitive- heavy metal salts
- Classify and characterise vitamins with suitable examples, sources and importance

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-II

Objective:

This course is offered to students to gain basic knowledge on Introduction to Virology and is followed by an exploration of theories of viral origin. The Virology course is designed in a

lucid manner outlining the essential morphological architecture, physiological, and genetic elements of viruses as well as viroids, satellites, and prions. They will also know how viruses are classified. The concept of interferon, proto-oncogenes is presented and their updated discussion of the role of viruses in causing cancer shall be discussed in detail.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Define viruses and label its different parts
- Describe the importance of viruses
- Give a general characteristics of viruses
- Give an examples of double stranded single stranded DNA/RNA virus
- Explain the importance of different theories of viral origin
- Describe the various methods available for isolation, purification and cultivation of viruses
- Contrast non-enveloped and enveloped viruses
- What are the possible ways available for the classifications of viruses
- Describe the structure of lambda phage virus
- Compare and contrast DNA and RNA viruses
- Compare and Contrast Plant and animal Viruses
- Explain in details the one step growth curve
- Describe the life cycle patterns of lambda phage
- Describe the role of molecular switches in regulating lytic and lysogenic cycles
- Compare and contrast the differences between lysogenic and latent viral infections
- Explain the various modes of Persistent, non-persistent, vertical and horizontal viral transmissions
- List the salient features of viral nucleic acids with respect to Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV)
- Know how viruses are classified
- Understand the architecture of viruses
- Know the methods used in studying viruses
- Classify the virus on the basis of replication strategies of representative viruses from the seven Baltimore classes
- Understand the interactions between viruses and the host immune system
- Describe the terms Oncogenes and tumor suppressor genes, and how tumor viruses interact with these products and their intersecting pathways and cause oncogenesis.
- Explain the term oncogenic with respect to viruses
- Differentiate between oncogenes and protooncogenes
- Give a concise account of oncogenic DNA and RNA viruses
- Describe the importance of antiviral compounds and their mode of action
- Explain vaccine strategies and mechanisms of antiviral drugs and Interferons
- What are interferon and comment on their mode of action
- Know how viruses can be used as tools to study biological processes , as cloning vectors and for gene transfer.

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-III

Course Objective:

This course is offered to students to understand the basic of bacterial metabolism and nutrient translocation. The chapter included in the course will be helpful for the student to know the nutritional requirements needed for the biosynthesis and energy yielding and energy-conserving process of each nutritional type. The concept of microbial metabolism is presented by discussing the chemical reaction mainly the redox reaction for understanding the interconnected biochemical pathways used by the cells. Moreover, the coverage of nitrogen metabolism is expanded and updated for better physico-chemical understanding of nitrogen fixation by Nitrogen fixing organisms.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe binary fission as a means of reproduction.
- Explain what is meant by the generation time of bacteria.
- Describe logarithmic growth.
- Draw and label a bacterial growth curve.
- Describe what occurs at each phase of a population's growth.
- Explain how a chemostat can maintain a microbial culture in a continuous phase.
- Contrast direct and indirect methods of measuring bacterial reproduction
- Name the five phases of bacterial batch culture growth, and describe what the cells are doing during each phase.
- Describe the mathematical expression of growth
- Describe the viable and non-viable growth attributes
- Explain the importance of batch and continuous culture
- Compare and contrast synchronous growth, diauxic growth
- Explain the concept of diauxic growth.
- Describe the various physical factors that influence growth
- Define thermophilic, psychrophilic, psychrotolerant, mesophilic, halophilic, acidophilic, alkalophilic, etc., organisms.
- Classify organism on the basis of temperature requirements

- Classify organism on the basis of pH requirements
- Classify organism on the basis of salt requirements
- Classify organism on the basis of oxygen requirements
- Classify organism on the basis of pressure requirements
- Differentiate autotroph with heterotroph
- Classify the organism on the basis of carbon requirements
- Compare and contrast Passive and facilitated diffusion
- Explain the mechanism of group translocation
- Define uniport, symport and antiport
- Describe the microbial growth and effect of environment on microbial growth
- Describe the concept of nutrient uptake and transport.
- Explain the concepts of aerobic respiration, anaerobic respiration and fermentation and various intermediary mechanism involved.
- Explain the pentose phosphate pathway with molecular structure and enzymes involved
- Comment on the various sugar degradation pathways
- Describe with flow diagram , EMP,ED, TCA cycle and electron transport phosphorylation
- What are uncouplers and inhibitors
- Describe anaerobic respiration with special reference to dissimilatory nitrate reduction
- Give a flow diagram of lactate fermentations
- Explain the importance of metabolic pathways in case living organism
- Give the importance of linear and branched fermentation pathways
- Describe the pathway related to alcohol production
- List two differences between substrate-level phosphorylation and oxidative phosphorylation.
- Explain the importance of chemolithotrophic group of organisms
- Explain the role of hydrogen and methane producing bacteria
- Describe the process of methanogenesis in terms of electron transport and energy generation
- What are the various mode of photosynthesis available in case of bacteria
- List the important bacteria capable of carrying out bacterial photosynthesis
- Give a redox diagram to explain the anoxygenic photosynthesis in case of Purple and Green Bacteria
- Give a redox diagram related to oxygenic photosynthesis
- Describe the concept of photosynthesis with relation to light harvesting molecules
- Explain the importance of cyclic photophosphorylation
- Compare and contrast photosynthesis in cyanobacteria and purple or green bacteria
- Describe the process of biological nitrogen fixation with respect to nitrogen fixing group of organisms
- Explain the importance of assimilatory and dissimilatory nitrate reduction

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-III

Course Objective:

This course introduces the concept of cell biology. The course deals with the discovery of cells and its historical perspectives. The chapters included in different unit deals with the morphology, types, ultrastructure and function of cells. It also discusses the mechanics of cell signalling with respect to second messenger and cell sorting to various cellular compartments. The course also throws light on the mechanism of cell division and itsregulatory mechanism through CDK phosphorylation. Moreover, a very significant topic of cancer biology and apoptosis has been covered to a greater extent.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe the cell organisation in relation to plant, animals and bacterial cells
- Describe the Garth-Nicholson fluid mosaic model for explaining the plasma membrane of the prokaryotes
- What are the various mode available for the transport of small molecules across the biological membrane
- Describe the general cell wall structure of Eukaryotes
- Explain the importance of cell organelles in the survival of living organisms
- Describe the ultra structure of various cell organelles present in eukaryotic microorganisms
- Comment on the importance of cytoskeleton for performing various cellular role
- Describe role of actin filaments, intermediate filaments and microtubules
- Describe the overall structure of nuclear envelope nuclear pore complex and nuclear lamina
- Describe the molecular organisation of nucleolus
- Give the importance of Golgi and endoplasmic reticulum in protein sorting mechanism
- What benefits does cell possess after phosphorylation
- Comment on the importance of lysosomes in protein sorting
- Explain various types of signalling molecules and their receptors
- Describe the functions of cell surface receptors
- Describe in general the second messenger pathways for cellular functions
- Comment on cAMP pathway
- Describe the various phases of cell cycle
- How cell cycles is regulated at various phases
- Explain mitosis with respect to animal and plant cell
- How does cytokinesis different in plant and animal cells
- Why does a cell undergo mitotic division? Explain
- Describe the various stages of cancer development
- Sort out the various reasons for cancer progression

- Explain the importance of Programmed cell death and various pathways used during apoptosis.

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-III

Course Objective:

Eubacteria and Eukaryotes genome replication and expression are considered together in this course. In both cases, the topics has been updated and expanded, and reflects the comparative information flow as carried out by members of Eubacteria and Eukaryote. It will enable the students to know the terms and terminologies related to molecular biology. It will help student to understand the properties, structure and function of genes at the molecular level.To discuss the molecular mechanisms underlying mutations, detection of mutations and DNAdamage and repair mechanisms along with the molecular mechanism involved in Replication,Transcription and Translation and the enzymes, accessory proteins involved in it.

Learning Outcome:

After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Know the terms and terminologies related to molecular biology and microbial genetics
- Explain Griffith's classic experiment with rough and smooth cells. Describe the relationship between capsule genes and virulence.
- Understand the properties, structure and function of genes in living organisms at the molecular level
- Explain the significance of central dogma of gene action
- Have a conceptual knowledge about DNA as a genetic material, enzymology, and replication strategies
- Compare and contrast prokaryotic and eukaryotic chromosomes.
- Describe the replication of DNA as a semiconservative process.
- Compare and contrast the synthesis of leading and lagging strands in DNA replication.
- Contrast bacterial DNA replication with that of eukaryotes.
- State the central dogma of genetics, and explain the roles of DNA and RNA in polypeptide synthesis.
- Describe the structure of DNA, and its importance as genetic material.
- Describe three steps in RNA transcription, mentioning the following: DNA, RNA polymerase, and promoter, 5' to 3' direction, terminator, and Rho.
- Contrast bacterial transcription with that of eukaryotes.

- Describe the genetic code in general, and identify the relationship between codons and amino acids.
- Describe the synthesis of polypeptides, identifying the roles of three types of RNA.
- Contrast translation in bacteria from that in eukaryotes.
- Explain the operon model of transcriptional control in prokaryotes.
- Contrast the regulation of an inducible operon with that of a repressible operon, and give an example of each.
- Understand the molecular mechanisms involved in transcription and translation
- Describe the importance of genetic code and wobble hypothesis
- Explain the role of post transcriptional mRNA processing in Eukaryotes
- Explain the translation process of eukaryotes and prokaryotes
- Describe the molecular mechanism of sporulation
- Describe the DNA methylations mechanism
- Describe the histone acetylation mechanism

SKILL ENHANCEMENT ELECTIVE COURSE
SEMESTER – III

Learning Outcome:
After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Understand good laboratory practices
- Understand good microbiological practices
- To know the working of biosafety cabinets
- To know the means of discarding biohazardous materials
- To know the methods of disinfection
- To understand the concept of cultural and microscopic methods
- To enumerate the number by standard plate count and MPN technique
- To know direct microscopic measurements
- Describe the various immunological and biochemical methods for determining food toxins
- Know the use of nucleic acid probes in the assessment of microbe in food sample
- To learn the art of enrichment technique
- To use differential selective media for isolating specific bacteria from water and food samples
- To ascertain the quality of milk sample by MBRT technique
- To learn the rapid detection technique of microbiological quality of milk using, COB, 10 min Resazurin assay
- To appreciate the importance of Hazard analysis of critical control point (HACCP)
- State the BIS standards for common foods and drinking water

SKILL ENHANCEMENT ELECTIVE COURSE
SEMESTER – IV

Learning Outcome:
After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- To list the different types of fermented foods
- State the health benefits advantages of fermented foods
- To learn the various types of milk based fermented foods like Dahi, Yogurt, Buttermilk (Chach) and cheese
- Describe the importance of cereal based fermented foods
- To learn the production methods of Soy sauce, Bread, Idli and Dosa
- To learn the production methods and microorganisms involved in Pickels, Saeurkraut
- To learn the basic of fermented meat and fish products
- To learn the importance of probiotics in promoting health benefits

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-IV

Course Objective:
Microbial genetics have revolutionized the field of microbiology and the present course covers genome organization, mutations and mechanism in the context of genetic variation into populations. Content also focuses on the mechanism of viral multiplications and stresses on phage genetics and molecular switch.

Learning Outcome:
After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Compare and contrast the genomes of prokaryotes and eukaryotes.
- Describe the structure and function of plasmids.
- Contrast vertical gene transfer with horizontal gene transfer.
- Explain the roles of an F factor, F+ cells, and Hfr cells in bacterial conjugation.
- Compare and contrast crossing over, transformation, transduction, and conjugation.
- Describe a lac operon.

- Define molecular basis of mutation.
- Define point mutation, and describe three types.
- List three effects of point mutations.
- Discuss how different types of radiation cause mutations in a genome.
- Describe three kinds of chemical mutagens and their effects.
- Describe light and dark repair of pyrimidine dimers, base excision repair, mismatch repair, and the SOS response.
- Contrast the positive and negative selection techniques for isolating mutants.
- Describe the Ames test, and discuss its use in discovering carcinogens.
- Discuss the molecular mechanisms underlying mutations, detection of mutations and DNA damage and repair mechanisms
- Describe the genetic basis of lytic and lysogenic switches
- Describe the mechanism of vector mediated horizontal gene transfer
- Explain the HFT and LFT
- Describe the importance of transposable element
- What are insertion sequences
- What are P elements in drosophila
- What are Ac/Dc in maize
- Explain the use of transposition and transposons in genetics

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-IV

Course Title:

Course Objective:

This course has been designed as student-friendly by incorporating pressing issues related to global environmental context. The content in this course also reflect the importance of microorganisms in providing many essential services through its interaction with the biotic and abiotic components of the ecosystem. The importance of essential gaseous and non- gaseous elements required for survival of diverse group of organisms on earth and its cyclic transformation through dynamic biogeochemical cycling and the microbes involved shall be dealt extensively. It also provides an opportunity to appreciate the diversity of

microorganism, abundance and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats. The content of the course also stresses the urgent need of understanding the water as indispensable resource for the survival of human on this planet. The student will learn the various methods available for the determination of sanitary quality of water and sewage treatment methods employed in waste water treatment.

Learning Outcome:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe how microbial metabolism can be manipulated for food production.
- Describe how food characteristics and the presence of microorganisms in food can lead to food spoilage.
- List several methods for preventing food spoilage.
- Discuss the basic types of illnesses caused by food spoilage or food contamination, and describe how they can be avoided.
- Describe the role of genetically manipulated microorganisms in industrial and agricultural processes and the basics of industrial- scale fermentation.
- List some of the various commercial products produced by microorganisms.
- Describe two waterborne illnesses.
- Explain how water for drinking and wastewater are treated to make them safe and usable.
- Define the terms used to describe microbial relationships within the environment.
- Explain the influences of competition, antagonism, and cooperation on microbial survival.
- Describe the process of bioremediation.
- Contrast the processes by which microorganisms cycle carbon, nitrogen, sulfur and phosphorus.
- Explain the work of microorganisms in the carbon cycle.
- Elucidate the phosphorous pathway
- Contrast the actions of microbes involved in nitrogen fixation, nitrification, ammonification, denitrification, and anammox reactions.
- How microbes are used for degradation of pesticides
- Describe the importance of hydrocarbon degrading bacteria
- Describe the reduction and oxidation of sulfur by microbes.
- Identify five factors affecting microbial abundance in soils.
- Describe the various methods for solid waste management
- List the various methods available for waste water treatment
- Compare the characteristics and microbial populations of freshwater and marine ecosystems.

- Describe the MPN, P/A tests and membrane filter technique for assessing water quality
- State the strength of sewage with respect to BOD and COD parameters
- Compare and contrast symbiotic and non-symbiotic interactions
- Comment on the microflora of ruminant animals
- Explain the importance of nematophagous fungi

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-IV

Course Objective:
The course will help the student to appreciate the importance of microbes in feeding the billions of population on earth. Additionally, preservation of food material from spoilage microorganisms with respect to food borne pathogens and its safety regulation shall be dealt extensively. The course will also focus on the traditional methods of food processing mainly the fermented food and how a microbe enhances the palatability of food by enhancing the nutrient quality and health benefits through development of antioxidant molecules in the finished products. Moreover, the economic importance of food from the microbiological perspective shall be studied in detail.

Learning Outcome:
After successful completion of this course students will be able to:

- Demonstrate an understanding of the principles of scientific inquiry.
- Demonstrate the ability to think critically and employ critical thinking skills.
- Demonstrate the ability to make connections between concepts across Microbiology.
- Describe the extrinsic and intrinsic factors that affect growth and survival of microorganism
- Describe various methods available for control of spoilage microorganisms
- Explain the importance of physical method for the control of microorganism in food
- State the importance of chemical methods of food preservations
- List the different starter cultures used in food production
- List the different types of fermented foods
- Describe the health promoting effect of probiotics
- Describe how microbial metabolism can be manipulated for food production.
- Describe how food characteristics and the presence of microorganisms in food can lead to food spoilage.
- List several methods for preventing food spoilage.
- Discuss the basic types of illnesses caused by food spoilage or food contamination, and describe how they can be avoided.

- Describe the role of genetically manipulated microorganisms in industrial and agricultural processes and the basics of industrial- scale fermentation.
- List some of the various commercial products produced by microorganisms.
- Describe the characteristics of food borne pathogens and how is it related to disease formation
- Explain the importance of HACCP
- Describe the various indices of food sanitary quality and sanitizers
- Describe the involvement of bacteria in Food intoxications
- Describe the involvement of bacterial infections in food with respect to both Gram positive and negative bacteria

PRACTICAL PAPERS

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-I

Course Objective:
The students will be attending a laboratory session of 6 hours weekly and they have to perform the practical related to the course list. The Purpose of the lab course is to introduce students to the various types of instruments used in microbiology laboratory. They will learn to take weight measurements using electronics balance for preparing microbial media and reagents required in laboratory along with the art of sterilisation using autoclaves, membrane filter, and hot air oven. The main objective of this subject is to help students identify the different latest measurement and sterilisation techniques available for specific microbiological applications. Lastly, the course is so designed to provide greater safetyawareness and to alert students to potential hazards in performing certain experiments in working laboratory.

Learning Outcomes:
This course will lead the students to
- Understand the various measurement techniques available.
- Understand the basic working of instruments used for measurement.
- Understand the errors in measurements and their rectification.
- Understand the importance of aseptic practises in Microbiology laboratory.
- Demonstrate practical skills in microscopy and their handling techniques along with staining procedures

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets,
Autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the

Microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar Plates to air.
8. Study of *Rhizopus*, *Aspergillus* using temporary mounts
9. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Plasmodium*

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-I

Course Objective: The course aims at developing an appreciation about the principles, functions of culture media used in microbiology laboratory and functioning of various instruments. Know various types of culture media and their applications and also understand various physical and chemical means of sterilization

Learning Outcomes: After completion of course students will be able to:

- Work independent in microbiological laboratory.
- To apply the principles and theories learned in the theory in the practical work context.
- Develop mastery of aseptic techniques.
- To perform routine culture handling task safe and effectively.

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-II

Course Objective:
The purpose of this practical course is to provide a basis for understanding the basic working design and use of spectrophotometer for determination of linear quantitative curve for the estimation of biological macromolecules, with basic operation and limitations of

spectrophotometer. The course is intended to equip students with a basic understanding of the underlying principles of quantitative and qualitative research methods. This course also helps the students to understand the preparation of reagents and serial dilutions for preparation of standard curve. They will also learn the effect of physical factors and inorganic components mainly the heavy metals on the activity of functional molecules like enzymes.

Learning Outcomes: After completion of course students will be able:

- To use spectrophotometer independently for carrying biochemistry experiments.
- To master hands on experience with electronic instruments.

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non-reducing sugars
4. Qualitative/Quantitative tests for lipids and proteins
5. Study of protein secondary and tertiary structures with the help of models
6. Study of enzyme kinetics – calculation of *V*max , Km, Kcat values
7. Study effect of temperature, pH and Heavy metals on enzyme activity
8. Estimation of any one vitamin

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-II

Course Objective:

To reinforce learning in the virology course through hands-on experience with plaque assay determination using agar double layer technique and plant assay using focal lesion technique. This course is intended to understand the students to critically analyze the operation of various electron microscopes for ultra-structure determination and morphological characterization of viruses.

Learning Outcomes:

After completion of this course, the students will be:

- Capable of working with sewage sample for water quality analysis using plaque assay.
- To understand the importance of various method used in studying viruses.
- Describe electron micrographs of both the animal and plant viruses.
- Know viral diversity using electron micrograph.

1. Study of the structure of important animal viruses (influenza, hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (Gemini, tobacco ring spot and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Study of cytopathic effects of viruses using photographs
6. Perform local lesion technique for assaying plant viruses.

BSc. MICROBIOLOGY (CBCS)

SYLLABUS: SEMESTER-III

Course Objective:
To reinforce learning in the microbial physiology course through hands-on experience with growth kinetics experiments using spectrophotometer. This course is intended to understand the students to critically analyze the physical factors which influence the growth dynamics of the organism. Moreover, knowledge acquired through practical doing will help the students to relate better with theoretical paper.

Learning Outcomes:
After completion of this course, the students will be;

- Capable of working with bacterial culture for determining the generation time and growth rate constant.
- Describe the roles of carbon, nitrogen, sodium chloride, pH and temperature in microbial growth and reproduction.
- Know the various Physical and Chemical growth requirements of microbes and get equipped with various methods of bacterial growth measurement.

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

BSc. MICROBIOLOGY (CBCS)

SEMESTER-III

Course Objective:
The purpose of this course is to introduce the students the basics of cell biology. The course provides the opportunity to observe cell undergoing mitotic and meiotic division in a realtime basis using compound microscope. Moreover, the experiments in this laboratory course enable the students to gather basic knowledge on chromosomal material through cytochemical staining. Different experiments are also performed which forms the fundamental blocks for understanding the ploidy level in an organisms.
Learning Outcomes:
After completion of this course, the students will be:

- Capable of counting chromosome under the microscope.
- Describe the size and shape of chromosome at various stages of mitotic phase.
- On a long term basis they will develop skill which will be helpful for those student who wants to pursue higher learning in the field of cytogenetics.

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Study of polyploidy in Onion root tip by colchicine treatment.
5. Identification and study of cancer cells by photomicrographs.
6. Study of different stages of Mitosis.
7. Study of different stages of Meiosis.

BSc. MICROBIOLOGY (CBCS)

SEMESTER-III

Course Objective:
The purpose of this course is to teach students the fundamentals of molecular biology through means of hands-on experiment. The student will be able to isolate DNA, estimate nucleic acid (RNA/DNA) and will characterize it using vertical gel electrophoresis. The main objective of this course is to help student's physical understanding of the genetic material present in all living organisms.

Learning Outcomes:
After completion of this course, the students will be;

- Capable of using electrophoretic unit for resolving the size of biomolecules. It will also enable them to take biotechnology as a discipline for pursuing MSc and higher research.

1. Study of different types of DNA and RNA using micrographs and model / schematic representations
2. Study of semi-conservative replication of DNA through micrographs / schematic representations
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

BSc. MICROBIOLOGY (CBCS)

SEMESTER-IV

Course Objective:
The purpose of this course is to teach students the fundamentals of microbial genetics through means of hands-on experiment. The students will also study the effects of chemical and physical mutagens on bacterial cells and carry out Ames test for the same. The course also provides them with the opportunity to learn various available techniques for assessment of vertical gene transfer. They will try to explain the concept of recombination and elucidate the gene transfer mechanisms in Prokaryotes.

Learning Outcomes:
After completion of this course, the students will be able:

- Master technique for isolation of mutants and its characterization.
- Master the skill to handle and work independently on lab protocols involving molecular techniques.
- To use spectrophotometer, bench top centrifuge during isolation of plasmid.

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

BSc. MICROBIOLOGY (CBCS)

SEMESTER-IV

Course Objective:
The purpose of this course is to teach students the fundamentals of environmental microbiology through means of hands-on experiment. They will be given on field hands-on exposure on experiments of microbial ecology through assessment of rhizosphere soil and rhizoplane habitat. This course will also help them to carry out water analysis on the physico-chemical basis.

Learning Outcomes:
The students will carry out field exclusion for sampling of water and soil sample. The course also provides them with the opportunity to learn various available techniques for assessment of ecological curriculum on class outside the classroom basis. It will be helpful to develop skilled human resource to study the effect of green house gases on climate change and management of natural and anthropogenic wastes.

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
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 (amylase) in soil.
7. Isolation of *Rhizobium* from root nodules.

BSc. MICROBIOLOGY (CBCS)

SEMESTER-IV

Course Objective:

This lab course will help the students to understand the basic principles of food and dairy microbiology through practical module systems. The experiments are designed in student friendly way that the theoretical concepts introduced in lectures are re- discussed and implemented practically. The characterization of the microbes isolated from spoiled food stuffs will be done extensively until the basic skill is developed among the student.

Learning Outcomes:

- To provide hands-on experience to the students so that they are able to put theoreticalconcepts to practice.
- To use MBRT and alkaline phosphatase test for the assessment of milk quality.
- To isolate food borne pathogens from the spoiled food/vegetables.
- On the long term basis the course will be fruitful to generate professionals with boththeoretical and practical knowledge for food and dairy industry.

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt.