DINABANDHU ANDREWS COLLEGE

DEPARTMENT OF MICROBIOLOGY

LESSION PLAN

2018-2022

Dr. Swapna Mukherjee

Associate Professor of Microbiology

Dinabandhu Andrews College

Dr. Swapna Mukherjee (July – Dec 2018)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **THEORY:** **Unit 2 Diversity of Microbial World:** B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions)and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. • Algae History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food. • Protozoa General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania* And *Giardia* ***Learning Objectives:*** *The objective of studying the diversity of the microbial world is to understand the vast array of microorganisms, including bacteria, viruses, fungi, and archaea, and their roles in various ecosystems, human health, industry, and biotechnology. By exploring microbial diversity, scientists can uncover new species, discover novel biochemical pathways, develop new antibiotics, and gain insights into evolutionary processes.* ***Learning Outcomes:*** *The diversity of the microbial world is vast and essential for maintaining ecological balance, human health, and various biotechnological applications. Microbes play crucial roles in nutrient cycling, decomposition, and symbiotic relationships with plants and animals. They also produce antibiotics, enzymes, and other valuable compounds. Understanding and harnessing this diversity can lead to*	8	1st – 2nd week of September

	advancements in medicine, agriculture, environmental remediation, and industry. **Unit 3 An overview of Scope of Microbiology** **PRACTICAL:** 8. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts 9. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts 10. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium **CC-2: BACTERIOLOGY** **THEORY:** **Unit 3 Microscopy:** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope. ***Learning Objectives:*** *The objective of microscopy is to magnify and visualize small objects or details that are not visible to the naked eye, enabling scientists and researchers to study and understand their structure, composition, and behaviour.* ***Learning Outcomes:*** *The outcomes of microscopy can vary depending on the specific technique and application. Generally, they include Visualizing the structure and morphology of specimens. Identifying specific features or components within a sample.Analyzing the spatial distribution of substances or structures. Observing dynamic processes in real-time, such as cellular activities. Generating images or data for further analysis and interpretation in fields like biology, materials science, forensics, and nanotechnology.*	4	3rd week of September

Dr. Swapna Mukherjee (Jan - June 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 1 Bioenergetics:** First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP ***Learning Objectives:*** *The objective of bioenergetics is to study how living organisms acquire and utilize energy to carry out their various functions, including metabolism, growth, reproduction, and movement. It explores the biochemical processes involved in the conversion of energy from one form to another within living systems.* ***Learning Outcomes:*** *The outcomes of bioenergetics include a deeper understanding of how energy is transformed and utilized within living organisms, which can lead to advancements in various fields such as medicine, biotechnology, and environmental science. By studying bioenergetics, researchers can develop strategies for improving energy efficiency, treating metabolic disorders, and designing sustainable bio-based technologies. Additionally, insights gained from bioenergetics research can contribute to our understanding of fundamental biological processes and evolutionary adaptations.* **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 2 Nucleus:** Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization, Nucleolus. ***Learning Objectives:*** *The primary objective of the nucleus is to serve as the control center of the cell, regulating gene expression and coordinating cellular activities. It houses the cell's genetic material (DNA) and controls the synthesis of RNA and proteins essential for cell function and development. Additionally, the nucleus plays a crucial role in cell division, ensuring the accurate segregation of chromosomes during mitosis and meiosis.*	5 3	1st – 2nd week of April 3rd week of April

	Learning Outcomes: *The outcomes of the nucleus's functions include the regulation of gene expression, which dictates the synthesis of proteins and ultimately influences the cell's structure, function, and behaviour. Additionally, the nucleus ensures the faithful transmission of genetic information from one generation of cells to the next during cell division, contributing to the maintenance of genetic stability and continuity of life.* **Unit 3 Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes ***Learning Objectives:*** *The objective of protein sorting and transport is to ensure that proteins are correctly targeted to their designated locations within the cell and beyond, facilitating their proper function. This process involves sorting proteins within the cell and transporting them to specific organelles, compartments, or extracellular spaces where they are needed. Proper protein sorting and transport are essential for various cellular processes, including metabolism, signaling, and cell communication.* ***Learning Outcomes:*** *The Outcomes of Protein sorting and transport are essential processes in the cell that ensure proteins are directed to their correct destinations and fulfill their specific functions. These processes occur in various cellular compartments such as the endoplasmic reticulum (ER), Golgi apparatus, endosomes, lysosomes, and plasma membrane.* **PRACTICAL:** 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. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B 5. Study of polyploidy in Onion root tip by colchicine treatment. 6. Identification and study of cancer cells by photomicrographs. 7. Study of different stages of Mitosis. 8. Study of different stages of Meiosis.	5	1st – 2nd week of May

Dr. Swapna Mukherjee (July – Dec 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **THEORY:** **Unit 2 Diversity of Microbial World:** B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions)and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. • Algae History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food. • Protozoa General characteristics with special reference to *Amoeba*, *Paramecium, Plasmodium, Leishmania* And *Giardia* ***Learning Objectives: The objective of studying the diversity of the microbial world is to understand the vast array of microorganisms, including bacteria, viruses, fungi, and archaea, and their roles in various ecosystems, human health, industry, and biotechnology. By exploring microbial diversity, scientists can uncover new species, discover novel biochemical pathways, develop new antibiotics, and gain insights into evolutionary processes.*** ***Learning Outcomes: The diversity of the microbial world is vast and essential for maintaining ecological balance, human health, and various biotechnological applications. Microbes play crucial roles in nutrient cycling, decomposition, and symbiotic relationships with plants and animals. They also produce antibiotics, enzymes, and other valuable compounds. Understanding and harnessing this diversity can lead to advancements in medicine, agriculture, environmental remediation, and industry.*** **Unit 3 An overview of Scope of Microbiology** **PRACTICAL:**	8	1st – 2nd week of October

	8. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts 9. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts 10. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium **CC-2: BACTERIOLOGY** **THEORY:** **Unit 3 Microscopy:** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope. ***Learning Objectives: The objective of microscopy is to magnify and visualize small objects or details that are not visible to the naked eye, enabling scientists and researchers to study and understand their structure, composition, and behaviour.*** ***Learning Outcomes: The outcomes of microscopy can vary depending on the specific technique and application. Generally, they include Visualizing the structure and morphology of specimens. Identifying specific features or components within a sample.Analyzing the spatial distribution of substances or structures. Observing dynamic processes in real-time, such as cellular activities. Generating images or data for further analysis and interpretation in fields like biology, materials science, forensics, and nanotechnology.***	4	3rd week of October
	SEMESTER –3 **CC-5: VIROLOGY:** **THEORY:** **Unit 1 Nature and Properties of Viruses:** Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses, Viral taxonomy: Classification and nomenclature of different groups of viruses ***Learning Objectives: The objective of studying the nature and properties of viruses is to understand their structure, replication mechanisms, interactions with host cells, and the diseases they cause. This knowledge is crucial for developing***	4	1st week of September

	effective strategies for prevention, diagnosis, and treatment of viral infections. ***Learning Outcomes:*** *The outcome of studying the nature and properties of viruses is critical for advancing our ability to prevent, diagnose, and treat viral infections, ultimately improving public health outcomes.* **Unit 2 Bacteriophages:** Diversity, classification, one step multiplication curve, lytic and lysogenic phage (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage ***Learning Objectives:*** *The objective of bacteriophages, also known as phages, is to infect and replicate within bacterial cells, ultimately leading to their destruction. Bacteriophages are viruses that specifically target bacteria, and they play a crucial role in regulating bacterial populations in various ecosystems. In addition to their natural role, bacteriophages are being researched for their potential use in treating bacterial infections, particularly those that are antibiotic-resistant.* ***Learning Outcomes:*** *The outcome of bacteriophage infection can range from the destruction of bacterial cells to the establishment of symbiotic relationships, with implications for bacterial population dynamics, evolution, and biotechnological applications.* **Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication:** Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : 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) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions) ***Learning Objectives:*** *The objective of viral transmission, from the virus's perspective, is to infect new hosts and replicateitself to ensure its survival and propagation.* *learning Outcomes: The outcome of viral transmission can vary depending on factors such as the virus's virulence, the host's immune response, and environmental conditions. Possible*	5 14	2^{nd} – 3^{rd} week of September 1^{st} – 3^{rd} week of October

	outcomes include successful infection and replication, asymptomatic infection, mild illness, severe illness, recovery, or death. **Unit 6 Applications of Virology:** Use of viral vectors in cloning and expression, Gene therapy and Phage display *Learning Objectives: The objective of applications of virology is to understand, prevent, and treat viral infections. This includes developing vaccines, antiviral drugs, diagnostic tests, and public health strategies to control the spread of viruses and mitigate their impact on human, animal, and plant health.* *Learning Outcomes: The outcomes of applications of virology can be diverse and impactful. They include the development of vaccines that prevent viral infections, antiviral medications that treat viral diseases, diagnostic tests that accurately identify viral pathogens, and public health strategies that control and mitigate the spread of viruses. These applications contribute to saving lives, reducing illness and suffering, and improving overall global health outcomes. Additionally, virology research helps advance our understanding of viruses, leading to innovations in biotechnology, agriculture, and other fields.*	4	4th week of October

Dr. Swapna Mukherjee (Jan – June 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 1 Bioenergetics:** First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP ***Learning Objectives: The objective of bioenergetics is to study how living organisms acquire and utilize energy to carry out their various functions, including metabolism, growth, reproduction, and movement. It explores the biochemical processes involved in the conversion of energy from one form to another within living systems.*** ***Learning Outcomes: The outcomes of bioenergetics include a deeper understanding of how energy is transformed and utilized within living organisms, which can lead to advancements in various fields such as medicine, biotechnology, and environmental science. By studying bioenergetics, researchers can develop strategies for improving energy efficiency, treating metabolic disorders, and designing sustainable bio-based technologies. Additionally, insights gained from bioenergetics research can contribute to our understanding of fundamental biological processes and evolutionary adaptations.*** **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 2 Nucleus:** Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization, Nucleolus ***Learning Objectives: The primary objective of the nucleus is to serve as the control center of the cell, regulating gene expression and coordinating cellular activities. It houses the cell's genetic material (DNA) and controls the synthesis of RNA and proteins essential for cell function and development. Additionally, the nucleus plays a crucial role***	5 3	1st – 2nd week of March 3rd week of March

	in cell division, ensuring the accurate segregation of chromosomes during mitosis and meiosis. *Learning Outcomes: The outcomes of the nucleus's functions include the regulation of gene expression, which dictates the synthesis of proteins and ultimately influences the cell's structure, function, and behaviour. Additionally, the nucleus ensures the faithful transmission of genetic information from one generation of cells to the next during cell division contributing to the maintenance of genetic stability and continuity of life.* **Unit 3 Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes. *Learning Objectives: The objective of protein sorting and transport is to ensure that proteins are correctly targeted to their designated locations within the cell and beyond, facilitating their proper function. This process involves sorting proteins within the cell and transporting them to specific organelles, compartments, or extracellular spaces where they are needed. Proper protein sorting and transport are essentialfor various cellular processes, including metabolism,signaling, and cell communication.* *Learning Outcomes: The Outcomes of Protein sorting and transport are essential processes in the cell that ensure proteins are directed to their correct destinations and fulfill their specific functions. These processes occur in variouscellular compartments such as the endoplasmic reticulum (ER), Golgi apparatus, endosomes, lysosomes, and plasmamembrane.* **PRACTICAL:** 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. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B 5. Study of polyploidy in Onion root tip by colchicine treatment.	5	1st – 2nd week of April

	6. Identification and study of cancer cells by photomicrographs. 7. Study of different stages of Mitosis. 8. Study of different stages of Meiosis.		
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 1 Genome Organization and Mutations:** Genome organization: E. coli, Saccharomyces, Tetrahymena ***Learning Objectives: The objective of studying genome organization and mutation is to understand how genetic information is structured within an organism's DNA or RNA and how it can change over time through mutation. This knowledge helps scientists comprehend the mechanisms underlying inheritance, evolution, and disease development. Additionally, studying genome organization and mutation aids in various applications, such as genetic engineering, personalized medicine, and evolutionary biology.*** ***Learning Outcomes: The outcomes of studying genome organization and mutation are manifold. They include advancements in fields such as molecular biology, genetics, and medicine. Understanding genome organization helps researchers identify genes, regulatory elements, and functional regions within the genome, leading to insights into normal biological processes and disease mechanisms. Additionally, studying mutations provides insights into evolutionary processes, genetic diversity, and the development of genetic diseases. Practical outcomes include thedevelopment of diagnostic tools, therapies, and strategies for genetic disorders, as well as advancements in biotechnology and agriculture.*** **Unit 4 Phage Genetics:** Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda. ***Learning Objectives: The objective of phage genetics is to understand the genetic structure, function, and regulation of bacteriophages, which are viruses that infect bacteria. By studying phage genetics, scientists aim to gain insights into fundamental genetic processes, such as replication, transcription, and recombination, as well as the interactions between phages and their bacterial hosts. This knowledge can have implications for biotechnology, medicine (such as phage***	4 4	1st week of April 2nd week of April

	therapy), and our understanding of microbial ecology and evolution. *Learning Outcomes: The outcomes of studying phage genetics are diverse and impactful. They include advancements in fields such as molecular biology, biotechnology, and medicine. By elucidating the genetic mechanisms of bacteriophages, researchers can develop novel tools for genetic engineering, such as viral vectors for gene delivery and editing. Additionally, phage genetics research contributes to our understanding of microbial ecology, bacterial pathogenesis, and the evolution of viruses. Practical outcomes include the development of phage therapy as an alternative to antibiotics, as well as the use of phages in bioremediation and food safety applications.* **Unit 5 Transposable elements:** Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements – Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition *Learning Objectives: The objective of studying transposable elements is to understand their structure, function, and evolutionary significance within genomes. Transposable elements are DNA sequences capable of moving from one location to another within a genome, and they can influence gene expression, genome organization, and genome evolution. By investigating transposable elements, researchers aim to uncover their roles in genetic variation, adaptation, and disease, as well as their potential applications in genetic engineering and biotechnology.* *Learning Outcomes: The outcomes of studying transposable elements are multifaceted. They include advancements in understanding genome dynamics, evolution, and genetic diversity. By elucidating the roles of transposable elements, researchers gain insights into genome organization, gene regulation, and genetic diseases. Furthermore, transposable elements contribute to genetic variation within populations, facilitating adaptation to changing environments. Practical outcomes include the development of genetic tools for manipulating genomes, such as transposon-based gene delivery systems, and the potential use of transposable elements in biotechnology, such as gene editing and synthetic biology applications.*	5	3rd – 4th week of April

Dr. Swapna Mukherjee (July – Dec 2020)

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	Unit 3 An overview of Scope of Microbiology **PRACTICAL:** 8. Study of Rhizopus, Penicillium, Aspergillus using temporary mounts 9. Study of Spirogyra and Chlamydomonas, Volvox using temporary Mounts 10. Study of the following protozoans using permanent mounts/photographs: Amoeba, Entamoeba, Paramecium and Plasmodium **CC-2: BACTERIOLOGY** **THEORY:** **Unit 3 Microscopy:** Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope ***Learning Objectives: The objective of microscopy is to magnify and visualize small objects or details that are not visible to the naked eye, enabling scientists and researchers to study and understand their structure, composition, and behaviour.*** ***Learning Outcomes: The outcomes of microscopy can vary depending on the specific technique and application. Generally, they include Visualizing the structure and morphology of specimens. Identifying specific features or components within a sample.Analyzing the spatial distribution of substances or structures. Observing dynamic processes in real-time, such as cellular activities. Generating images or data for further analysis and interpretation in fields like biology, materials science, forensics, and nanotechnology.***	4	3rd week of September
	SEMESTER –3 **CC-5: VIROLOGY:** **THEORY:** **Unit 1 Nature and Properties of Viruses:** Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses, Viral taxonomy: Classification and nomenclature of different groups of viruses	4	1st week of September

	Learning Objectives: The objective of studying the nature and properties of viruses is to understand their structure, replication mechanisms, interactions with host cells, and the diseases they cause. This knowledge is crucial for developing effective strategies for prevention, diagnosis, and treatment of viral infections. ***Learning Outcomes: The outcome of studying the nature and properties of viruses is critical for advancing our ability to prevent, diagnose, and treat viral infections, ultimately improving public health outcomes.*** **Unit 2 Bacteriophages:** Diversity, classification, one step multiplication curve, lytic and lysogenic phage (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage ***Learning Objectives: The objective of bacteriophages, also known as phages, is to infect and replicate within bacterial cells, ultimately leading to their destruction. Bacteriophages are viruses that specifically target bacteria, and they play a crucial role in regulating bacterial populations in various ecosystems. In addition to their natural role, bacteriophages are being researched for their potential use in treating bacterial infections, particularly those that are antibiotic-resistant.*** ***Learning Outcomes: The outcome of bacteriophage infection can range from the destruction of bacterial cells to the establishment of symbiotic relationships, with implications for bacterial population dynamics, evolution, and biotechnological applications.*** **Unit 3 Viral Transmission, Salient features of viral nucleic acids and Replication:** Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : 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) Viral multiplication and replication	5 14	2^{nd} – 3^{rd} week of September 1^{st}- 3^{rd} week of October

	strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions) ***learning Objectives: The objective of viraC transmission, from the virus's perspective, is to infect new hosts and replicate itseCf to ensure its survivaC and propagation.*** ***learning Outcomes: The outcome of viraC transmission can vary depending on factors such as the virus's virulence, the host's immune response, and environmental conditions. Possible outcomes incCude successfuC infection and replication, asymptomatic infection, miCd iCCness, severe iCCness, recovery, or death.*** **Unit 6 Applications of Virology:** Use of viral vectors in cloning and expression, Gene therapy and Phage display. ***learning Objectives: The objective of applications of viroCogy is to understand, prevent, and treat viraC infections. This incCudes developing vaccines, antiviral drugs, diagnostic tests, and puCic heaCth strategies to controC the spread of viruses and mitigate their impact on human, animaC, and pCant heaCth.*** ***learning Outcomes: The outcomes of applications of viroCogy can be diverse and impactfuC. They incCude the deveCopment of vaccines that prevent viraC infections, antiviraC medications that treat viraC diseases, diagnostic tests that accurately identify viraC pathogens, and puCic heaCth strategies that controC and mitigate the spread of viruses. These applications contribute to saving Cives, reducing iCCness and suffering, and improving overaCC gCobaC heaCth outcomes. Additionally, virology research heCps advance our understanding of viruses, Ceading to innovations in biotechnology, agriCture, and other fieCds.***	4	4th week of October
	SEMESTER –5 **CC-12: INDUSTRIAL MICROBIOLOGY:** **THEORY:**		

	Unit 1 Introduction to industrial microbiology: Brief history and developments in industrial microbiology ***Learning Objectives: The objective of an introduction to industriaC microbiology is to provide students or Learners with fundamental knowledge and skills related to the application of microorganisms in industrial processes. This includes understanding the role of microorganisms in various industries such as food and beverage, pharmaceuticals, biotechnology, agriculture, and environmental management. Additionally, the objective is to familiarize learners with techniques for microbial cultivation, fermentation, product development, quality control, and regulatory considerations in industrial settings. OveraCC, the goaC is to prepare individuals for careers in industries where microbiological processes play a crucial role.*** ***Learning Outcomes: The outcomes of an introduction to industriaC microbiology are diverse and impactful. They include equipping individuals with the knowledge and skills needed to work in various industries where microorganisms are utilized. This can lead to career opportunities in fields such as food and beverage production, pharmaceuticals, biotechnology, agriculture, environmental management, and more. Additionally, understanding industrial microbiology enables individuals to contribute to research and development efforts aimed at improving microbial processes, developing new products, and enhancing production efficiency. OveraCC, the outcome is to empower individuals to make meaningfuC contributions to the diverse applications of microbiology in industry.***	1	1st week of August
	Unit 2 Isolation of industrially important microbial strains and fermentation media: Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. ***Learning Objectives: The objective of isolating industrially important microbial strains and optimizing fermentation media is to identify and cultivate microorganisms that can efficiently produce desired products or carry out specific functions in industrial processes. This involves selecting***	4	1st – 2nd week of August

	strains with desirable traits such as high productivity, robustness, and compatibility with industrial conditions. Additionally, the objective is to develop fermentation media tailored to the nutritional needs of the selected strains, optimizing parameters such as carbon source, nitrogen source, pH, temperature, and oxygen levels to maximize product yield and quality. Overall, the goal is to establish reliable and efficient microbial fermentation processes for industrial applications. ***Learning Outcomes: The outcome of isolating industrially important microbial strains and optimizing fermentation media is the establishment of efficient, sustainable, and innovative production processes that meet the needs of industries and society.*** **Unit 3 Types of fermentation processes, bio-reactors and measurement of fermentation Parameters:** Types of fermentation processes – Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. Baker's yeast) and continuous fermentations Components of a typical bio-reactor, Types of bioreactors- Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters – pH, temperature, dissolved oxygen, foaming and aeration ***Learning Objectives: The objectives aim to equip individuals with the knowledge and skills needed to design, optimize, and operate fermentation processes efficiently and effectively for various industrial applications.*** ***Learning Outcomes: The outcomes empower individuals and industries to efficiently harness microbial fermentation for the production of a wide range of valuable products while advancing sustainability and innovation in bioprocessing.*** **PRACTICAL:** 1. Study different parts of fermenter 3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations. **DSE-A:1.MICROBIAL BIOTECHNOLOGY:** **THEORY:**	6	3rd – 4th week of August

	Unit 1 Microbial Biotechnology and its Applications: Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast ***Learning Objectives: The objective of microbial biotechnologyis to harness the diverse capabilities of microorganisms to address societal challenges, promote sustainable development, and improve human we@@-being across various sectors.*** ***Learning Outcomes: The outcomes of microbial biotechnologyand its applications lead to advancements in industry, agriculture, environmental stewardship, healthcare, and biodiversity conservation, promoting sustainable development and improving human we@@-being.***	5	1st – 2nd week of October
	Unit 3 Applications of Microbes in Biotransformations : Microbial based transformation of steroids and sterols Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute ***Learning Objectives: The objective of applying microbes in biotransformation is to harness their enzymatic capabilities to facilitate the synthesis, modification, and diversification of organic compounds in a sustainable and efficient manner for various industrial applications.*** ***Learning Outcomes: The outcomes of applying microbes in biotransformation contribute to the deve@opment of sustainable, efficient, and versatile processes for synthesizing valuable compounds, driving innovation in various industries and promoting environmental stewardship.***	3	3rd week of October
	Unit 4 Microbial Products and their Recovery: Microbial product purification: filtration, ion exchange & affinity chromatography techniques Immobilization methods and their application: Whole cell immobilization ***Learning Objectives: The objective is to advance our understanding of microbial products and their recovery processes, enabling the development of sustainable and***	4	4th week of October

	economically viable methods for producing and purifying valuable compounds from microorganisms for various industrial applications. ***Learning Outcomes: The outcomes of studying microbial products and their recovery processes lead to the development of sustainable, economically viable, and technologically advanced solutions for producing valuable compounds from microorganisms, thereby contributing to societal well-being and environmental stewardship.*** **Unit 5 Microbes for Bio-energy and Environment:** Bio-ethanol and bio-diesel production: commercial production from lignocellulosic waste and algal biomass, Biogas production: Methane and hydrogen production using microbial culture. Microorganisms in bioremediation: Degradation of xenobiotics, mineral recovery, removal of heavy metals from aqueous effluents. ***Learning Objectives: The objectives of using microbes forbioenergy and environmental applications aim to address pressing challenges related to energy security, environmental sustainability, and climate change mitigation, while also promoting the development of economically viable and socially beneficial solutions.*** ***Learning Outcomes: The outcomes of utilizing microbes for bioenergy and environmental applications lead to environmental sustainability, resource efficiency, and resilience to climate change, while also providing economic opportunities and societal benefits. These microbial-based solutions play a crucial role in transitioning towards a more sustainable and resilient future for both humans and the planet.***	5	1st – 2nd week of November

Dr. Swapna Mukherjee (Jan – June 2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 1 Bioenergetics:** First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy, and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant, Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP ***Learning Objectives: The objective of bioenergetics is to study how living organisms acquire and utilize energy to carry out their various functions, including metabolism, growth, reproduction, and movement. It explores the biochemical processes involved in the conversion of energy from one form to another within living systems.*** ***Learning Outcomes: The outcomes of bioenergetics include a deeper understanding of how energy is transformed and utilized within living organisms, which can lead to advancements in various fields such as medicine, biotechnology, and environmental science. By studying bioenergetics, researchers can develop strategies for improving energy efficiency, treating metabolic disorders, and designing sustainable bio-based technologies. Additionally, insights gained from bioenergetics research can contribute to our understanding of fundamental biological processes and evolutionary adaptations.***	5	1st – 2nd week of April
	CC-4: CELL BIOLOGY: **THEORY:** **Unit 2 Nucleus:** Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization, Nucleolus. ***Learning Objectives: The primary objective of the nucleus is to serve as the control center of the cell, regulating gene expression and coordinating cellular activities. It houses the cell's genetic material (DNA) and controls the synthesis of***	3	3rd week of April

	RNA and proteins essential for ceCC function and development. AdditionaCCy, the nucleus plays a crucial role in ceCC division, ensuring the accurate segregation of chromosomes during mitosis and meiosis. *Learning Outcomes: The outcomes of the nucleus's functions include the regulation of gene expression, which dictates the synthesis of proteins and ultimately infCuences the ceCC's structure, function, and behaviour. Additionally, the nucleus ensures the faithfuC transmission of genetic information from one generation of ceCCs to the next during ceCC division contributing to the maintenance of genetic stability and continuity of life.* **Unit 3 Protein Sorting and Transport:** Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes *Learning Objectives: The objective of protein sorting and transport is to ensure that proteins are correctly targeted to their designated locations within the ceCC and beyond, facilitating their proper function. This process involves sorting proteins within the ceCC and transporting them to specific organelles, compartments, or extracellular spaces where they are needed. Proper protein sorting and transportare essential for various cellular processes, including metabolism, signaling, and ceCC communication.* *Learning Outcomes: The Outcomes of Protein sorting andtransport are essential processes in the ceCC that ensure proteins are directed to their correct destinations and fulfill their specific functions. These processes occur in various cellular compartments such as the endoplasmic reticulum (ER), Golgi apparatus, endosomes, lysosomes, and plasmamembrane.* **PRACTICAL:** 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	5	1st – 2nd Week of May

	4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B 5. Study of polyploidy in Onion root tip by colchicine treatment. 6. Identification and study of cancer cells by photomicrographs. 7. Study of different stages of Mitosis. 8. Study of different stages of Meiosis.		
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 1 Genome Organization and Mutations:** Genome organization: E. coli, Saccharomyces, Tetrahymena ***Learning Objectives: The objective of studying genome organization and mutation is to understand how genetic information is structured within an organism's DNA or RNA and how it can change over time through mutation. This knowledge helps scientists comprehend the mechanisms underlying inheritance, evolution, and disease development. Additionally, studying genome organization and mutation aids in various applications, such as genetic engineering, personalized medicine, and evolutionary biology.*** ***Learning Outcomes: The outcomes of studying genome organization and mutation are manifold. They include advancements in fields such as molecular biology, genetics,and medicine. Understanding genome organization helps researchers identify genes, regulatory elements, and functional regions within the genome, leading to insights into normal biological processes and disease mechanisms. Additionally, studying mutations provides insights into evolutionary processes, genetic diversity, and the development of genetic diseases. Practical outcomes includethe development of diagnostic tools, therapies, and strategies for genetic disorders, as well as advancements in biotechnology and agriculture.*** **Unit 4 Phage Genetics:** Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda ***Learning Objectives: The objective of phage genetics is to understand the genetic structure, function, and regulation of bacteriophages, which are viruses that infect bacteria. By***	4 4	1st week of April 2nd week of April

	studying phage genetics, scientists aim to gain insights into fundamental genetic processes, such as replication, transcription, and recombination, as weCC as the interactions between phages and their bacteriaC hosts. This knowledge can have implications for biotechnology, medicine (such as phage therapy), and our understanding of microbial ecology and evolution. *Learning Outcomes: The outcomes of studying phage geneticsare diverse and impactful. They include advancements in fields such as molecular biology, biotechnology, and medicine. By elucidating the genetic mechanisms of bacteriophages, researchers can develop noveC tools for genetic engineering, such as viraC vectors for gene delivery and editing. Additionally, phage genetics research contributes to our understanding of microbial ecology,bacteriaC pathogenesis, and the evolution of viruses.* *Practical outcomes include the development of phage therapy as an alternative to antibiotics, as weCC as the use of phages in bioremediation and food safety applications.* **Unit 5 Transposable elements:** Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon Eukaryotic transposable elements – Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds) Uses of transposons and transposition *Learning Objectives: The objective of studying transposable elements is to understand their structure, function, and evolutionary significance within genomes. Transposable elements are DNA sequences capable of moving from one location to another within a genome, and they can influence gene expression, genome organization, and genome evolution. By investigating transposable elements, researchers aim to uncover their roles in genetic variation, adaptation, and disease, as weCC as their potential applications in genetic engineering and biotechnology.* *Learning Outcomes: The outcomes of studying transposable elements are multifaceted. They include advancements in understanding genome dynamics, evolution, and genetic diversity. By elucidating the roles of transposable elements, researchers gain insights into genome organization, gene*	5	3rd – 4th week of April

	regulation, and genetic diseases. Furthermore, transposable elements contribute to genetic variation within populations, facilitating adaptation to changing environments. Practical outcomes include the development of genetic tools for manipulating genomes, such as transposon-based gene delivery systems, and the potential use of transposable elements in biotechnology, such as gene editing and synthetic biology applications.		
	SEMESTER –6 **CC-14: MEDICAL MICROBIOLOGY:** **THEORY:** **Unit 2 Sample collection, transport and diagnosis:** Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). ***Learning Objectives: The objectives of sample collection, transport, and diagnosis aim to ensure the quality and reliability of microbiological data, inform clinical decision-making, and contribute to the prevention and control of infectious diseases in both clinical and public health settings.*** ***Learning Outcomes: The outcomes of sample collection, transport, and diagnosis in microbiology play a crucial role in disease management, public health surveillance, antimicrobial stewardship, and research efforts aimed at addressing current and emerging infectious disease threats.*** **Unit 4 Viral diseases:** List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control – Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis ***Learning Objectives: The objective of studying viral diseases is to improve our understanding of viral pathogens, develop strategies for disease prevention and control, and mitigate the impact of viral infections on human, animal, and plant health.***	4 6	1st week of February 2nd to 3rd week of February

	learning Outcomes: The outcomes of studying viraC diseases contribute to the prevention, treatment, and control of infectious diseases, improving global health, and saving lives. AdditionaCCy, research on viraC diseases enhances our understanding of virology, immunology, and epidemiology, leading to advancements in biomedicaC science and pubCic health practice. **DSE-B:3. INSTRUMENTATION AND BIOTECHNIQUES** **THEORY:** **Unit 1 Microscopy:** Brightfield and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry. *Learning Objectives: The objective of microscopy is to magnify and visuaCize smaCC objects or detaiCs that are not visibCe to the naked eye, enabCing scientists and researchers to study and understand their structure, composition, and behaviour.* *Learning Outcomes: The outcomes of microscopy can vary depending on the specific technique and appCication. GeneraCCy, they incCude VisuaCizing the structure and morphoCogy of specimens. IdentifyingspecificfeaturesorcomponentswithinasampCe.AnaCyzing the spatiaC distribution of substances or structures. Observing dynamic processes in reaC-time, such as ceCCuCar activities. Generating images or data for further anaCysis and interpretation in fieCds CikebioCogy, materiaCs science, forensics, and nanotechnoCogy.* **Unit 2 Chromatography:** Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion exchange chromatography and affinity chromatography, GLC, HPLC. *Learning Objectives: The objective of chromatography is to provide a powerfuC tooC for separating, analyzing, and purifying complex mixtures of substances, leading to advancements in scientific research, quaCity controC, process optimization, and product development in various industries.*	4 6	4th week of February 1st-2nd week of March

	Learning Outcomes: The outcomes of chromatography have wide-ranging applications and implications, impacting industries, research, and society by enabling the separation, analysis, and characterization of substances with precisionand efficiency. **Unit 4 Spectrophotometry:** Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry. ***Learning Objectives: The objective of spectrophotometry is to provide a versatile and sensitive analytical tool for quantitative and qualitative analysis, molecular characterization, and environmental monitoring across various scientific disciplines.*** ***Learning Outcomes: The outcomes of spectrophotometry contribute to advancements in scientific research, quality control, environmental protection, and public health by providing a versatile and sensitive analytical technique for quantitative and qualitative analysis, molecular characterization, and environmental monitoring.*** **PRACTICAL:** 1. Study of fluorescent micrographs to visualize bacterial cells. 2. Ray diagrams of phase contrast microscopy and Electron microscopy. 3. Separation of mixtures by paper / thin layer chromatography. 4. Demonstration of column packing in any form of column chromatography. 5. Separation of protein mixtures by any form of chromatography. 7. Determination of λmax for an unknown sample and calculation of extinction coefficient. 8. Separation of components of a given mixture using a laboratory scale centrifuge. 9. Understanding density gradient centrifugation with the help of pictures.	5	3rd to 4th week of March

Dr. Ratna China

Lecturer in Microbiology

Dinabandhu Andrews College

Dr. Ratna China (July – Dec 2018)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching Learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **PRACTICAL:** 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. **CC-2: BACTERIOLOGY** **THEORY:** **Unit 2 Bacteriological techniques:** Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing nonculturable bacteria. ***Learning Objectives: The objective of bacteriological techniques is to study and manipulate bacteria for various purposes, including identification, characterization, and understanding their behavior, physiology, and interactions with other organisms. These techniques are fundamental in fields like microbiology, medicine, agriculture, and environmental science. They involve culturing, staining, microscopy, biochemical tests, and molecular techniques to analyze bacterial cells and their components.*** ***Learning Outcome: The outcomes of bacteriological techniques can vary depending on the specific goals of the study or application. Techniques such as culturing, staining, and***	4	1st week of September

	Biochemical tests can help identify unknown bacterial species. Bacteriological techniques allow for the study of bacterial morphology, physiology, metabolism, and genetics. Overall, bacteriological techniques contribute to our understanding of bacteria and their roles in diverse ecosystems, human health, and biotechnological applications. **Unit 4 Growth and nutrition:** Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action ***Learning Objectives: The objective of studying growth and nutrition in organisms, including bacteria, is to understand the mechanisms and factors that govern their population dynamics, proliferation, and survival. Specifically, regarding bacteria. Overall, studying growth and nutrition in bacteria is fundamental to understanding their biology, ecology, and practical applications in various fields.*** ***Learning Outcome: Growth and nutrition are crucial biological processes that contribute to the survival, diversity, adaptation, and overall health of organisms and populations. Understanding these outcomes is important for studying biology, ecology, evolution, and human health.***	4	2nd week of September

Dr. Ratna China (Jan – June 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 4 Proteins:** Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. 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 Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins. ***Learning Objectives: The primary objective of proteins is to facilitate various biological functions within the body. These functions include structural support, enzymatic activity, immune response, cell signaling, and transportation of molecules. Proteins are essential for the growth, repair, and maintenance of cells and tissues in organisms.*** ***Learning Outcome: The outcome of proteins depends on their function and structure. Proteins can act as enzymes, hormones, antibodies, structural components, or transport molecules, among other roles. Their function is determined by their specific amino acid sequence and how they fold into a three-dimensional structure.*** **Unit 5. Enzymes:** Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts	10 8	1st – 2nd week of April 3rd week of April

	Learning Objectives: Enzymes serve as biological catalysts, speeding up chemical reactions in living organisms by lowering the activation energy required for reactions to occur. They facilitate processes like digestion, metabolism, and cellular signaling, crucial for life to function efficiently. ***Learning Outcome: Enzymes are biological catalysts that speed up chemical reactions in living organisms. Their outcomes vary depending on the specific enzyme and reaction involved. Generally, enzymes facilitate processes like digestion, metabolism, and cellular signaling, ultimately contributing to the maintenance of life processes.*** **Unit 6. Vitamins:** Classification and characteristics with suitable examples, sources and importance ***Learning Objectives: Vitamins play essential roles in various bodily functions, including metabolism, immunity, and overall health. Each vitamin has specific functions, such as vitamin C for immune support and vitamin D for bone health. The objective of vitamins is to ensure proper functioning and maintenance of the body's processes, as deficiencies can lead to health problems.*** ***Learning Outcome: The outcome of taking vitamins can vary depending on individual health needs and deficiencies. Generally, they help support overall health by filling in nutrient gaps, boosting immune function, improving energy levels, and promoting various bodily functions. However, taking excessive amounts can sometimes be harmful, so it's important to follow recommended dosages and consult with a healthcare professional if unsure.*** **PRACTICAL:** 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. Standard Free Energy Change of coupled reactions 4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars 5. Qualitative/Quantitative tests for lipids and proteins 6. Study of protein secondary and tertiary structures with the help of models 7. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values 8. Study effect of temperature, pH and Heavy metals on enzyme activity 9. Estimation of any one vitamin	2	4th week of April

Dr. Ratna China (July – Dec 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **PRACTICAL:** 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. **CC-2: BACTERIOLOGY** **THEORY:** **Unit 2 Bacteriological techniques:** Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing nonculturable bacteria. ***Learning Objectives: The objective of bacteriological techniques is to study and manipulate bacteria for various purposes, including identification, characterization, and understanding their behavior, physiology, and interactions with other organisms. These techniques are fundamental in fields like microbiology, medicine, agriculture, and environmental science. They involve culturing, staining, microscopy, biochemical tests, and molecular techniques to analyze bacterial cells and their components.*** ***Learning Outcome: The outcomes of bacteriological techniques can vary depending on the specific goals of the study or application. Techniques such as culturing, staining, and biochemical tests can help identify unknown bacterial species. Bacteriological techniques allow for the study of bacterial morphology, physiology, metabolism, and genetics. Overall,***	4	1st week of September

	bacteriological techniques contribute to our understanding of bacteria and their roles in diverse ecosystems, human health, and biotechnological applications. **Unit 4 Growth and nutrition:** Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action ***Learning Objectives: The objective of studying growth and nutrition in organisms, including bacteria, is to understand the mechanisms and factors that govern their population dynamics, proliferation, and survival. Specifically, regarding bacteria. Overall, studying growth and nutrition in bacteria is fundamental to understanding their biology, ecology, and practical applications in various fields.*** ***Learning Outcome: Growth and nutrition are crucial biological processes that contribute to the survival, diversity, adaptation, and overall health of organisms and populations. Understanding these outcomes is important for studying biology, ecology, evolution, and human health.***	4	2nd week of September
	SEMESTER 3: **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM** **THEORY** **Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration** Concept of aerobic respiration, anaerobic respiration and fermentation,Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway,TCA cycle,Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors ***Learning Objectives: The objective of chemoheterotrophic metabolism in aerobic respiration is to produce energy in the form of ATP by oxidizing organic molecules, such as glucose, using oxygen as the final electron acceptor. This process occurs in several stages, including glycolysis, the citric acid cycle, and the electron transport chain, ultimately yielding a large amount of ATP for cellular processes.*** ***Learning Outcome: Chemoheterotrophic metabolism in aerobic respiration results in the breakdown of organic molecules to produce energy in the form of ATP. Glucose, for example, is***	14	1st – 3rd week of August

	commonly used as a substrate. Through a series of biochemical reactions, glucose is oxidized, releasing energy that is captured by molecules like NADH and FADH2. These molecules then donate electrons to the electron transport chain, generating a proton gradient across the inner mitochondrial membrane. The flow of protons back across the membrane drives ATP synthesis via ATP synthase. Overall, this process produces a net gain of ATP, carbon dioxide, and water as byproducts. **Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation** Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways ***Learning Objectives: The objective of chemoheterotrophic metabolism during anaerobic respiration is to generate energy in the absence of oxygen. This process involves breaking down organic molecules, such as sugars, to produce ATP (adenosine triphosphate) for cellular functions. In anaerobic conditions, organisms use alternative electron acceptors, like nitrate or sulfate, instead of oxygen, to complete the electron transport chain and generate ATP.*** ***Learning Outcome: In chemoheterotrophic metabolism, organisms obtain energy by breaking down organic molecules, such as glucose, through anaerobic respiration when oxygen is not available. The specific outcomes of anaerobic respiration depend on the organism and the pathway it employs. For example, in humans and many other organisms, anaerobic respiration produces lactic acid or ethanol as byproducts, along with a smaller amount of ATP compared to aerobic respiration. In some bacteria, anaerobic respiration can produce various end products such as acetate, methane, or hydrogen sulfide.*** **Unit 5 Chemolithotrophic and Phototrophic Metabolism** Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria	6 8	4^{th} week of august 1^{st} – 2^{nd} week of September

	Learning Objectives: Chemoheterotrophic metabolism involves obtaining energy and carbon from organic compounds through chemical reactions, commonly seen in organisms like animals and fungi. Phototrophic metabolism, on the other hand, involves using light energy to convert inorganic carbon into organic compounds, typically seen in photosynthetic organisms like plants and algae. ***Learning Outcome: Chemoheterotrophic metabolism involves organisms that obtain energy by breaking down organic molecules through chemical reactions, such as aerobic respiration in animals or fermentation in certain bacteria. Phototrophic metabolism, on the other hand, relies on photosynthesis to convert light energy into chemical energy, typically found in plants, algae, and some bacteria.*** **Unit 6 Nitrogen Metabolism** – an overview Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification ***Learning Objectives: The objective of nitrogen metabolism is to ensure the efficient utilization of nitrogen in living organisms. This includes processes such as nitrogen fixation, assimilation, ammonification, nitrification, and denitrification, all of which are crucial for the synthesis of biomolecules like amino acids, nucleotides, and proteins, as well as for the recycling of nitrogenous waste.*** ***Learning Outcomes: The outcome of nitrogen metabolism involves the conversion of nitrogen-containing compounds into usable forms for various cellular processes. This includes the synthesis of proteins, nucleic acids, and other essential molecules, as well as the elimination of nitrogenous waste products like urea. The process is tightly regulated to maintain nitrogen balance in the body and ensure proper functioning of cells and tissues.*** **PRACTICAL:** 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	6	3rd week of September

Dr. Ratna China (Jan – June 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 4 Proteins:** Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. 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 Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins. ***Learning Objectives: The primary objective of proteins is to facilitate various biological functions within the body. These functions include structural support, enzymatic activity, immune response, cell signaling, and transportation of molecules. Proteins are essential for the growth, repair, and maintenance of cells and tissues in organisms.*** ***Learning Outcome: The outcome of proteins depends on their function and structure. Proteins can act as enzymes, hormones, antibodies, structural components, or transport molecules, among other roles. Their function is determined by their specific amino acid sequence and how they fold into a three-dimensional structure.*** **Unit 5. Enzymes:** Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts ***Learning Objectives: Enzymes serve as biological catalysts, speeding up chemical reactions in living organisms by***	10 6	1st – 2nd week of April 3rd week of April

	lowering the activation energy required for reactions to occur. They facilitate processes like digestion, metabolism, and cellular signaling, crucial for life to function efficiently. ***Learning Outcome: Enzymes are biological catalysts that speed up chemical reactions in living organisms. Their outcomes vary depending on the specific enzyme and reaction involved. Generally, enzymes facilitate processes like digestion, metabolism, and cellular signaling, ultimately contributing to the maintenance of life processes.*** **Unit 6. Vitamins:** Classification and characteristics with suitable examples, sources and importance ***Learning Objectives: Vitamins play essential roles in various bodily functions, including metabolism, immunity, and overall health. Each vitamin has specific functions, such as vitamin C for immune support and vitamin D for bone health. The objective of vitamins is to ensure proper functioning and maintenance of the body's processes, as deficiencies can lead to health problems.*** ***Learning Outcome: The outcome of taking vitamins can vary depending on individual health needs and deficiencies. Generally, they help support overall health by filling in nutrient gaps, boosting immune function, improving energy levels, and promoting various bodily functions. However, taking excessive amounts can sometimes be harmful, so it's important to follow recommended dosages and consult with a healthcare professional if unsure.*** **PRACTICAL:** 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. Standard Free Energy Change of coupled reactions 4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars 5. Qualitative/Quantitative tests for lipids and proteins 6. Study of protein secondary and tertiary structures with the help of models 7. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values 8. Study effect of temperature, pH and Heavy metals on enzyme activity 9. Estimation of any one vitamin	2	4th week of April
	SEMESTER-4:		

	CC-9: ENVIRONMENTAL MICROBIOLOGY **THEORY:** **Unit 1 Microorganisms and their Habitats:** Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter ***Learning Objectives: The objectives of microorganisms in their habitats vary depending on the organism and environment. Generally, they play crucial roles in nutrient cycling, decomposition, symbiotic relationships, and even pathogenicity. Some objectives include energy production, resource utilization, and reproduction, all contributing to the balance and functioning of ecosystems.*** ***Learning Outcomes: The outcome of microorganisms play essential roles in maintaining the health and functioning of ecosystems, influencing the balance of nutrient cycles, energy flow, and biodiversity.***	4	1st week of March
	Unit 2 Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria ***Learning Objectives: The objective of microbial interaction can vary depending on the context, but generally, it includes aspects such as competition for resources, cooperation for mutual benefit, communication, genetic exchange, and the shaping of ecological communities.*** ***Learning Outcome: Microbial interactions can lead to various outcomes depending on factors like species involved, environment, and resources. They can result in mutualism, where both species benefit, commensalism, where one benefits while the other is unaffected, competition, where both vie for the same resources, predation, where one species benefits at the expense of the other, or parasitism, where one benefits and the other is harmed. These interactions play critical roles in ecosystems, influencing nutrient cycling, disease dynamics, and overall community structure.***	4	2nd week of march

	Unit 3 Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese ***Learning Objectives: The objective of biogeochemical cycles is to efficiently recycle essential elements like carbon, nitrogen, phosphorus, and water between living organisms and the environment, ensuring the sustainability of ecosystems and life on Earth. These cycles maintain the balance of nutrients and chemicals necessary for life processes.*** ***Learning Outcome: The outcome of biogeochemical cycles is the continuous recycling and redistribution of essential elements such as carbon, nitrogen, phosphorus, and water within ecosystems. This leads to the maintenance of nutrient availability for organisms, the regulation of atmospheric composition, the stabilization of climate, and the overall sustainability of life on Earth.***	8	3^{rd} – 4^{th} week of march
	Unit 5 Microbial Bioremediation: Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants ***Learning Objectives: The objective of microbial bioremediation is to use microorganisms to degrade or neutralize pollutants in contaminated environments, such as soil, water, or air. This process aims to restore ecosystems to their natural state or reduce the harmful effects of pollutants on human health and the environment.*** ***Learning Outcome: The outcome of microbial bioremediation is the reduction, degradation, or complete removal of pollutants from contaminated environments through the activity of microorganisms. This process often leads to the restoration of ecosystem health, improved water and air quality, and the mitigation of potential risks to human health and the environment associated with pollutants.***	6	1^{st} – 2^{nd} week of april

Dr. Ratna China (July – Dec 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **PRACTICAL:** 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. **CC-2: BACTERIOLOGY** **THEORY:** **Unit 2 Bacteriological techniques:** Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing nonculturable bacteria. ***Learning Objectives: The objective of bacteriological techniques is to study and manipulate bacteria for various purposes, including identification, characterization, and understanding their behavior, physiology, and interactions with other organisms. These techniques are fundamental in fields like microbiology, medicine, agriculture, and environmental science. They involve culturing, staining, microscopy, biochemical tests, and molecular techniques to analyze bacterial cells and their components.*** ***Learning Outcome: The outcomes of bacteriological techniques can vary depending on the specific goals of the study or application. Techniques such as culturing, staining, and biochemical tests can help identify unknown bacterial species. Bacteriological techniques allow for the study of bacterial morphology, physiology, metabolism, and genetics. Overall, bacteriological techniques contribute to our understanding of***	4	1st week of September

	bacteria and their roles in diverse ecosystems, human health, and biotechnological applications. **Unit 4 Growth and nutrition:** Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: disinfectants, types and mode of action ***Learning Objectives: The objective of studying growth and nutrition in organisms, including bacteria, is to understand the mechanisms and factors that govern their population dynamics, proliferation, and survival. Specifically, regarding bacteria. Overall, studying growth and nutrition in bacteria is fundamental to understanding their biology, ecology, and practical applications in various fields.*** ***Learning Outcome: Growth and nutrition are crucial biological processes that contribute to the survival, diversity, adaptation, and overall health of organisms and populations. Understanding these outcomes is important for studying biology, ecology, evolution, and human health.***	4	2nd week of September
	SEMESTER 3: **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM** **THEORY** **Unit 3 Chemoheterotrophic Metabolism - Aerobic Respiration** Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors ***Learning Objectives: The objective of chemoheterotrophic metabolism in aerobic respiration is to produce energy in the form of ATP by oxidizing organic molecules, such as glucose, using oxygen as the final electron acceptor. This process occurs in several stages, including glycolysis, the citric acid cycle, and the electron transport chain, ultimately yielding a large amount of ATP for cellular processes.*** ***Learning Outcome: Chemoheterotrophic metabolism in aerobic respiration results in the breakdown of organic molecules to produce energy in the form of ATP. Glucose, for example, is commonly used as a substrate. Through a series of biochemical reactions, glucose is oxidized, releasing energy that is captured by molecules like NADH and FADH2. These molecules then donate electrons to the electron transport***	14	1st – 3rd week of August

	chain, generating a proton gradient across the inner mitochondrial membrane. The flow of protons back across the membrane drives ATP synthesis via ATP synthase. Overall, this process produces a net gain of ATP, carbon dioxide, and water as byproducts.		4^{th} week of august
	Unit 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways ***Learning Objectives: The objective of chemoheterotrophic metabolism during anaerobic respiration is to generate energy in the absence of oxygen. This process involves breaking down organic molecules, such as sugars, to produce ATP (adenosine triphosphate) for cellular functions. In anaerobic conditions, organisms use alternative electron acceptors, like nitrate or sulfate, instead of oxygen, to complete the electron transport chain and generate ATP.*** ***Learning Outcome: In chemoheterotrophic metabolism, organisms obtain energy by breaking down organic molecules, such as glucose, through anaerobic respiration when oxygen is not available. The specific outcomes of anaerobic respiration depend on the organism and the pathway it employs. For example, in humans and many other organisms, anaerobic respiration produces lactic acid or ethanol as byproducts, along with a smaller amount of ATP compared to aerobic respiration. In some bacteria, anaerobic respiration can produce various end products such as acetate, methane, or hydrogen sulfide.***	6	
	Unit 5 Chemolithotrophic and Phototrophic Metabolism Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria ***Learning Objectives: Chemoheterotrophic metabolism involves obtaining energy and carbon from organic compounds through chemical reactions, commonly seen in organisms like animals and fungi. Phototrophic metabolism, on the other hand,***	6	1^{st} – 2^{nd} week of September

	involves using light energy to convert inorganic carbon into organic compounds, typically seen in photosynthetic organisms like plants and algae. ***Learning Outcome: Chemoheterotrophic metabolism involves organisms that obtain energy by breaking down organic molecules through chemical reactions, such as aerobic respiration in animals or fermentation in certain bacteria. Phototrophic metabolism, on the other hand, relies on photosynthesis to convert light energy into chemical energy, typically found in plants, algae, and some bacteria.*** **Unit 6 Nitrogen Metabolism** – an overview Introduction to biological nitrogen fixation Ammonia assimilation Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification ***Learning Objectives: The objective of nitrogen metabolism is to ensure the efficient utilization of nitrogen in living organisms. This includes processes such as nitrogen fixation, assimilation, ammonification, nitrification, and denitrification, all of which are crucial for the synthesis of biomolecules like amino acids, nucleotides, and proteins, as well as for the recycling of nitrogenous waste.*** ***Learning Outcomes: The outcome of nitrogen metabolism involves the conversion of nitrogen-containing compounds into usable forms for various cellular processes. This includes the synthesis of proteins, nucleic acids, and other essential molecules, as well as the elimination of nitrogenous waste products like urea. The process is tightly regulated to maintain nitrogen balance in the body and ensure proper functioning of cells and tissues.*** **PRACTICAL:** 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	4	3rd week of September
	SEMESTER –5 **CC-12: INDUSTRIAL MICROBIOLOGY:** **THEORY:** **Unit 4 Down-stream processing:** Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying	8	1st – 2nd week of august

	Learning Objectives: The objective of downstream processing is to purify and isolate the desired product from a mixture of biological materials, typically after fermentation or cell culture, to obtain a high-quality final product. This can include processes like filtration, chromatography, centrifugation, and drying to separate and concentrate the target compound. ***Learning Outcome: Downstream processing refers to the purification and recovery of a product from a biological source, such as fermentation broth or cell culture. Overall, the goal of downstream processing is to obtain a purified, high-quality product that can be used effectively in various applications, such as pharmaceuticals, food and beverages, biotechnology, and cosmetics.***		
	Unit 5 Microbial production of industrial products (microorganisms involved, media, fermentation conditions, downstream processing and uses): Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 Enzymes (amylase, protease, lipase) Wine, beer ***Learning Objectives: The objective of microbial production of industrial products is to harness the metabolic capabilities of microorganisms, such as bacteria, yeast, or fungi, to produce various chemicals, fuels, enzymes, and pharmaceuticals on a large scale. This process offers advantages like sustainability, cost-effectiveness, and efficiency compared to traditional chemical synthesis methods.*** ***Learning Outcome: Microbial production of industrial products has various outcomes, including increased efficiency, reduced production costs, and the ability to produce environmentally friendly alternatives to traditional methods. This approach often results in the synthesis of diverse products such as biofuels, enzymes, organic acids, pharmaceuticals, and biopolymers. Additionally, it contributes to sustainable practices by utilizing renewable resources and reducing waste generation.***	10	3rd – 4th week of august
	Unit 6 Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase) ***Learning Objectives: The primary objective of enzyme immobilization is to enhance enzyme stability, reusability, and operational parameters, thereby improving the efficiency and economy of enzyme-based processes.*** ***Learning Outcome: Enzyme immobilization offers several advantages that can significantly enhance the efficiency,***	6	1st week of September

	stability, reusability, and versatility of enzymes in various biotechnological, pharmaceutical, food, and environmental applications. By harnessing the benefits of immobilization, researchers and industries can optimize enzymatic processes and develop innovative solutions for a wide range of practical challenges. **PRACTICAL:** 2. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzymes: Amylase and Protease (b) Amino acid: Glutamic acid (c) Organic acid: Citric acid (d) Alcohol: Ethanol **DSE-A:1.MICROBIAL BIOTECHNOLOGY:** **PRACTICAL:** 1. Study yeast cell immobilization in calcium alginate gels 2. Study enzyme immobilization by sodium alginate method 3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium) 4. Isolation of xylanase or lipase producing bacteria 5. Study of algal Single Cell Proteins **DSE-B:2. MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT:** **THEORY:** **Unit 2 Mineralization of Organic & Inorganic Matter in Soil:** Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium ***Learning Objectives: The primary objective of mineralization of organic and inorganic matter in soil is to release essential nutrients in forms that are available for plant uptake. This process helps sustain soil fertility and supports plant growth, which is vital for agricultural productivity and ecosystem health. Additionally, mineralization contributes to the decomposition of organic matter, improving soil structure and promoting microbial activity. Overall, it plays a crucial role in nutrient cycling and maintaining soil health.*** ***Learning Outcome: The outcome of mineralization of organic and inorganic matter in soil is the conversion of these materials into simpler forms, such as minerals, gases (like carbon dioxide and methane), and water. This process releases nutrients, like nitrogen, phosphorus, and sulfur, making them available for plant uptake. It also contributes to soil fertility and the overall health of ecosystems.***	2	2nd week of September

	Unit 3 Microbial Activity in Soil and Green House Gases: Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control. ***Learning Objectives: The primary objective of microbial activity in soil is to decompose organic matter, cycling nutrients, and facilitating plant growth. However, this activity also plays a crucial role in the production and consumption of greenhouse gases such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). Microbes can both produce and consume these gases through various metabolic processes, impacting the overall greenhouse gas balance in the atmosphere.*** ***Learning Outcome: Microbial activity in soil can lead to the production and consumption of greenhouse gases (GHGs) such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). For example, microbial decomposition of organic matter releases CO2, while certain bacteria produce CH4 during anaerobic conditions. Additionally, nitrifying and denitrifying bacteria contribute to N2O emissions through processes like nitrification and denitrification. Overall, the outcome depends on factors like soil type, temperature, moisture, and the availability of organic matter.***	6	3rd week of September
	Unit 4 Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds ***Learning Objectives: The primary objective of microbial control of soil-borne plant pathogens is to manage and reduce the populations of harmful microorganisms that can cause diseases in plants. This is typically achieved by using beneficial microorganisms, such as certain species of bacteria, fungi, or viruses, to suppress or antagonize the growth and activity of pathogenic organisms in the soil. By enhancing the presence of these beneficial microbes, the aim is to protect plants from diseases and promote healthier plant growth without relying heavily on chemical pesticides.*** ***Learning Outcome: Microbial control of soil-borne plant pathogens involves using beneficial microorganisms to suppress or eliminate harmful pathogens. This can result in improved plant health, increased crop yield, and reduced reliance on chemical pesticides. Some common methods include using biocontrol agents like certain bacteria, fungi, or nematodes, which compete with or antagonize the pathogens, or through soil amendments like compost or biofertilizers that promote a healthy soil microbiome. Ultimately, the outcome depends on various factors such as the specific pathogens***	4	4th week of September

	present, environmental conditions, and the effectiveness of the chosen control methods.		
	Unit 5 Biofertilization, Phytostimulation, Bioinsecticides: Plant growth promoting bateria, biofertilizers – symbiotic (Bradyrhizobium, Rhizobium, Frankia), Non Symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs. ***Learning Objectives: The objectives of biofertilization include enhancing soil fertility, improving nutrient availability to plants, and promoting sustainable agricultural practices. Phytostimulation aims to boost plant growth and development by stimulating physiological processes. Bioinsecticides are used to control insect pests through environmentally friendly means, minimizing harm to non-target organisms and reducing chemical residues in food.*** ***Learning Outcome: The outcomes of these bio-based agricultural practices include improved soil health, enhanced plant growth and resilience, and reduced environmental impact compared to conventional farming methods.***	8	1st – 2nd week of October

Dr. Ratna China (Jan – June2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 4 Proteins:** Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. 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 Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins. ***Learning Objectives: The primary objective of proteins is to facilitate various biological functions within the body. These functions include structural support, enzymatic activity, immune response, cell signaling, and transportation of molecules. Proteins are essential for the growth, repair, and maintenance of cells and tissues in organisms.*** ***Learning Outcome: The outcome of proteins depends on their function and structure. Proteins can act as enzymes, hormones, antibodies, structural components, or transport molecules, among other roles. Their function is determined by their specific amino acid sequence and how they fold into a three-dimensional structure.*** **Unit 5. Enzymes:** Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts ***Learning Objectives: Enzymes serve as biological catalysts, speeding up chemical reactions in living organisms by***	10 6	1st – 2nd week of April 3rd week of April

	lowering the activation energy required for reactions to occur. They facilitate processes like digestion, metabolism, and cellular signaling, crucial for life to function efficiently. ***Learning Outcome: Enzymes are biological catalysts that speed up chemical reactions in living organisms. Their outcomes vary depending on the specific enzyme and reaction involved. Generally, enzymes facilitate processes like digestion, metabolism, and cellular signaling, ultimately contributing to the maintenance of life processes.*** **Unit 6. Vitamins:** Classification and characteristics with suitable examples, sources and importance ***Learning Objectives: Vitamins play essential roles in various bodily functions, including metabolism, immunity, and overall health. Each vitamin has specific functions, such as vitamin C for immune support and vitamin D for bone health. The objective of vitamins is to ensure proper functioning and maintenance of the body's processes, as deficiencies can lead to health problems.*** ***Learning Outcome: The outcome of taking vitamins can vary depending on individual health needs and deficiencies. Generally, they help support overall health by filling in nutrient gaps, boosting immune function, improving energy levels, and promoting various bodily functions. However, taking excessive amounts can sometimes be harmful, so it's important to follow recommended dosages and consult with a healthcare professional if unsure.*** **PRACTICAL:** 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. Standard Free Energy Change of coupled reactions 4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars 5. Qualitative/Quantitative tests for lipids and proteins 6. Study of protein secondary and tertiary structures with the help of models 7. Study of enzyme kinetics – calculation of Vmax , Km, Kcat values 8. Study effect of temperature, pH and Heavy metals on enzyme activity 9. Estimation of any one vitamin	2	4th week of April
	SEMESTER-4: **CC-9: ENVIRONMENTAL MICROBIOLOGY**		

	THEORY: **Unit 1 Microorganisms and their Habitats:** Structure and function of ecosystems Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter ***Learning Objectives: The objectives of microorganisms in their habitats vary depending on the organism and environment. Generally, they play crucial roles in nutrient cycling, decomposition, symbiotic relationships, and even pathogenicity. Some objectives include energy production, resource utilization, and reproduction, all contributing to the balance and functioning of ecosystems.*** ***Learning Outcomes: The outcome of microorganisms play essential roles in maintaining the health and functioning of ecosystems, influencing the balance of nutrient cycles, energy flow, and biodiversity.***	4	1st week of March
	Unit 2 Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation Microbe-Plant interaction: Symbiotic and non symbiotic interactions. Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria ***Learning Objectives: The objective of microbial interaction can vary depending on the context, but generally, it includes aspects such as competition for resources, cooperation for mutual benefit, communication, genetic exchange, and the shaping of ecological communities.*** ***Learning Outcome: Microbial interactions can lead to various outcomes depending on factors like species involved, environment, and resources. They can result in mutualism, where both species benefit, commensalism, where one benefits while the other is unaffected, competition, where both vie for the same resources, predation, where one species benefits at the expense of the other, or parasitism, where one benefits and the other is harmed. These interactions play critical roles in ecosystems, influencing nutrient cycling, disease dynamics, and overall community structure.*** **Unit 3 Biogeochemical Cycling:**	4 8	2nd week of march

	Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese ***Learning Objectives: The objective of biogeochemical cycles is to efficiently recycle essential elements like carbon, nitrogen, phosphorus, and water between living organisms and the environment, ensuring the sustainability of ecosystems and life on Earth. These cycles maintain the balance of nutrients and chemicals necessary for life processes.*** ***Learning Outcome: The outcome of biogeochemical cycles is the continuous recycling and redistribution of essential elements such as carbon, nitrogen, phosphorus, and water within ecosystems. This leads to the maintenance of nutrient availability for organisms, the regulation of atmospheric composition, the stabilization of climate, and the overall sustainability of life on Earth.*** **Unit 5 Microbial Bioremediation:** Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants ***Learning Objectives: The objective of microbial bioremediation is to use microorganisms to degrade or neutralize pollutants in contaminated environments, such as soil, water, or air. This process aims to restore ecosystems to their natural state or reduce the harmful effects of pollutants on human health and the environment.*** ***Learning Outcome: The outcome of microbial bioremediation is the reduction, degradation, or complete removal of pollutants from contaminated environments through the activity of microorganisms. This process often leads to the restoration of ecosystem health, improved water and air quality, and the mitigation of potential risks to human health and the environment associated with pollutants.***	6	3^{rd} – 4^{th} week of march 1^{st} – 2^{nd} week of april
	SEMESTER –6 **CC-13: IMMUNOLOGY** **THEORY** **Unit 1 Introduction:**	2	1^{st} week of February

	Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa ***Learning Objectives: The objective of introducing immunology is to understand how the immune system functions, including its mechanisms of defense against pathogens, its role in maintaining health, and its involvement in diseases such as infections, autoimmune disorders, allergies, and cancer. This knowledge enables the development of vaccines, therapies, and strategies to prevent, treat, and manage various immunological conditions, ultimately improving human health and well-being.*** ***Learning Outcome: The outcome of introducing immunology is a deeper understanding of how the immune system works and its role in health and disease. This knowledge leads to advancements in medicine, including the development of vaccines, immunotherapies, and treatments for infectious diseases, autoimmune disorders, allergies, and cancer. It also enhances our ability to diagnose, prevent, and manage immunological conditions, ultimately improving public health outcomes and quality of life.*** **Unit 2 Immune Cells and Organs:** Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT ***Learning Objectives: The objective of immune cells and organs is to defend the body against pathogens, foreign substances, and abnormal cells, thus maintaining overall health and well-being. Immune cells, such as lymphocytes, macrophages, and dendritic cells, work together with immune organs, including the thymus, spleen, lymph nodes, and bone marrow, to recognize and eliminate harmful invaders while distinguishing them from the body's own cells. This coordinated response ensures protection against infections, helps to remove damaged or abnormal cells, and contributes to the body's ability to heal and recover from illness or injury.*** ***Learning Outcome: The outcome of immune cells and organs working together is the effective defense of the body against pathogens, foreign substances, and abnormal cells. This leads to the prevention and control of infections, the removal of damaged or abnormal cells (such as cancerous cells), and the maintenance of overall health and well-being. Additionally, a properly functioning immune system helps to regulate inflammation, promotes tissue repair, and* 4	2nd week of February

	contributes to the body's ability to adapt to changing environmental conditions and challenges.		
	Unit 3 Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants. ***Learning Objectives: The objective of antigens is to provoke an immune response in the body. Antigens are molecules, often proteins or polysaccharides, that are recognized by the immune system as foreign or non-self. When the immune system detects antigens, it triggers a series of responses aimed at neutralizing or eliminating the perceived threat, such as producing antibodies or activating immune cells. This immune response helps to protect the body against infections and other harmful substances.*** ***Learning Outcome: The outcome of antigens interacting with the immune system is the initiation of an immune response. This response can lead to various outcomes, including the production of antibodies specific to the antigen, activation of immune cells to eliminate the antigen, and the development of immunological memory to provide long-term protection against future exposures to the same antigen. Additionally, in some cases, the immune response may lead to inflammation or tissue damage if it is not properly regulated. Overall, the outcome of antigens interacting with the immune system is crucial for the body's defense against pathogens and maintaining immune surveillance.***	4	3rd week of February
	Unit 4 Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies ***Learning Objectives: The objective of antibodies is to recognize and neutralize harmful substances, such as pathogens (e.g., bacteria, viruses) and toxins, in the body. Antibodies, also known as immunoglobulins, are produced by specialized immune cells called B lymphocytes in response to the presence of antigens. These Y-shaped proteins bind specifically to antigens, marking them for destruction by other components of the immune system or directly neutralizing their activity. By targeting and eliminating harmful substances, antibodies play a critical role in the body's defense against infections and maintaining overall health.*** ***Learning Outcome: Antibodies play a diverse range of roles in the immune system, diagnostics, and therapeutics, contributing***	4	4th week of February

	to host defense, immune regulation, and disease management. Their specificity, versatility, and ability to modulate immune responses make them valuable tools for research, clinical applications, and biotechnological advancements.		
	Unit 5 Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways) ***Learning Objectives: The objective of the Major Histocompatibility Complex (MHC) is to present antigens to T lymphocytes, thus initiating specific immune responses. MHC molecules are cell surface proteins that display fragments of antigens, derived from pathogens or other proteins, to T cells. This presentation allows T cells to recognize and respond to the antigen, leading to the activation of immune responses tailored to combat the specific pathogen or abnormal cell. The MHC also plays a role in self-recognition, helping the immune system distinguish between self and non-self, thereby preventing autoimmune reactions. Overall, the objective of the MHC is to facilitate adaptive immune responses and maintain immune surveillance.*** ***Learning Outcome: MHC molecules are essential for antigen presentation, T cell activation, immune regulation, and immune tolerance, shaping adaptive immune responses and maintaining immune homeostasis. Their diverse functions in orchestrating cellular interactions and immune responses underscore their pivotal role in host defense and immunological surveillance.***	4	1st week of march
	Unit 7 Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to Tolerance ***Learning Objectives: The objective of the generation of an immune response is to recognize and eliminate pathogens, foreign substances, or abnormal cells while preserving healthy tissues. This process involves the coordinated activation of various components of the immune system, including antigen-presenting cells (APCs), T lymphocytes, B lymphocytes, and antibodies. The immune response aims to neutralize or eliminate the threat, prevent its spread throughout the body, and establish long-term immunity against future encounters with the same antigen. Additionally, the immune response seeks to maintain immune***	8	2nd – 3rd week of march

	homeostasis, ensuring a balanced and effective defense against pathogens while minimizing damage to host tissues. Learning Outcome: The outcomes of the generation of an immune response are crucial for protecting the body against pathogens, maintaining immune function, and establishing long-term immunity. **PRACTICAL:** 1. Identification of human blood groups. 2. Perform Total Leukocyte Count of the given blood sample. 3. Perform Differential Leukocyte Count of the given blood sample. 4. Separate serum from the blood sample (demonstration). 5. Perform immunodiffusion by Ouchterlony method. 6. Perform DOT ELISA. 7. Perform immunoelectrophoresis.		

Prof. Subhasree Roy

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Subhasree Roy (July – Dec 2018)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **Unit 1 History of Development of Microbiology:** • Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming • Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, • Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman • Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner ***Learning Objectives: Microbiology's development is marked by key discoveries and advancements that revolutionized our understanding of microscopic life. It began in the 17th century with Antonie van Leeuwenhoek's invention of the microscope, allowing observation of microorganisms for the first time. Louis Pasteur's experiments in the 19th century established the germ theory of disease and the principles of sterilization and pasteurization. Robert Koch's work in the late 19th century led to the development of Koch's postulates, which are criteria for establishing the causative relationship between a microbe and a disease. The 20th century saw the discovery of antibiotics, such as penicillin by Alexander Fleming, which revolutionized medicine. Today, microbiology continues to evolve with advancements in molecular biology, genetics, and bioinformatics, contributing to fields like biotechnology, medicine, and environmental science.*** ***Learning Outcomes: Microbiology's development is a fascinating journey. It began with Antonie van Leeuwenhoek's discovery of microorganisms in the 17th century, leading to the***	3	1st week of September

	Golden Age of Microbiology in the late 19th century with Louis Pasteur and Robert Koch's work on germ theory and identifying disease-causing microbes. This laid the foundation for modern microbiology, advancing through the 20th century with breakthroughs in genetics, immunology, and molecular biology. Today, microbiology continues to evolve, playing a crucial role in various fields like medicine, biotechnology, and environmental science. **CC-2: BACTERIOLOGY** **THEORY:** **Unit 1 Cell organization:** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation. ***Learning Objectives: The objective of cell organization is to create functional structures within an organism by arranging individual cells into specialized tissues, organs, and systems. This organization enables efficient communication and cooperation among cells, allowing them to perform specific tasks and functions essential for the survival and proper functioning of the organism as a whole.*** ***Learning Outcomes: Cell organization is the process by which cells assemble into tissues, organs, and systems, enabling the formation of complex biological structures necessary for the functioning of living organisms. This intricate arrangement allows for specialization and coordination of tasks, ultimately facilitating growth, development, and the maintenance of homeostasis within the organism.*** **PRACTICAL:** 1. Preparation of different media: synthetic media Czapek Dox media and /or 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.	12	2nd - 4th week of September

	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.		

Subhasree Roy (Jan -June 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 4 Cell Signalling:** Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway ***Learning Objectives: The objective of cell signaling is to facilitate communication between cells, allowing them to coordinate their activities and respond appropriately to internal and external stimuli. This intricate process enables cells to regulate various biological functions, maintain homeostasis, and ensure the proper development and functioning of multicellular organisms.*** ***Learning Outcomes: Cell signaling involves the transmission of signals or messages between cells to regulate various biological processes such as growth, development, and homeostasis. The outcome of cell signaling is the coordination of cellular activities, ensuring proper responses to environmental cues, and maintaining the overall health and function of the organism. This process is essential for cell communication and enables cells to interact with each other in a coordinated manner to carry out complex functions.*** **Unit 5 Cell Cycle, Cell Death and Cell Renewal:** Eukaryotic cell cycle and its regulation, Mitosis and Meiosis	4 4	1^{st} – 2^{nd} week of April 2^{nd} – 3^{rd} week of April

	Development of cancer, causes and types Programmed cell death Stem cells Embryonic stem cell, induced pluripotent stem cells ***Learning Objectives: The cell cycle is the series of events that take place in a cell leading to its division and duplication. It consists of interphase (growth and DNA replication) and mitotic phase (division of the nucleus and cytoplasm).*** ***Cell death, also known as apoptosis, is a natural process in which cells self-destruct to maintain tissue homeostasis, remove damaged or infected cells, and regulate development. Cell renewal refers to the process by which old or damaged cells are replaced by new ones, ensuring the continuous functioning and regeneration of tissues and organs in multicellular organisms.*** ***Learning Outcomes : The cell cycle involves stages of growth, replication, and division. Cell death, or apoptosis, is a natural process to remove damaged or unnecessary cells. Cell renewal ensures tissues remain healthy and functional. In brief, the outcome is the maintenance of tissue integrity, growth, and repair.***		

Subhasree Roy (July – Dec 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **Unit 1 History of Development of Microbiology:** • Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming • Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, • Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman • Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner. ***Learning Objectives: Microbiology's development is marked by key discoveries and advancements that revolutionized our understanding of microscopic life. It began in the 17th century with Antonie van Leeuwenhoek's invention of the microscope, allowing observation of microorganisms for the first time. Louis Pasteur's experiments in the 19th century established the germ theory of disease and the principles of sterilization and pasteurization. Robert Koch's work in the late 19th century led***	3	1st week of October

	to the development of Koch's postulates, which are criteria for establishing the causative relationship between a microbe and a disease. The 20th century saw the discovery of antibiotics, such as penicillin by Alexander Fleming, which revolutionized medicine. Today, microbiology continues to evolve with advancements in molecular biology, genetics, and bioinformatics, contributing to fields like biotechnology, medicine, and environmental science. ***Learning Outcomes: Microbiology's development is a fascinating journey. It began with Antonie van Leeuwenhoek's discovery of microorganisms in the 17th century, leading to the Golden Age of Microbiology in the late 19th century with Louis Pasteur and Robert Koch's work on germ theory and identifying disease-causing microbes. This laid the foundation for modern microbiology, advancing through the 20th century with breakthroughs in genetics, immunology, and molecular biology. Today, microbiology continues to evolve, playing a crucial role in various fields like medicine, biotechnology, and environmental science.*** **CC-2: BACTERIOLOGY** **THEORY:** **Unit 1 Cell organization:** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cellwall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation. ***Learning Objectives: The objective of cell organization is to create functional structures within an organism by arranging individual cells into specialized tissues, organs, and systems. This organization enables efficient communication and cooperation among cells, allowing them to perform specific tasks and functions essential for the survival and proper functioning of the organism as a whole.*** ***Learning Outcomes: Cell organization is the process by which cells assemble into tissues, organs, and systems, enabling the formation of complex biological structures necessary for the functioning of living organisms. This intricate arrangement allows for specialization and coordination of tasks,***	12	2nd – 4th week of October

	ultimately facilitating growth, development, and the maintenance of homeostasis within the organism. **PRACTICAL:** 1. Preparation of different media: synthetic media Czapek Dox media and /or 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.		
	SEMESTER –3 **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM** **PRACTICAL:** 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. **CC-7: MOLECULAR BIOLOGY:** **THEORY:** **Unit 2 Replication of DNA (Prokaryotes and Eukaryotes):** Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair. ***Learning Objectives : The primary objective of DNA replication in both prokaryotes and eukaryotes is to ensure accurate transmission of genetic information from one generation to the next during cell division. By faithfully copying the entire genome, DNA replication ensures that each daughter cell receives a complete set of genetic instructions necessary for its***	8	1st – 2nd week of October

	proper function and survival. This process is essential for maintaining genetic stability and diversity within populations. ***Learning Outcomes: In prokaryotes, like bacteria, DNA replication starts from a single origin point and proceeds bidirectionally around the circular chromosome. This process is rapid and occurs in the cytoplasm. In contrast, eukaryotic DNA replication is more complex, occurring in the nucleus. Multiple origins of replication exist along linear chromosomes, and the process involves many enzymes and proteins. Replication is semiconservative, meaning each new DNA molecule consists of one parental strand and one newly synthesized strand.*** **Unit 3 Transcription in Prokaryotes and Eukaryotes:** Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors ***Learning Objectives: The objective of transcription in both prokaryotes and eukaryotes is to synthesize RNA molecules from DNA templates. These RNA molecules serve various functions, such as encoding proteins (messenger RNA), regulating gene expression (non-coding RNA), or serving as components of ribosomes (ribosomal RNA). The process involves the initiation, elongation, and termination phases, with differences in the mechanisms and regulation between prokaryotes and eukaryotes.*** ***Learning Outcomes: Transcription is the process by which genetic information stored in DNA is copied into RNA. In prokaryotes, transcription occurs in the cytoplasm and is carried out by a single RNA polymerase enzyme. In eukaryotes, transcription occurs in the nucleus and involves multiple RNA polymerases. Additionally, eukaryotic transcription requires various transcription factors and spliceosome regulatory elements, such as enhancers and promoters, to initiate and regulate the process. After transcription, the resulting RNA molecule undergoes further processing, such as splicing and capping, before being transported to the cytoplasm for translation into proteins.*** **Unit 4 Post-Transcriptional Processing:** Split genes, concept of introns and exons, RNA splicing, machinery, concept of alternative splicing, Polyadenylation and	6 6	2^{nd} – 3^{rd} week of October 1^{st} – 2^{nd} week of November

	capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance ***Learning Objectives: The objective of post-transcriptional processing is to modify and refine the mRNA transcript generated during transcription, ensuring its functionality for protein synthesis. This process involves adding protective caps and tails, removing non-coding regions (introns), and splicing together the coding regions (exons) to create a mature mRNA molecule. These modifications enhance mRNA stability, facilitate its transport out of the nucleus, and regulate gene expression by determining which portions of the transcript are translated into proteins. Overall, post-transcriptional processing is crucial for producing functional mRNA molecules that accurately convey genetic information for protein synthesis.*** ***Learning Outcomes:*** ***The outcome of post-transcriptional processing is the maturation of mRNA molecules in eukaryotic cells, ensuring they are functional for protein synthesis. This process involves several key steps, including capping, splicing, and polyadenylation. Capping adds a modified guanine nucleotide to the 5' end of the mRNA, which helps protect it from degradation and facilitates its binding to ribosomes. Splicing removes introns (non-coding regions) from the pre-mRNA and joins together exons (coding regions) to form a mature mRNA transcript. Polyadenylation adds a poly-A tail to the 3' end of the mRNA, which also aids in stability and translation. Overall, post-transcriptional processing ensures that the mRNA is properly modified and ready to be translated into proteins.*** **Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes:** Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus, Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms. ***Learning Objectives: The objective of regulating gene expression in both prokaryotes and eukaryotes is to finely control the amount and timing of protein production in response to internal and external cues. This regulation ensures that cells can adapt to changing environments, maintain homeostasis, and carry out specific functions necessary for growth, development, and survival. In prokaryotes, regulation often focuses on conserving energy and resources,***	6	2^{nd} – 3^{rd} week of November

	while in eukaryotes, it involves intricate control mechanisms to coordinate complex processes like development and tissue differentiation. ***Learning Outcomes: In prokaryotes, gene expression regulation often involves the control of transcription through mechanisms like operons and transcription factors. This allows bacteria to respond rapidly to environmental changes and conserve energy by producing only the necessary proteins. In eukaryotes, gene expression regulation is more complex and occurs at multiple levels, including transcriptional, post-transcriptional, translational, and post-translational regulation. This intricate control allows for precise temporal and spatial expression of genes, crucial for development, cell differentiation, and adaptation to varying environmental conditions.*** **SEC-A:** **1.Microbial Quality Control in Food and Pharmaceutical Industries** **Unit 3 Pathogenic Microorganisms of Importance in Food & Water:** Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay) ***Learning Objectives: Pathogenic microorganisms of importance in food and water include bacteria like Salmonella, Escherichia coli (E. coli), Listeria monocytogenes, and Campylobacter jejuni, as well as viruses like norovirus and hepatitis A virus, and parasites like Giardia lamblia and Cryptosporidium parvum. They can cause various illnesses when ingested through contaminated food or water.*** ***Learning Outcomes: Pathogenic microorganisms in food and water can lead to various outcomes, including foodborne illness and waterborne diseases. Common pathogens include bacteria like Salmonella, Escherichia coli (E. coli), Listeria monocytogenes, and Campylobacter, as well as viruses like norovirus and hepatitis A. These pathogens can cause symptoms ranging from gastrointestinal discomfort to severe illness, depending on the specific microorganism and the individual's health status.***	6 2	3rd – 4th week of November 4th week of November

	Unit 4 HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water ***Learning Objectives: The objective of Hazard Analysis and Critical Control Points (HACCP) for food safety and microbial standards is to systematically identify, assess, and control potential hazards in food production to ensure the safety of food products. By implementing HACCP, food producers aim to prevent foodborne illnesses by identifying critical control points (CCPs), establishing monitoring procedures, implementing corrective actions, and verifying that the system is effective. This proactive approach helps ensure that food products meet microbial standards and are safe for consumption, thereby protecting public health and enhancing consumer confidence in the food supply chain.*** ***Learning Outcomes: The outcome of Hazard Analysis and Critical Control Points (HACCP) for food safety and microbial standards is the systematic identification, assessment, and control of potential hazards at all stages of food production, processing, and distribution. By implementing HACCP, food producers can ensure that their products meet stringent microbial standards and are safe for consumption. This preventive approach involves identifying critical control points (CCPs) where hazards can be controlled or eliminated, establishing monitoring procedures, implementing corrective actions when necessary, and verifying that the system is working effectively. Ultimately, HACCP helps prevent foodborne illnesses, enhances consumer confidence, and ensures compliance with regulatory requirements.***		

Subhasree Roy (Jan – June 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 4 Cell Signalling:** Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway ***Learning Objectives: The objective of cell signaling is to facilitate communication between cells, allowing them to coordinate their activities and respond appropriately to internal and external stimuli. This intricate process enables cells to regulate various biological functions, maintain homeostasis, and ensure the proper development and functioning of multicellular organisms.*** ***Learning Outcomes: Cell signaling involves the transmission of signals or messages between cells to regulate various biological processes such as growth, development, and homeostasis. The outcome of cell signaling is the coordination of cellular activities, ensuring proper responses to environmental cues, and maintaining the overall health and function of the organism. This process is essential for cell communication and enables cells to interact with each other in a coordinated manner to carry out complex functions.*** **Unit 5 Cell Cycle, Cell Death and Cell Renewal:** Eukaryotic cell cycle and its regulation, Mitosis and Meiosis	4 4	1st week of April 2nd week of April

	Development of cancer, causes and types Programmed cell death, Stem cells, Embryonic stem cell, induced pleuripotent stem cells ***Learning Objectives: The cell cycle is the series of events that take place in a cell leading to its division and duplication. It consists of interphase (growth and DNA replication) and mitotic phase (division of the nucleus and cytoplasm).*** ***Cell death, also known as apoptosis, is a natural process in which cells self-destruct to maintain tissue homeostasis, remove damaged or infected cells, and regulate development.*** ***Cell renewal refers to the process by which old or damaged cells are replaced by new ones, ensuring the continuous functioning and regeneration of tissues and organs in multicellular organisms.*** ***Learning Outcomes : The cell cycle involves stages of growth, replication, and division. Cell death, or apoptosis, is a natural process to remove damaged or unnecessary cells. Cell renewal ensures tissues remain healthy and functional. In brief, the outcome is the maintenance of tissue integrity, growth, and repair.***		
	SEMESTER-4: **CC-9: ENVIRONMENTAL MICROBIOLOGY** **THEORY:** **Unit 4 Waste Management:** Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment ***Learning Objectives: The objective of waste management is to effectively and responsibly handle waste to minimize its adverse environmental, social, and health impacts. This includes reducing the amount of waste generated, maximizing recycling and reuse, safely treating and disposing of waste, and promoting sustainable practices to conserve resources and protect ecosystems. Ultimately, the goal is to achieve a cleaner, healthier environment while promoting resource efficiency and reducing pollution.***	6	1st – 2nd week of March

	Learning Outcomes: The outcome of waste management is the efficient and sustainable handling, treatment, and disposal of waste to minimize its environmental impact and protect public health. This involves strategies such as waste reduction, recycling, composting, and safe disposal of hazardous waste. By managing waste effectively, communities can conserve resources, reduce pollution, mitigate environmental degradation, and promote a healthier and more sustainable environment for current and future generations. **Unit 6 Water Potability:** Treatment and safety of drinking (potable) water, methods to detect potability of water samples: **(2)** standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests ***Learning Objectives: The objective of water portability is to ensure that water is safe for consumption regardless of its source or location, thereby minimizing the risk of waterborne diseases and promoting public health. This involves implementing measures such as water treatment, testing, and regulatory standards to guarantee that water meets certain quality criteria for human consumption.*** ***Learning Outcomes: The potability of water depends on various factors including its source, treatment, and possible contaminants. Testing water quality is essential to determine if it's safe for consumption.*** **PRACTICAL:** 4. Assessment of microbiological quality of water. 5. Determination of BOD of waste water sample. **SEC-B:** **2. MICROBIOLOGICAL ANALYSIS OF AIR AND WATER** **Unit 1 Aeromicrobiology:** Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens ***Learning Objectives: The objective of aeromicrobiology is to investigate the presence, behavior, and impact of microorganisms in the air. This includes understanding their distribution, diversity, survival mechanisms, and potential effects on human health, agriculture, and the environment. By studying aeromicrobiology, researchers aim to develop***	4 2	3rd week of March 1st week of April

	strategies for monitoring and managing airborne microbial populations, assessing air quality, and mitigating risks associated with airborne pathogens and pollutants. ***Learning Outcomes: The outcome of aeromicrobiology is the study of microorganisms present in the air, their distribution, behaviour, and impact on human health and the environment. This field explores the diversity of airborne microbes, their survival mechanisms, dispersal patterns, and potential roles in atmospheric processes. Understanding aeromicrobiology helps assess air quality, predict disease transmission, monitor environmental changes, and develop strategies for mitigating airborne microbial risks in various settings, such as hospitals, agricultural fields, and urban areas.*** **Unit 2 Air Sample Collection and Analysis:** Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics. ***Learning Objectives: The objective of air sample collection and analysis is to assess the composition of the air for various substances, such as pollutants, gases, particulate matter, and microorganisms. This helps in monitoring air quality, identifying sources of pollution, assessing health risks, and developing strategies for air pollution control and management.*** ***Learning Outcomes: The outcome of a microbiological analysis of water typically includes data on the presence and concentration of various microorganisms such as bacteria, viruses, and protozoa. Results may also indicate whether the water is safe for consumption, recreational use, or other purposes, based on established safety guidelines and standards.*** **Unit 3 Control Measures:** Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration ***Learning Objectives: The objective of control measures is to mitigate risks, hazards, or undesirable situations by implementing specific actions or interventions. These measures aim to prevent accidents, protect public health, safeguard the environment, or achieve other desired outcomes. By identifying and implementing appropriate control measures, individuals, organizations, and governments seek to minimize negative impacts and promote safety, security, and sustainability in***	3 2	2nd week of April 2nd week of April

	various domains such as healthcare, workplace safety, environmental protection, and public health. ***Learning Outcomes: The outcome of control measures is the effective management, reduction, or elimination of risks, hazards, or undesirable situations. Control measures are implemented to achieve specific objectives, such as enhancing safety, protecting public health, preserving the environment, or optimizing operational efficiency. These measures can include preventive actions, regulatory standards, engineering controls, administrative procedures, and personal protective equipment. The ultimate goal of control measures is to minimize or eliminate adverse outcomes and ensure the attainment of desired outcomes in various domains, including health, safety, security, and environmental protection.*** **Unit 4 Water Microbiology:** Water borne pathogens, water borne diseases ***Learning Objectives: The objective of water microbiology is to study the microorganisms found in water environments, including their diversity, interactions, and roles within aquatic ecosystems. By investigating water microbiology, researchers aim to understand the ecological dynamics of microbial communities, assess water quality, monitor potential threats to human health, and develop effective strategies for water treatment and sanitation. Ultimately, the goal is to safeguard water resources, protect public health, and promote sustainable management of aquatic ecosystems.*** ***Learning Outcomes: The outcome of water microbiology is the study of microorganisms present in water bodies, their diversity, abundance, behaviour, and impact on human health and the environment. This field investigates the distribution of aquatic microbes, their roles in nutrient cycling, biogeochemical processes, and their potential as indicators of water quality. Understanding water microbiology helps assess the safety of drinking water, predict and prevent waterborne diseases, monitor ecosystem health, and develop strategies for water treatment and sanitation.*** **Unit 5 Microbiological Analysis of Water:** Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests	2 4 3	3rd week of April 1st- 2nd week of May 3rd week of May

	Learning Objectives: The objective of microbiological analysis of water is to assess its safety by identifying and quantifying microorganisms such as bacteria, viruses, and parasites present in the water. This helps in ensuring that the water is safe for consumption and other uses, and also helps in monitoring and controlling waterborne diseases. ***Learning Outcomes: The outcome of a microbiological analysis of water typically includes data on the presence and concentration of various microorganisms such as bacteria, viruses, and protozoa. Results may also indicate whether the water is safe for consumption, recreational use, or other purposes, based on established safety guidelines and standards.*** **Unit 6 Control Measures** Precipitation, chemical disinfection, filtration, high temperature, UV light ***Learning Objectives: The objective of control measures is to minimize risks associated with the handling, use, storage, and disposal of hazardous chemicals. These measures aim to prevent accidents, environmental contamination, and adverse health effects by implementing specific actions or interventions. By establishing safety protocols, regulatory standards, and proper training, chemical control measures seek to protect human health, the environment, and property while promoting responsible chemical management practices.*** ***Learning Outcomes: The outcome of control measures is the effective management or mitigation of risks associated with the use, storage, handling, or disposal of hazardous chemicals. These measures aim to prevent accidents, environmental contamination, and adverse health effects by implementing specific actions or interventions. This may include implementing engineering controls, administrative procedures, personal protective equipment (PPE), and regulatory standards to minimize exposure to harmful chemicals and ensure compliance with safety regulations. Ultimately, the goal is to protect human health, the environment, and property while promoting safe and responsible chemical management practices.***		

Subhasree Roy (July – Dec 2020)

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	crucial role in various fields like medicine, biotechnology, and environmental science. **CC-2: BACTERIOLOGY** **THEORY:** **Unit 1 Cell organization:** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cellwall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation. ***Learning Objectives: The objective of cell organization is to create functional structures within an organism by arranging individual cells into specialized tissues, organs, and systems. This organization enables efficient communication and cooperation among cells, allowing them to perform specific tasks and functions essential for the survival and proper functioning of the organism as a whole.*** ***Learning Outcomes: Cell organization is the process by which cells assemble into tissues, organs, and systems, enabling the formation of complex biological structures necessary for the functioning of living organisms. This intricate arrangement allows for specialization and coordination of tasks, ultimately facilitating growth, development, and the maintenance of homeostasis within the organism.*** **PRACTICAL:** 11. Preparation of different media: synthetic media Czapek Dox media and /or 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.		2^{nd} – 4^{th} week of September

	SEMESTER –3 **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM** **PRACTICAL:** 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. **CC-7: MOLECULAR BIOLOGY:** **THEORY:** **Unit 2 Replication of DNA (Prokaryotes and Eukaryotes):** Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair ***Learning Objectives : The primary objective of DNA replication in both prokaryotes and eukaryotes is to ensure accurate transmission of genetic information from one generation to the next during cell division. By faithfully copying the entire genome, DNA replication ensures that each daughter cell receives a complete set of genetic instructions necessary for its proper function and survival. This process is essential for maintaining genetic stability and diversity within populations.*** ***Learning Outcomes: In prokaryotes, like bacteria, DNA replication starts from a single origin point and proceeds bidirectionally around the circular chromosome. This process is rapid and occurs in the cytoplasm. In contrast, eukaryotic DNA replication is more complex, occurring in the nucleus. Multiple origins of replication exist along linear chromosomes, and the process involves many enzymes and proteins. Replication is semiconservative, meaning each new DNA molecule consists of one parental strand and one newly synthesized strand.*** **Unit 3 Transcription in Prokaryotes and Eukaryotes:** Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors	8 6	1st -2nd week of September 2nd – 3rd week of September

	Learning Objectives: The objective of transcription in both prokaryotes and eukaryotes is to synthesize RNA molecules from DNA templates. These RNA molecules serve various functions, such as encoding proteins (messenger RNA), regulating gene expression (non-coding RNA), or serving as components of ribosomes (ribosomal RNA). The process involves the initiation, elongation, and termination phases, with differences in the mechanisms and regulation between prokaryotes and eukaryotes. ***Learning Outcomes: Transcription is the process by which genetic information stored in DNA is copied into RNA. In prokaryotes, transcription occurs in the cytoplasm and is carried out by a single RNA polymerase enzyme. In eukaryotes, transcription occurs in the nucleus and involves multiple RNA polymerases. Additionally, eukaryotic transcription requires various transcription factors and spliceosome regulatory elements, such as enhancers and promoters, to initiate and regulate the process. After transcription, the resulting RNA molecule undergoes further processing, such as splicing and capping, before being transported to the cytoplasm for translation into proteins.*** **Unit 4 Post-Transcriptional Processing:** Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance ***Learning Objectives: The objective of post-transcriptional processing is to modify and refine the mRNA transcript generated during transcription, ensuring its functionality for protein synthesis. This process involves adding protective caps and tails, removing non-coding regions (introns), and splicing together the coding regions (exons) to create a mature mRNA molecule. These modifications enhance mRNA stability, facilitate its transport out of the nucleus, and regulate gene expression by determining which portions of the transcript are translated into proteins. Overall, post-transcriptional processing is crucial for producing functional mRNA molecules that accurately convey genetic information for protein synthesis.*** ***Learning Outcomes: The outcome of post-transcriptional processing is the maturation of mRNA molecules in eukaryotic cells, ensuring they are functional for protein***	6	3rd – 4th week of September

	synthesis. This process involves several key steps, including capping, splicing, and polyadenylation. Capping adds a modified guanine nucleotide to the 5' end of the mRNA, which helps protect it from degradation and facilitates its binding to ribosomes. Splicing removes introns (non-coding regions) from the pre-mRNA and joins together exons (coding regions) to form a mature mRNA transcript. Polyadenylation adds a poly-A tail to the 3' end of the mRNA, which also aids in stability and translation. Overall, post-transcriptional processing ensures that the mRNA is properly modified and ready to be translated into proteins. **Unit 6 Regulation of gene Expression in Prokaryotes and Eukaryotes:** Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus, Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms. ***Learning Objectives: The objective of regulating gene expression in both prokaryotes and eukaryotes is to finely control the amount and timing of protein production in response to internal and external cues. This regulation ensures that cells can adapt to changing environments, maintain homeostasis, and carry out specific functions necessary for growth, development, and survival. In prokaryotes, regulation often focuses on conserving energy and resources, while in eukaryotes, it involves intricate control mechanisms to coordinate complex processes like development and tissue differentiation.*** ***Learning Outcomes: In prokaryotes, gene expression regulation often involves the control of transcription through mechanisms like operons and transcription factors. This allows bacteria to respond rapidly to environmental changes and conserve energy by producing only the necessary proteins. In eukaryotes, gene expression regulation is more complex and occurs at multiple levels, including transcriptional, post-transcriptional, translational, and post-translational regulation. This intricate control allows for precise temporal and spatial expression of genes, crucial for development, cell differentiation, and adaptation to varying environmental conditions.*** **SEC-A:** **1.Microbial Quality Control in Food and Pharmaceutical Industries**	6 4	1st – 2nd week of October 3rd week of October

	Unit 3 Pathogenic Microorganisms of Importance in Food & Water: Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay) ***Learning Objectives: Pathogenic microorganisms of importance in food and water include bacteria like Salmonella, Escherichia coli (E. coli), Listeria monocytogenes, and Campylobacter jejuni, as well as viruses like norovirus and hepatitis A virus, and parasites like Giardia lamblia and Cryptosporidium parvum. They can cause various illnesses when ingested through contaminated food or water.*** ***Learning Outcomes: Pathogenic microorganisms in food and water can lead to various outcomes, including foodborne illness and waterborne diseases. Common pathogens include bacteria like Salmonella, Escherichia coli (E. coli), Listeria monocytogenes, and Campylobacter, as well as viruses like norovirus and hepatitis A. These pathogens can cause symptoms ranging from gastrointestinal discomfort to severe illness, depending on the specific microorganism and the individual's health status.*** **Unit 4 HACCP for Food Safety and Microbial Standards:** Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water ***Learning Objectives: The objective of Hazard Analysis and Critical Control Points (HACCP) for food safety and microbial standards is to systematically identify, assess, and control potential hazards in food production to ensure the safety of food products. By implementing HACCP, food producers aim to prevent foodborne illnesses by identifying critical control points (CCPs), establishing monitoring procedures, implementing corrective actions, and verifying that the system is effective. This proactive approach helps ensure that food products meet microbial standards and are safe for consumption, thereby protecting public health and enhancing consumer confidence in the food supply chain.*** ***Learning Outcomes: The outcome of Hazard Analysis and Critical Control Points (HACCP) for food safety and***	2	4th week of October

	microbial standards is the systematic identification, assessment, and control of potential hazards at all stages of food production, processing, and distribution. By implementing HACCP, food producers can ensure that their products meet stringent microbial standards and are safe for consumption. This preventive approach involves identifying critical control points (CCPs) where hazards can be controlled or eliminated, establishing monitoring procedures, implementing corrective actions when necessary, and verifying that the system is working effectively. Ultimately, HACCP helps prevent foodborne illnesses, enhances consumer confidence, and ensures compliance with regulatory requirements.		
	SEMESTER –5 **CC-11: FOOD AND DAIRY MICROBIOLOGY:** **THEORY:** **Unit 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures):** Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni ***Learning Objectives: The objective of preventing foodborne diseases is to ensure the safety of the food supply chain, from production to consumption, by implementing measures such as proper food handling, storage, and sanitation practices. This helps minimize the risk of contamination by pathogens or harmful substances, ultimately safeguarding public health.*** ***Learning Outcomes: The outcome of a foodborne disease can vary depending on factors such as the type and severity of the illness, the individual's overall health, and the promptness and effectiveness of medical treatment. In mild cases, symptoms may resolve on their own, while severe cases can lead to hospitalization, long-term health complications, or even death in rare instances. Prompt medical attention and proper hygiene practices can greatly reduce the risk and severity of foodborne illnesses.*** **Unit 6 Food sanitation and control:** HACCP, Indices of food sanitary quality and sanitizers	4 2	1st week of August 2nd week of August

	Learning Objectives: The objective of food sanitation and control is to maintain the safety, quality, and integrity of food products throughout their production, processing, storage, distribution, and consumption. This involves implementing measures to prevent contamination, reduce the risk of foodborne illnesses, and ensure compliance with regulatory standards and industry best practices. By promoting hygiene practices, sanitation protocols, and quality assurance procedures, food sanitation and control aim to safeguard public health, protect consumers, and maintain confidence in the safety and integrity of the food supply chain. ***Learning Outcomes : The outcome of food sanitation and control measures is to ensure the safety and quality of food products throughout the entire food supply chain, from production to consumption. This involves implementing hygiene practices, sanitation protocols, and quality control measures to prevent contamination, reduce foodborne illnesses, and maintain product integrity. By monitoring and enforcing regulatory standards, conducting inspections, and implementing hazard analysis and critical control points (HACCP), food sanitation and control measures aim to safeguard public health, build consumer trust, and promote confidence in the safety and quality of the food supply.*** **Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.** ***Learning Objectives: The objective of preventing foodborne diseases is to ensure the safety of the food supply chain, from production to consumption, by implementing measures such as proper food handling, storage, and sanitation practices. This helps minimize the risk of contamination by pathogens or harmful substances, ultimately safeguarding public health.*** ***Learning Outcomes: The outcome of a foodborne disease can vary depending on factors such as the type and severity of the illness, the individual's overall health, and the promptness and effectiveness of medical treatment. In mild cases, symptoms may resolve on their own, while severe cases can lead to hospitalization, long-term health complications, or even death in rare instances. Prompt medical attention and proper hygiene practices can greatly reduce the risk and severity of foodborne illnesses.***	3	3rd week of August

	PRACTICAL: 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/Dahi. **DSE-A:1.MICROBIAL BIOTECHNOLOGY:** **THEORY:** **Unit 6 RNAi :** RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen interactions ***Learning Objectives: The objective of RNA interference (RNAi) is to silence or regulate the expression of specific genes by introducing small RNA molecules that can interfere with the mRNA molecules transcribed from those genes. This technique is widely used in research to study gene function and has potential applications in medicine, agriculture, and biotechnology.*** ***Learning Outcomes: RNA interference (RNAi) is a biological process where RNA molecules inhibit gene expression or translation by neutralizing targeted mRNA molecules. Its outcomes depend on the specific genes being targeted and the context in which it's applied. Typically, RNAi can lead to the down regulation of gene expression, which can have various effects such as suppressing the activity of harmful genes or regulating developmental processes. However, the outcomes can vary widely depending on the specific genes involved and the cell types in which RNAi is applied.***	4	1st week of September

Subhasree Roy (Jan – June 2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching learning
	SEMESTER –2 **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 4 Cell Signalling:** Signalling molecules and their receptors Function of cell surface receptors Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway ***Learning Objectives: The objective of cell signaling is to facilitate communication between cells, allowing them to coordinate their activities and respond appropriately to internal and external stimuli. This intricate process enables cells to regulate various biological functions, maintain homeostasis, and ensure the proper development and functioning of multicellular organisms.*** ***Learning Outcomes: Cell signaling involves the transmission of signals or messages between cells to regulate various biological processes such as growth, development, and homeostasis. The outcome of cell signaling is the coordination of cellular activities, ensuring proper responses to environmental cues, and maintaining the overall health and function of the organism. This process is essential for cell communication and enables cells to interact with each other in a coordinated manner to carry out complex functions.*** **Unit 5 Cell Cycle, Cell Death and Cell Renewal:** Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types Programmed cell death Stem cells, Embryonic stem cell, induced pleuripotent stem cells	4 6	1st week of April 2nd – 3rd week of April

	Learning Objectives: The cell cycle is the series of events that take place in a cell leading to its division and duplication. It consists of interphase (growth and DNA replication) and mitotic phase (division of the nucleus and cytoplasm). ***Cell death, also known as apoptosis, is a natural process in which cells self-destruct to maintain tissue homeostasis, remove damaged or infected cells, and regulate development. Cell renewal refers to the process by which old or damaged cells are replaced by new ones, ensuring the continuous functioning and regeneration of tissues and organs in multicellular organisms.*** ***Learning Outcomes : The cell cycle involves stages of growth, replication, and division. Cell death, or apoptosis, is a natural process to remove damaged or unnecessary cells. Cell renewal ensures tissues remain healthy and functional. In brief, the outcome is the maintenance of tissue integrity, growth, and repair.***		
	SEMESTER-4: **CC-9: ENVIRONMENTAL MICROBIOLOGY** **THEORY:** **Unit 4 Waste Management:** Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill) Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment ***Learning Objectives: The objective of waste management is to effectively and responsibly handle waste to minimize its adverse environmental, social, and health impacts. This includes reducing the amount of waste generated, maximizing recycling and reuse, safely treating and disposing of waste, and promoting sustainable practices to conserve resources and protect ecosystems. Ultimately, the goal is to achieve a cleaner, healthier environment while promoting resource efficiency and reducing pollution.*** ***Learning Outcomes: The outcome of waste management is the efficient and sustainable handling, treatment, and disposal of waste to minimize its environmental impact and protect public health. This involves strategies such as waste reduction, recycling, composting, and safe disposal of hazardous waste.***	6	1st- 2nd week of May

	By managing waste effectively, communities can conserve resources, reduce pollution, mitigate environmental degradation, and promote a healthier and more sustainable environment for current and future generations. **Unit 6 Water Potability:** Treatment and safety of drinking (potable) water, methods to detect potability of water samples: **(2)** standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests ***Learning Objectives: The objective of water portability is to ensure that water is safe for consumption regardless of its source or location, thereby minimizing the risk of waterborne diseases and promoting public health. This involves implementing measures such as water treatment, testing, and regulatory standards to guarantee that water meets certain quality criteria for human consumption.*** ***Learning Outcomes: The potability of water depends on various factors including its source, treatment, and possible contaminants. Testing water quality is essential to determine if it's safe for consumption.*** **PRACTICAL:** 4. Assessment of microbiological quality of water. 5. Determination of BOD of waste water sample. **SEC-B:** **2. MICROBIOLOGICAL ANALYSIS OF AIR AND WATER** **Unit 1 Aeromicrobiology:** Bio aerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens ***Learning Objectives: The objective of aeromicrobiology is to investigate the presence, behaviour, and impact of microorganisms in the air. This includes understanding their distribution, diversity, survival mechanisms, and potential effects on human health, agriculture, and the environment. By studying aeromicrobiology, researchers aim to develop strategies for monitoring and managing airborne microbial populations, assessing air quality, and mitigating risks associated with airborne pathogens and pollutants.***	4 4	3rd week of May 4th week of May

	Learning Outcomes: The outcome of aeromicrobiology is the study of microorganisms present in the air, their distribution, behaviour, and impact on human health and the environment. This field explores the diversity of airborne microbes, their survival mechanisms, dispersal patterns, and potential roles in atmospheric processes. Understanding aeromicrobiology helps assess air quality, predict disease transmission, monitor environmental changes, and develop strategies for mitigating airborne microbial risks in various settings, such as hospitals, agricultural fields, and urban areas.	3	1st week of June
	Unit 2 Air Sample Collection and Analysis: Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics		
	Learning Objectives: The objective of air sample collection and analysis is to assess the composition of the air for various substances, such as pollutants, gases, particulate matter, and microorganisms. This helps in monitoring air quality, identifying sources of pollution, assessing health risks, and developing strategies for air pollution control and management.	2	2nd week of June
	Learning Outcomes: The outcome of a microbiological analysis of water typically includes data on the presence and concentration of various microorganisms such as bacteria, viruses, and protozoa. Results may also indicate whether the water is safe for consumption, recreational use, or other purposes, based on established safety guidelines and standards.		
	Unit 3 Control Measures: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration		
	Learning Objectives: The objective of control measures is to mitigate risks, hazards, or undesirable situations by implementing specific actions or interventions. These measures aim to prevent accidents, protect public health, safeguard the environment, or achieve other desired outcomes. By identifying and implementing appropriate control measures, individuals, organizations, and governments seek to minimize negative impacts and promote safety, security, and sustainability in various domains such as healthcare, workplace safety, environmental protection, and public health.	2	2nd week of June

	Learning Outcomes: The outcome of control measures is the effective management, reduction, or elimination of risks, hazards, or undesirable situations. Control measures are implemented to achieve specific objectives, such as enhancing safety, protecting public health, preserving the environment, or optimizing operational efficiency. These measures can include preventive actions, regulatory standards, engineering controls, administrative procedures, and personal protective equipment. The ultimate goal of control measures is to minimize or eliminate adverse outcomes and ensure the attainment of desired outcomes in various domains, including health, safety, security, and environmental protection. **Unit 4 Water Microbiology:** Water borne pathogens, water borne diseases ***Learning Objectives: The objective of water microbiology is to study the microorganisms found in water environments, including their diversity, interactions, and roles within aquatic ecosystems. By investigating water microbiology, researchers aim to understand the ecological dynamics of microbial communities, assess water quality, monitor potential threats to human health, and develop effective strategies for water treatment and sanitation. Ultimately, the goal is to safeguard water resources, protect public health, and promote sustainable management of aquatic ecosystems.*** ***Learning Outcomes: The outcome of water microbiology is the study of microorganisms present in water bodies, their diversity, abundance, behaviour, and impact on human health and the environment. This field investigates the distribution of aquatic microbes, their roles in nutrient cycling, biogeochemical processes, and their potential as indicators of water quality. Understanding water microbiology helps assess the safety of drinking water, predict and prevent waterborne diseases, monitor ecosystem health, and develop strategies for water treatment and sanitation.*** **Unit 5 Microbiological Analysis of Water:** Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests ***Learning Objectives: The objective of microbiological analysis of water is to assess its safety by identifying and quantifying***	4 3	3rd week of June 4th week of June

	microorganisms such as bacteria, viruses, and parasites present in the water. This helps in ensuring that the water is safe for consumption and other uses, and also helps in monitoring and controlling waterborne diseases. ***Learning Outcomes: The outcome of a microbiological analysis of water typically includes data on the presence and concentration of various microorganisms such as bacteria, viruses, and protozoa. Results may also indicate whether the water is safe for consumption, recreational use, or other purposes, based on established safety guidelines and standards.*** **Unit 6 Control Measures** Precipitation, chemical disinfection, filtration, high temperature, UV light ***Learning Objectives: The objective of control measures is to minimize risks associated with the handling, use, storage, and disposal of hazardous chemicals. These measures aim to prevent accidents, environmental contamination, and adverse health effects by implementing specific actions or interventions. By establishing safety protocols, regulatory standards, and proper training, chemical control measures seek to protect human health, the environment, and property while promoting responsible chemical management practices.*** ***Learning Outcomes: The outcome of control measures is the effective management or mitigation of risks associated with the use, storage, handling, or disposal of hazardous chemicals. These measures aim to prevent accidents, environmental contamination, and adverse health effects by implementing specific actions or interventions. This may include implementing engineering controls, administrative procedures, personal protective equipment (PPE), and regulatory standards to minimize exposure to harmful chemicals and ensure compliance with safety regulations. Ultimately, the goal is to protect human health, the environment, and property while promoting safe and responsible chemical management practices.***		
	SEMESTER – 6 **CC-14: MEDICAL MICROBIOLOGY:** **THEORY:**		

	Unit 1 Normal microflora of the human body and host pathogen interaction: Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract Host pathogen interaction: Definitions – Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS ***Learning Objectives: The objectives of the normal microflora of the human body include maintaining a symbiotic relationship with the host, aiding in digestion and nutrient absorption, synthesizing essential vitamins, and contributing to the development and regulation of the immune system. Host-pathogen interactions aim to establish a balance between the invading pathogens and the host's immune defenses. The objectives of these interactions include the pathogen's attempts to establish infection and replicate within the host, while the host aims to recognize and eliminate the pathogen to maintain health and prevent disease. These interactions are critical for understanding infectious diseases and developing strategies for prevention and treatment.*** ***Learning Outcomes: The normal microflora, or microbiota, of the human body consists of various microorganisms like bacteria, fungi, and viruses that reside on the skin, in the gastrointestinal tract, respiratory tract, and other mucosal surfaces. These microorganisms play vital roles in digestion, immune system regulation, and protection against pathogens by competing for nutrients and producing antimicrobial substances. . However, when the balance of these microorganisms is disrupted, either due to factors like antibiotics, stress, or diet, it can lead to dysbiosis, which may result in infections or other health issues. . Host-pathogen interactions occur when pathogens invade the host's body and attempt to establish infection. This interaction involves a complex interplay between the pathogen's virulence factors and the host's immune defenses. Pathogens employ various strategies to evade or suppress the host's immune response, while the host mounts defenses to eliminate the invading pathogen. Successful host-pathogen interactions can lead to either the clearance of the pathogen or the establishment of infection, depending on factors such as the virulence of the pathogen and the effectiveness of the host's immune response. Understanding these interactions is crucial for developing strategies to prevent and treat infectious diseases.***	4 8	1st week of February 2nd- 3rd week of February

	Unit 3 Bacterial diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum,Clostridium difficie ***Learning Objectives: Bacterial diseases are caused by harmful bacteria invading the body, leading to various illnesses. Examples include tuberculosis, strep throat, and cholera. These diseases often require antibiotic treatment and can range from mild to life-threatening, depending on the bacteria involved and the individual's health.*** ***Learning Outcomes: The outcome of a bacterial disease can vary depending on factors such as the type of bacteria, the individual's immune system, and how quickly treatment is sought. Some bacterial diseases can be mild and resolve on their own, while others can be severe or even life-threatening if not treated promptly and effectively.***	4	4th week of February
	Unit 5 Protozoan diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar ***Learning Objectives: Protozoan diseases are caused by single-celled organisms called protozoa. Their objectives, so to speak, are survival and reproduction, often at the expense of the host organism. Protozoa can cause various diseases in humans and animals, such as malaria, amoebiasis, giardiasis, and sleeping sickness. Their primary goal is to find a suitable host, establish infection, and proliferate to ensure their survival and spread.*** ***Learning Outcomes: The outcome of protozoan diseases can vary widely depending on factors such as the specific organism causing the infection, the individual's immune system, and the timing and effectiveness of treatment. Some protozoan diseases, like malaria or leishmaniasis, can be life-threatening if not treated promptly. Others, such as giardiasis or toxoplasmosis, may cause discomfort but are generally not fatal in healthy individuals. Early diagnosis and appropriate treatment are crucial for a favorable outcome.***	4	1st week of March

	Unit 6 Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis ***Learning Objectives: The objective of fungal diseases is survival and reproduction, typically by infecting host organisms to obtain nutrients and propagate. Fungi can cause various diseases in plants, animals, and humans, ranging from mild infections to severe illnesses.*** ***Learning Outcomes: The outcomes of fungal diseases can vary depending on factors such as the type of fungus, the individual's immune system, and the timing of treatment. In general, outcomes can range from mild and self-limiting infections to severe and life-threatening conditions if left untreated or if the immune system is compromised.*** **Unit 7 Antimicrobial agents: General characteristics and mode of action:** Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1 ***Learning Objectives: Antimicrobial agents are substances that kill or inhibit the growth of microorganisms, such as bacteria, fungi, viruses, or parasites. Their objective is to treat or prevent infections by targeting specific pathogens while minimizing harm to the host. They can be antibiotics, antifungals, antivirals, or antiparasitics, and their effectiveness depends on factors like the type of microorganism and the host's immune response.*** ***Learning Outcomes: The outcome of antimicrobial agents can vary depending on factors such as the type of microorganism targeted, the effectiveness of the agent, the dosage, and the patient's response. Generally, they aim to inhibit or kill microorganisms, thereby treating or preventing infections. However, their effectiveness can be influenced by factors such as antimicrobial resistance, patient compliance, and adverse***	8	2^{nd} – 3^{rd} week of March

	effects. Regular monitoring and appropriate use are crucial for achieving successful outcomes. **PRACTICAL:** 7. Identify bacteria (any three of E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests 2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS 3. Study of bacterial flora of skin by swab method 4. Perform antibacterial sensitivity by Kirby-Bauer method 5. Determination of minimal inhibitory concentration (MIC) of an antibiotic. 6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms) 7. Study of various stages of malarial parasite in RBCs using permanent mounts.		

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Dr. Maitreyee Mondal (July – Dec 2018)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **THEORY:** **Unit 2 Diversity of Microbial World:** A. Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. ***Learning Objectives: The objective of studying the diversity of the microbial world is to understand the vast array of microorganisms, their roles in ecosystems, their impacts on human health, and their potential applications in various fields such as medicine, agriculture, and industry.*** ***Learning Outcome: Studying the diversity of the microbial world yields insights into new biotechnological applications, enhances our understanding of ecosystem dynamics, aids in the development of novel medical treatments, and fosters innovations in agriculture and environmental management.*** **CC-2: BACTERIOLOGY** **THEORY:** **Unit 5 Reproduction in Bacteria:** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate ***Learning Objectives: The primary objective of reproduction in bacteria is to increase their population size, ensuring the survival of the species. Bacterial reproduction occurs mainly through binary fission, where a single bacterial cell divides into two identical daughter cells. This process allows bacteria to quickly multiply and colonize new environments.*** ***Learning Outcome: Reproduction in bacteria typically involves a process called binary fission, where a single bacterial cell divides into two identical daughter cells. This rapid mode of reproduction allows bacteria to multiply quickly under favorable conditions. Some outcomes of bacterial***	4 4	1st week of September 1st – 2nd week of September

	reproduction include population growth, genetic diversity through mutation, and adaptation to changing environments. However, it's important to note that not all bacterial reproduction leads to successful offspring, as environmental factors, competition, and genetic mutations can also influence outcomes. **Unit 6 Bacterial Systematics:** Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria. ***Learning Objectives: The objective of bacterial systematics is to classify and organize bacteria into groups based on their evolutionary relationships, genetic similarities, and other characteristics. This helps scientists understand bacterial diversity, evolution, and relationships between different species.*** ***Learning Outcome: The outcomes of bacterial systematics include the classification, identification, and understanding of bacterial diversity, evolutionary relationships, and ecological roles, aiding in various fields such as medicine, agriculture, and environmental science.*** **Unit 7 Important archaeal and eubacterial groups:** **Archaebacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota(Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: **Gram Negative:** Non proteobacteria: General characteristics with suitable examples. Alpha proteobacteria: General characteristics with suitable examples. Beta proteobacteria: General characteristics with suitable examples. Gamma proteobacteria: General characteristics with suitable examples. Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples. **Gram Positive:** Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples **Cyanobacteria:**An Introduction	7 16	3^{rd} – 4^{th} week of September 1^{st} week of October

	Learning Objectives: Archaea: Often found in extreme environments like hot springs and deep-sea vents, archaea play crucial roles in biogeochemical cycles and are important for understanding early life on Earth.Eubacteria (Bacteria): They're ubiquitous and diverse, with members found in virtually every environment on Earth. They're essential for processes like nutrient cycling, decomposition, and symbiotic relationships with other organisms, including humans. ***Learning Outcome: Archaeal and eubacterial groups have diverse outcomes and roles in various ecosystems. Archaea, known for their ability to thrive in extreme environments, contribute to nutrient cycling, especially in anaerobic conditions like deep-sea vents. Eubacteria, on the other hand, are ubiquitous and play crucial roles in processes such as nitrogen fixation, decomposition, and symbiotic relationships with plants and animals. Some eubacteria, like cyanobacteria, are photosynthetic and play a vital role in oxygen production and carbon cycling. Both groups are essential for maintaining ecological balance and supporting life on Earth.***		

Dr. Maitreyee Mondal (Jan – June 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 3 Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers ***Learning Objectives: The primary objective of lipids in the body is to serve as a concentrated energy source, provide insulation and protection for organs, assist in the absorption of fat-soluble vitamins, and act as structural components of cell membranes. Additionally, lipids play crucial roles in signaling pathways and hormone production.*** ***Learning Outcome: Lipids play various roles in the body, including energy storage, insulation, and cell membrane structure. They can have different outcomes depending on their type and how they're metabolized. For example, excess consumption of certain types of lipids, like trans fats, can lead to negative health outcomes such as cardiovascular disease. Conversely, consuming healthy fats, like omega-3 fatty acids, can have positive effects on heart health and brain function.*** **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 1 Structure and organization of Cell:** Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with	10 6	1st – 2nd week of April 3rd week of April

	plasma membrane, cell surface protrusions, intermediate filaments, microtubules ***Learning Objectives: The objective of studying the structure and organization of cells is to understand the fundamental units of life, how they function, communicate, and interact with their environment. This knowledge is crucial for advancing fields like biology, medicine, and biotechnology, as well as for comprehending the basis of life itself.*** ***Learning Outcome: Studying the structure and organization of cells leads to a deeper understanding of cellular processes, including metabolism, growth, and reproduction. It also enables advancements in medical research, biotechnology, and pharmacology, ultimately contributing to the development of treatments for diseases and the improvement of various industries such as agriculture and biomanufacturing.***		

Dr. Maitreyee Mondal (July – Dec 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
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	CC-2: BACTERIOLOGY **THEORY:** **Unit 5 Reproduction in Bacteria:** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate ***Learning Objectives: The primary objective of reproduction in bacteria is to increase their population size, ensuring the survival of the species. Bacterial reproduction occurs mainly through binary fission, where a single bacterial cell divides into two identical daughter cells. This process allows bacteria to quickly multiply and colonize new environments.*** ***Learning Outcome: Reproduction in bacteria typically involves a process called binary fission, where a single bacterial cell divides into two identical daughter cells. This rapid mode of reproduction allows bacteria to multiply quickly under favorable conditions. Some outcomes of bacterial reproduction include population growth, genetic diversity through mutation, and adaptation to changing environments. However, it's important to note that not all bacterial***	4	1st – 2nd week of September

	reproduction leads to successful offspring, as environmental factors, competition, and genetic mutations can also influence outcomes. **Unit 6 Bacterial Systematics:** Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria. ***Learning Objectives: The objective of bacterial systematics is to classify and organize bacteria into groups based on their evolutionary relationships, genetic similarities, and other characteristics. This helps scientists understand bacterial diversity, evolution, and relationships between different species.*** ***Learning Outcome: The outcomes of bacterial systematics include the classification, identification, and understanding of bacterial diversity, evolutionary relationships, and ecological roles, aiding in various fields such as medicine, agriculture, and environmental science.*** **Unit 7 Important archaeal and eubacterial groups:** **Archaebacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota(Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: **Gram Negative:** Non proteobacteria: General characteristics with suitable examples. Alpha proteobacteria: General characteristics with suitable examples. Beta proteobacteria: General characteristics with suitable examples. Gamma proteobacteria: General characteristics with suitable examples. Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples. **Gram Positive:** Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples **Cyanobacteria:**An Introduction ***Learning Objectives: Archaea: Often found in extreme environments like hot springs and deep-sea vents, archaea play crucial roles in biogeochemical cycles and are***	7 16	3^{rd} – 4^{th} week of September 1^{st} – 3^{rd} week of October

	important for understanding early life on Earth.Eubacteria (Bacteria): They're ubiquitous and diverse, with members found in virtually every environment on Earth. They're essential for processes like nutrient cycling, decomposition, and symbiotic relationships with other organisms, including humans. ***Learning Outcome: Archaeal and eubacterial groups have diverse outcomes and roles in various ecosystems. Archaea, known for their ability to thrive in extreme environments, contribute to nutrient cycling, especially in anaerobic conditions like deep-sea vents. Eubacteria, on the other hand, are ubiquitous and play crucial roles in processes such as nitrogen fixation, decomposition, and symbiotic relationships with plants and animals. Some eubacteria, like cyanobacteria, are photosynthetic and play a vital role in oxygen production and carbon cycling. Both groups are essential for maintaining ecological balance and supporting life on Earth.***		
	SEMESTER –3 **CC-5: VIROLOGY:** **PRACTICAL:** 1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs 2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs 3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph. 4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique 5. Studying isolation and propagation of animal viruses by chick embryo technique 6. Study of cytopathic effects of viruses using photographs 7. Perform local lesion technique for assaying plant viruses. **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM:** **Unit 1 Microbial Growth and Effect of Environment on Microbial Growth** Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles,thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe,	10	1st – 3rd week of August

	facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph,Chemolithoheterotroph, Chemoheterotroph,Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. ***Learning Objectives: The objective of microbial growth is for microorganisms to reproduce and thrive in their environment, often by multiplying their numbers. The environment plays a crucial role in microbial growth, as factors like temperature, pH, moisture, oxygen availability, and nutrient availability can significantly impact the rate and extent of growth. For example, some microorganisms thrive in acidic environments while others prefer alkaline conditions. Similarly, variations in temperature can either inhibit or promote microbial growth depending on the species involved.*** ***Learning Outcome: Microbial growth outcomes can vary widely based on factors like environment, nutrients, and species. Generally, it leads to population increase, biofilm formation, and potentially pathogenicity. The environment significantly influences microbial growth, with factors like temperature, pH, moisture, and oxygen levels impacting growth rates and metabolic activities.*** **Unit 2 Nutrient uptake and Transport**: Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake ***Learning Objectives: The primary objective of nutrient uptake and transport in plants is to ensure the delivery of essential nutrients, such as nitrogen, phosphorus, potassium, and micronutrients, from the soil to various parts of the plant where they are needed for growth, development, and metabolism. This process involves absorption of nutrients by the roots, their movement through the plant via vascular tissues (xylem and phloem), and their distribution to cells and tissues for various physiological functions.*** ***Learning Outcome: The outcome of nutrient uptake and transport in plants is vital for their growth, development, and overall health. It ensures that essential nutrients are efficiently delivered to various parts of the plant, supporting processes such as photosynthesis, metabolism, and structural development, ultimately leading to optimal plant growth, reproduction, and resilience against environmental stresses.*** **CC-7: MOLECULAR BIOLOGY :** **THEORY**	6	4th week of august

	Unit 1 Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA. ***Learning Objectives: The primary objective of DNA and RNA, as genetic material, is to store, transmit, and express genetic information. DNA serves as the stable repository of genetic instructions, while RNA plays a key role in translating those instructions into functional proteins. Additionally, both DNA and RNA contribute to the regulation of gene expression and various cellular processes essential for life.*** ***Learning Outcome: The structures of DNA and RNA play critical roles in genetic material. DNA's double helix structure allows for stable storage of genetic information, while RNA's single-stranded structure enables various functions like protein synthesis. The outcomes include accurate replication of genetic material, transcription of DNA into RNA, translation of RNA into proteins, and ultimately, the inheritance and expression of traits in organisms. Mutations in these structures can lead to genetic diseases or variations that drive evolution.***	6	1st – 2nd week of September
	Unit 5 Translation (Prokaryotes and Eukaryotes): Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote ***Learning Objectives: The objective of translation is to convey the meaning and intent of a text accurately from one language to another, while taking into account cultural nuances and linguistic differences.*** ***Learning Outcome: The outcomes of translation depend on various factors such as the quality of the translation, the context, and the purpose. Generally, it aims to convey the meaning of a text accurately from one language to another, ensuring clarity, coherence, and cultural sensitivity. Successful outcomes include effective communication, preservation of original intent, and facilitating cross-cultural understanding. However, poor translation can lead to misunderstandings, loss of nuance, or even offense.*** **PRACTICAL:**	6	3rd week of September

	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).		

Dr. Maitreyee Mondal (Jan – June 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 3 Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers ***Learning Objectives: The primary objective of lipids in the body is to serve as a concentrated energy source, provide insulation and protection for organs, assist in the absorption of fat-soluble vitamins, and act as structural components of cell membranes. Additionally, lipids play crucial roles in signaling pathways and hormone production.*** ***Learning Outcome: Lipids play various roles in the body, including energy storage, insulation, and cell membrane structure. They can have different outcomes depending on their type and how they're metabolized. For example, excess consumption of certain types of lipids, like trans fats, can lead to negative health outcomes such as cardiovascular disease. Conversely, consuming healthy fats, like omega-3 fatty acids, can have positive effects on heart health and brain function.*** **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 1 Structure and organization of Cell:** Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with	10 6	1^{st} – 2^{nd} week of April 3^{rd} week of April

	plasma membrane, cell surface protrusions, intermediate filaments, microtubules ***Learning Objectives: The objective of studying the structure and organization of cells is to understand the fundamental units of life, how they function, communicate, and interact with their environment. This knowledge is crucial for advancing fields like biology, medicine, and biotechnology, as well as for comprehending the basis of life itself.*** ***Learning Outcome: Studying the structure and organization of cells leads to a deeper understanding of cellular processes, including metabolism, growth, and reproduction. It also enables advancements in medical research, biotechnology, and pharmacology, ultimately contributing to the development of treatments for diseases and the improvement of various industries such as agriculture and biomanufacturing.***		
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 1 Genome Organization and Mutations:** Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes ***Learning Objectives: The objective of genome organization is to efficiently store and regulate genetic information within a cell. Mutation, on the other hand, introduces genetic variation, which is essential for evolution and adaptation to changing environments.*** ***Learning Outcome: Genome organization helps maintain stability, ensures accurate transmission of genetic information during cell division, and facilitates gene regulation. Mutation, meanwhile, generates genetic diversity, which can lead to evolutionary adaptation, disease, or genetic disorders, depending on the nature and impact of the mutation.*** **Unit 2 Plasmids:** Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids.	6 4	1st week of march 2nd week of march

	Learning Objectives: The main objective of plasmids is to replicate independently of the host chromosome, serving as vectors for the transfer of genetic material between bacteria. They often carry genes that provide advantages such as antibiotic resistance or the ability to metabolize certain nutrients. In biotechnology, plasmids are used for gene cloning, expression of recombinant proteins, and other genetic engineering purposes. ***Learning Outcome: Plasmids are small, circular DNA molecules found in bacteria. They can carry genes that provide advantages such as antibiotic resistance or the ability to metabolize certain substances. Plasmids can be passed between bacteria through horizontal gene transfer, contributing to bacterial diversity and adaptation.*** **PRACTICAL:** 1. Preparation of Master and Replica Plates 2. Study the effect of chemical (HNO2) 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 **CC-10: RECOMBINANT DNA TECHNOLOGY** **THEORY:** **Unit 1 Introduction to Genetic Engineering:** Milestones in genetic engineering and biotechnology ***Learning Objectives: The primary objective of introducing genetic engineering is to manipulate an organism's genetic material to produce desired traits or outcomes. This technology can be applied in various fields such as agriculture, medicine, and industry to enhance crop yield, create genetically modified organisms (GMOs) with improved characteristics, develop new medical treatments, and produce valuable substances like insulin or enzymes*** ***Learning Outcome: The outcomes of the introduction of genetic engineering have been significant, including advancements in medicine, agriculture, and biotechnology. This technology has enabled the development of genetically modified crops with enhanced traits, such as resistance to pests and diseases, improved nutritional content, and increased yield. In medicine, genetic engineering has facilitated the production of insulin***	1	2nd week of march

	and other pharmaceuticals, gene therapy for treating genetic disorders, and personalized medicine tailored to individual genetic profiles. However, it has also raised ethical concerns regarding the manipulation of genes and potential unforeseen consequences.		
	Unit 2 Molecular Cloning- Tools and Strategies: Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors. ***Learning Objectives: The objective of molecular cloning is to make identical copies of a particular DNA sequence. This involves isolating a DNA fragment, inserting it into a vector (often a plasmid), and then replicating it within a host organism, typically bacteria. Tools like restriction enzymes, DNA ligase, and polymerase chain reaction (PCR) are commonly used in the cloning process. Strategies include selecting appropriate vectors, designing primers, and optimizing conditions for successful cloning. Ultimately, molecular cloning facilitates various applications such as gene expression studies, protein production, and genetic engineering.*** ***Learning Outcome: Tools and techniques involved in molecular cloning include restriction enzymes for cutting DNA at specific sequences, DNA ligase for joining DNA fragments, PCR for amplifying DNA sequences, vectors for carrying DNA fragments, and various selection markers for identifying transformed cells containing the cloned DNA. Additionally, strategies such as DNA sequencing, hybridization, and bioinformatics analysis are often used to verify and characterize cloned DNA fragments.***	12	3^{rd} – 4^{th} week of march

	Unit 3 Methods in Molecular Cloning: Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting. ***Learning Objectives: The objective of methods in molecular cloning is to replicate or amplify DNA fragments, genes, or entire genomes for various purposes such as research, diagnostics, or therapeutic applications. These methods enable scientists to manipulate and study DNA sequences, including inserting, deleting, or modifying specific genes.*** ***Learning Outcome: The outcome of methods in molecular cloning is the replication of specific DNA sequences, allowing for gene manipulation, expression, and analysis, crucial in various fields like biotechnology, medicine, and genetics.***	10	1st – 2nd week of april
	Unit4 DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing ***Learning Objectives: The objective of DNA amplification is to make multiple copies of a specific DNA sequence, which is useful for various purposes such as genetic testing, forensic analysis, and research. DNA sequencing aims to determine the precise order of nucleotides in a DNA molecule, providing insights into genetic information, mutations, and evolutionary relationships.*** ***Learning Outcome: The outcome of DNA amplification is the generation of multiple copies of a specific DNA sequence, enabling further analysis or manipulation of that sequence. In DNA sequencing, the outcome is the determination of the precise order of nucleotides in a DNA molecule, providing valuable information about genetic variations, mutations, and biological functions.***	6	3rd week of april
	Unit 5 Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping ***Learning Objective: The objective of constructing genomic and cDNA libraries is to create comprehensive collections of genetic material that represent the entire genome or***	6	4th week of april

	transcriptome of an organism, respectively. These libraries serve as valuable resources for studying gene structure, function, regulation, and expression. Screening these libraries allows researchers to isolate specific genes or sequences of interest for further analysis and experimentation, such as gene cloning, sequencing, and functional studies. ***Learning Outcome: The outcomes of construction and screening of genomic and cDNA libraries provide researchers with valuable tools for studying gene structure, function, and regulation, as well as for applications in biotechnology and medicine.***		
	Unit 6 Applications of Recombinant DNA Technology: Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis ***Learning Objectives: The main objective of recombinant DNA technology is to manipulate DNA to achieve specific goals, such as gene cloning, gene therapy, protein production, genetic engineering, biotechnology applications, and research purposes.*** ***Learning Outcome: Recombinant DNA technology has led to advancements in medicine, agriculture, biotechnology, industry, and research, including the production of therapeutic proteins, genetically modified crops, gene editing tools, biochemicals for manufacturing, and breakthroughs in genetic research.*** **PRACTICAL:** 1. Preparation of competent cells for transformation 2. Demonstration of Bacterial Transformation and calculation of transformation efficiency. 3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis 4. Ligation of DNA fragments 5. Cloning of DNA insert and Blue white screening of recombinants. 6. Interpretation of sequencing gel electropherograms 7. Designing of primers for DNA amplification 8. Amplification of DNA by PCR 9. Demonstration of Southern blotting	6	1st week of may

Dr. Maitreyee Mondal (July -Dec 2020)

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	factors, competition, and genetic mutations can also influence outcomes. **Unit 6 Bacterial Systematics:** Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria. ***Learning Objectives: The objective of bacterial systematics is to classify and organize bacteria into groups based on their evolutionary relationships, genetic similarities, and other characteristics. This helps scientists understand bacterial diversity, evolution, and relationships between different species.*** ***Learning Outcome: The outcomes of bacterial systematics include the classification, identification, and understanding of bacterial diversity, evolutionary relationships, and ecological roles, aiding in various fields such as medicine, agriculture, and environmental science.*** **Unit 7 Important archaeal and eubacterial groups:** **Archaebacteria:** General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota(Nanoarchaeum), Crenarchaeota (Sulfolobus, Thermoproteus) and Euryarchaeota [Methanogens (Methanobacterium, Methanocaldococcus), thermophiles (Thermococcus, Pyrococcus, Thermoplasma), and Halophiles (Halobacterium, Halococcus)] **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: **Gram Negative:** Non proteobacteria: General characteristics with suitable examples. Alpha proteobacteria: General characteristics with suitable examples. Beta proteobacteria: General characteristics with suitable examples. Gamma proteobacteria: General characteristics with suitable examples. Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples. **Gram Positive:** Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples **Cyanobacteria:**An Introduction ***Learning Objectives: Archaea: Often found in extreme environments like hot springs and deep-sea vents, archaea play crucial roles in biogeochemical cycles and are important for understanding early life on Earth.Eubacteria***	7 16	3^{rd} – 4^{th} week of September 1^{st} – 3^{rd} week of October

	(Bacteria): They're ubiquitous and diverse, with members found in virtually every environment on Earth. They're essential for processes like nutrient cycling, decomposition, and symbiotic relationships with other organisms, including humans. ***Learning Outcome: Archaeal and eubacterial groups have diverse outcomes and roles in various ecosystems. Archaea, known for their ability to thrive in extreme environments, contribute to nutrient cycling, especially in anaerobic conditions like deep-sea vents. Eubacteria, on the other hand, are ubiquitous and play crucial roles in processes such as nitrogen fixation, decomposition, and symbiotic relationships with plants and animals. Some eubacteria, like cyanobacteria, are photosynthetic and play a vital role in oxygen production and carbon cycling. Both groups are essential for maintaining ecological balance and supporting life on Earth.***		
	SEMESTER –3 **CC-5: VIROLOGY:** **PRACTICAL:** 1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs 2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs 3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph. 4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique 5. Studying isolation and propagation of animal viruses by chick embryo technique 6. Study of cytopathic effects of viruses using photographs 7. Perform local lesion technique for assaying plant viruses. **CC-6: MICROBIAL PHYSIOLOGY AND METABOLISM:** **Unit 1 Microbial Growth and Effect of Environment on Microbial Growth** Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles,thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe,	8	1st – 3rd week of August

	facultative anaerobe),barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph,Chemolithoheterotroph, Chemoheterotroph,Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. ***Learning Objectives: The objective of microbial growth is for microorganisms to reproduce and thrive in their environment, often by multiplying their numbers. The environment plays a crucial role in microbial growth, as factors like temperature, pH, moisture, oxygen availability, and nutrient availability can significantly impact the rate and extent of growth. For example, some microorganisms thrive in acidic environments while others prefer alkaline conditions. Similarly, variations in temperature can either inhibit or promote microbial growth depending on the species involved.*** ***Learning Outcome: Microbial growth outcomes can vary widely based on factors like environment, nutrients, and species. Generally, it leads to population increase, biofilm formation, and potentially pathogenicity. The environment significantly influences microbial growth, with factors like temperature, pH, moisture, and oxygen levels impacting growth rates and metabolic activities.***		
	Unit 2 Nutrient uptake and Transport: Passive and facilitated diffusion Primary and secondary active transport, concept of uniport, symport and antiport Group translocation Iron uptake ***Learning Objectives: The primary objective of nutrient uptake and transport in plants is to ensure the delivery of essential nutrients, such as nitrogen, phosphorus, potassium, and micronutrients, from the soil to various parts of the plant where they are needed for growth, development, and metabolism. This process involves absorption of nutrients by the roots, their movement through the plant via vascular tissues (xylem and phloem), and their distribution to cells and tissues for various physiological functions.*** ***Learning Outcome: The outcome of nutrient uptake and transport in plants is vital for their growth, development, and overall health. It ensures that essential nutrients are efficiently delivered to various parts of the plant, supporting processes such as photosynthesis, metabolism, and structural development, ultimately leading to optimal plant growth, reproduction, and resilience against environmental stresses.***	6	4th week of august
	CC-7: MOLECULAR BIOLOGY :		

	THEORY **Unit 1 Structures of DNA and RNA / Genetic Material:** DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA. ***Learning Objectives: The primary objective of DNA and RNA, as genetic material, is to store, transmit, and express genetic information. DNA serves as the stable repository of genetic instructions, while RNA plays a key role in translating those instructions into functional proteins. Additionally, both DNA and RNA contribute to the regulation of gene expression and various cellular processes essential for life.*** ***Learning Outcome: The structures of DNA and RNA play critical roles in genetic material. DNA's double helix structure allows for stable storage of genetic information, while RNA's single-stranded structure enables various functions like protein synthesis. The outcomes include accurate replication of genetic material, transcription of DNA into RNA, translation of RNA into proteins, and ultimately, the inheritance and expression of traits in organisms. Mutations in these structures can lead to genetic diseases or variations that drive evolution.***	4	1st – 2nd week of September
	Unit 5 Translation (Prokaryotes and Eukaryotes): Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote ***Learning Objectives: The objective of translation is to convey the meaning and intent of a text accurately from one language to another, while taking into account cultural nuances and linguistic differences.*** ***Learning Outcome: The outcomes of translation depend on various factors such as the quality of the translation, the context, and the purpose. Generally, it aims to convey the meaning of a text accurately from one language to another, ensuring clarity, coherence, and cultural sensitivity. Successful outcomes include effective communication, preservation of original intent, and facilitating cross-cultural understanding. However, poor translation can lead to misunderstandings, loss of nuance, or even offense.***	6	3rd week of September

	PRACTICAL: 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).		
	SEMESTER –5 **DSE-A:1.MICROBIAL BIOTECHNOLOGY:** **THEORY:** **Unit 2 Therapeutic and Industrial Biotechnology:** Recombinant microbial production processes in pharmaceutical industries - Streptokinase, recombinant vaccines (Hepatitis B vaccine) Microbial polysaccharides and polyesters, Microbial production of bio-pesticides, bioplastics Microbial biosensors ***Learning Objectives: The objective of therapeutic biotechnology is to develop treatments, therapies, and interventions to improve human health and combat diseases. Industrial biotechnology aims to utilize biological systems to produce valuable products such as chemicals, fuels, and materials in a sustainable and efficient manner, reducing reliance on traditional, often environmentally harmful, industrial processes.*** ***Learning Outcome: Therapeutic biotechnology focuses on developing treatments for diseases, including gene therapies, monoclonal antibodies, and personalized medicine. Industrial biotechnology, on the other hand, aims to produce renewable chemicals, fuels, and materials using biological systems. Both have led to significant advancements in healthcare, sustainable manufacturing, and environmental protection.*** **Unit 7 Intellectual Property Rights**: Patents, Copyrights, Trademarks ***Learning Objectives: The objective of intellectual property rights (IPR) is to protect the creations of the human intellect. This includes inventions, literary and artistic works, symbols, names, and designs used in commerce. IPR aims to encourage***	4 3	1st week of September 2nd week of September

	innovation and creativity by providing creators and inventors with exclusive rights to their creations, thereby allowing them to benefit financially and ensuring that society can benefit from their contributions. ***Learning Outcome: Intellectual Property Rights (IPR) provide creators with legal protections for their inventions, artistic works, designs, and symbols. The outcomes include fostering innovation, incentivizing creativity, protecting investments, promoting economic growth, and ensuring fair competition.*** **DSE-B:2. MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT:** **THEORY:** **Unit 1 Soil Microbiology:** Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil ***Learning Objectives: The objective of soil microbiology is to study the diverse microorganisms living in soil and their interactions with each other, plants, and the environment. This field aims to understand the roles of soil microbes in nutrient cycling, decomposition, plant health, and ecosystem functioning. By understanding these processes, soil microbiologists can develop strategies for sustainable agriculture, soil conservation, and environmental remediation.*** ***Learning Outcome: The outcomes of soil microbiology research include improved agricultural practices, enhanced soil health, increased crop productivity, better understanding of ecosystem dynamics, and development of sustainable solutions for environmental management and remediation.*** **Unit 6 Secondary Agriculture Biotechnology:** Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters ***Learning Objectives: The primary objective of secondary agriculture biotechnology is to enhance crop productivity, improve crop quality, and develop varieties that are resistant to pests, diseases, and environmental stresses. This branch of biotechnology focuses on genetic manipulation, molecular breeding, and biotechnological interventions to address agricultural challenges and contribute to sustainable farming practices.*** ***Learning Outcome: Secondary agriculture biotechnology refers to the application of biotechnology in areas like food processing, crop improvement, and waste management within the agricultural sector. Some outcomes include enhanced crop yields through genetic modification, development of biofuels***	2 5	2nd week of September 3rd week of September

	from agricultural waste, and the creation of improved food products with longer shelf lives and enhanced nutritional content. Additionally, secondary agriculture biotechnology can contribute to environmental sustainability by reducing pesticide and fertilizer use through the cultivation of pest-resistant crops and nitrogen-fixing plants. **Unit 7 GM crops:** Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals. ***Learning Objectives: The objective of genetically modified (GM) crops is to introduce specific genetic traits into plants to enhance their characteristics, such as resistance to pests, diseases, or herbicides, and to improve nutritional content or yield. GM crops aim to address challenges in agriculture, such as reducing the need for chemical inputs, increasing crop resilience to environmental stressors, and enhancing food security by improving crop productivity and nutritional quality.*** ***Learning Outcome: The outcomes of genetically modified (GM) crops include increased crop yields, reduced reliance on chemical pesticides and herbicides, improved nutritional content, enhanced resistance to pests and diseases, and the potential for more sustainable agricultural practices. Additionally, GM crops can contribute to food security by providing crops with traits suited to different environmental conditions and by helping to alleviate malnutrition through biofortification. However, there are also concerns regarding the potential environmental impacts and socio-economic implications of GM crop cultivation.***	4	4th week of September

Dr. Maitreyee Mondal (Jan – June 2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of teaching learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 3 Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers ***Learning Objectives: The primary objective of lipids in the body is to serve as a concentrated energy source, provide insulation and protection for organs, assist in the absorption of fat-soluble vitamins, and act as structural components of cell membranes. Additionally, lipids play crucial roles in signaling pathways and hormone production.*** ***Learning Outcome: Lipids play various roles in the body, including energy storage, insulation, and cell membrane structure. They can have different outcomes depending on their type and how they're metabolized. For example, excess consumption of certain types of lipids, like trans fats, can lead to negative health outcomes such as cardiovascular disease. Conversely, consuming healthy fats, like omega-3 fatty acids, can have positive effects on heart health and brain function.*** **CC-4: CELL BIOLOGY:** **THEORY:** **Unit 1 Structure and organization of Cell:** Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects) Mitochondria, chloroplasts and peroxisomes	8 6	1^{st} – 2^{nd} week of April 3^{rd} week of April

	Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules		
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 1 Genome Organization and Mutations:** Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes ***Learning Objectives: The objective of genome organization is to efficiently store and regulate genetic information within a cell. Mutation, on the other hand, introduces genetic variation, which is essential for evolution and adaptation to changing environments.*** ***Learning Outcome: Genome organization helps maintain stability, ensures accurate transmission of genetic information during cell division, and facilitates gene regulation. Mutation, meanwhile, generates genetic diversity, which can lead to evolutionary adaptation, disease, or genetic disorders, depending on the nature and impact of the mutation.*** **Unit 2 Plasmids:** Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids. ***Learning Objectives: The main objective of plasmids is to replicate independently of the host chromosome, serving as vectors for the transfer of genetic material between bacteria. They often carry genes that provide advantages such as antibiotic resistance or the ability to metabolize certain nutrients. In biotechnology, plasmids are used for gene cloning, expression of recombinant proteins, and other genetic engineering purposes.*** ***Learning Outcome: Plasmids are small, circular DNA molecules found in bacteria. They can carry genes that provide advantages such as antibiotic resistance or the ability to metabolize certain substances. Plasmids can be passed***	6 4	1st week of march 2nd week of march

	between bacteria through horizontal gene transfer, contributing to bacterial diversity and adaptation. **PRACTICAL:** 1. Preparation of Master and Replica Plates 2. Study the effect of chemical (HNO2) 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 **CC-10: RECOMBINANT DNA TECHNOLOGY** **THEORY:** **Unit 1 Introduction to Genetic Engineering:** Milestones in genetic engineering and biotechnology ***Learning Objectives: The primary objective of introducing genetic engineering is to manipulate an organism's genetic material to produce desired traits or outcomes. This technology can be applied in various fields such as agriculture, medicine, and industry to enhance crop yield, create genetically modified organisms (GMOs) with improved characteristics, develop new medical treatments, and produce valuable substances like insulin or enzymes*** ***Learning Outcome: The outcomes of the introduction of genetic engineering have been significant, including advancements in medicine, agriculture, and biotechnology. This technology has enabled the development of genetically modified crops with enhanced traits, such as resistance to pests and diseases, improved nutritional content, and increased yield. In medicine, genetic engineering has facilitated the production of insulin and other pharmaceuticals, gene therapy for treating genetic disorders, and personalized medicine tailored to individual genetic profiles. However, it has also raised ethical concerns regarding the manipulation of genes and potential unforeseen consequences.*** **Unit 2 Molecular Cloning- Tools and Strategies:** Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal	1 12	2^{nd} week of march $3^{rd} – 4^{th}$ week of march

	deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: E.coli lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors. ***Learning Objectives: The objective of molecular cloning is to make identical copies of a particular DNA sequence. This involves isolating a DNA fragment, inserting it into a vector (often a plasmid), and then replicating it within a host organism, typically bacteria. Tools like restriction enzymes, DNA ligase, and polymerase chain reaction (PCR) are commonly used in the cloning process. Strategies include selecting appropriate vectors, designing primers, and optimizing conditions for successful cloning. Ultimately, molecular cloning facilitates various applications such as gene expression studies, protein production, and genetic engineering.*** ***Learning Outcome: Tools and techniques involved in molecular cloning include restriction enzymes for cutting DNA at specific sequences, DNA ligase for joining DNA fragments, PCR for amplifying DNA sequences, vectors for carrying DNA fragments, and various selection markers for identifying transformed cells containing the cloned DNA. Additionally, strategies such as DNA sequencing, hybridization, and bioinformatics analysis are often used to verify and characterize cloned DNA fragments.***		
	Unit 3 Methods in Molecular Cloning: Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium - mediated delivery DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting. ***Learning Objectives: The objective of methods in molecular cloning is to replicate or amplify DNA fragments, genes, or entire genomes for various purposes such as research, diagnostics, or therapeutic applications. These methods***	10	1^{st} – 2^{nd} week of april

	enable scientists to manipulate and study DNA sequences, including inserting, deleting, or modifying specific genes. ***Learning Outcome: The outcome of methods in molecular cloning is the replication of specific DNA sequences, allowing for gene manipulation, expression, and analysis, crucial in various fields like biotechnology, medicine, and genetics.*** **Unit4 DNA Amplification and DNA sequencing:** PCR: Basics of PCR, RT-PCR, Real-Time PCR Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing ***Learning Objectives: The objective of DNA amplification is to make multiple copies of a specific DNA sequence, which is useful for various purposes such as genetic testing, forensic analysis, and research. DNA sequencing aims to determine the precise order of nucleotides in a DNA molecule, providing insights into genetic information, mutations, and evolutionary relationships.*** ***Learning Outcome: The outcome of DNA amplification is the generation of multiple copies of a specific DNA sequence, enabling further analysis or manipulation of that sequence. In DNA sequencing, the outcome is the determination of the precise order of nucleotides in a DNA molecule, providing valuable information about genetic variations, mutations, and biological functions.*** **Unit 5 Construction and Screening of Genomic and cDNA libraries:** Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping ***Learning Objective: The objective of constructing genomic and cDNA libraries is to create comprehensive collections of genetic material that represent the entire genome or transcriptome of an organism, respectively. These libraries serve as valuable resources for studying gene structure, function, regulation, and expression. Screening these libraries allows researchers to isolate specific genes or sequences of interest for further analysis and experimentation, such as gene cloning, sequencing, and functional studies.*** ***Learning Outcome: The outcomes of construction and screening of genomic and cDNA libraries provide researchers with valuable tools for studying gene structure, function, and regulation, as well as for applications in biotechnology and medicine.***	6 4	3rd week of april 4th week of april

	Unit 6 Applications of Recombinant DNA Technology: Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis ***Learning Objectives: The main objective of recombinant DNA technology is to manipulate DNA to achieve specific goals, such as gene cloning, gene therapy, protein production, genetic engineering, biotechnology applications, and research purposes.*** ***Learning Outcome: Recombinant DNA technology has led to advancements in medicine, agriculture, biotechnology, industry, and research, including the production of therapeutic proteins, genetically modified crops, gene editing tools, biochemicals for manufacturing, and breakthroughs in genetic research.*** **PRACTICAL:** 1. Preparation of competent cells for transformation 2. Demonstration of Bacterial Transformation and calculation of transformation efficiency. 3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis 4. Ligation of DNA fragments 5. Cloning of DNA insert and Blue white screening of recombinants. 6. Interpretation of sequencing gel electropherograms 7. Designing of primers for DNA amplification 8. Amplification of DNA by PCR 9. Demonstration of Southern blotting	4	1st week of may
	SEMESTER –6 **CC-13: IMMUNOLOGY** **THEORY** **Unit 6 Complement System:** Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation ***Learning Objectives: The complement system's main objectives are to enhance immune responses, promote inflammation, and assist in the clearance of pathogens and damaged cells.*** ***Learning Outcome: The complement system enhances immune responses by tagging pathogens for destruction, recruiting immune cells, and initiating inflammation. It helps clear pathogens, but dysregulation can lead to autoimmune diseases.***	4 6	1st week of march

	Unit 8 Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers. ***Learning Objectives: The objective of studying immunological disorders is to understand abnormalities in the immune system, which can lead to conditions like autoimmune diseases, allergies, and immunodeficiencies. Tumor immunity focuses on understanding how the immune system recognizes and eliminates cancer cells, with the aim of developing immunotherapies to enhance this process and treat cancer effectively.*** ***Learning Outcome: The outcome of studying immunological disorders is to develop treatments for conditions like autoimmune diseases, allergies, and immunodeficiencies. In tumor immunity, the goal is to enhance the immune system's ability to recognize and eliminate cancer cells, leading to improved cancer therapies and outcomes***		2nd week of march
	Unit 9 Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy. ***Learning Objectives: The objective of immunological techniques is to detect, quantify, or manipulate specific components of the immune system, such as antibodies, antigens, or immune cells, for various purposes including diagnosis, research, and therapy. These techniques play a crucial role in understanding immune responses, identifying pathogens, diagnosing diseases, and developing vaccines and therapeutics.*** ***Learning Outcome: The outcome of immunological techniques is the detection, quantification, or manipulation of specific components of the immune system, aiding in diagnosis, research, and therapeutic development.***	4	3rd week of march
	DSE-B:3. INSTRUMENTATION AND BIOTECHNIQUES **THEORY:** **Unit 3 Electrophoresis:** Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel ***Learning Objectives: The objective of electrophoresis is to separate charged molecules, such as DNA, RNA, or proteins,***	6	4th week of march

	based on their size and charge by subjecting them to an electric field within a gel matrix. This technique is widely used in molecular biology and biochemistry for various applications, including genetic analysis, protein purification, and forensic identification. ***Learning Outcome: Electrophoresis separates charged molecules based on their size and charge. The outcomes depend on the type of electrophoresis and the molecules being separated. For example, in gel electrophoresis, DNA fragments migrate through a gel matrix based on their size, producing distinct bands that can be visualized. In protein electrophoresis, proteins separate based on their charge and size, revealing bands that can indicate purity or identify specific proteins.*** **Unit 5 Centrifugation:** Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation. ***Learning Objectives: The objective of centrifugation is to separate components of a heterogeneous mixture based on their different densities by spinning it at high speeds, causing the heavier components to settle at the bottom while the lighter ones remain suspended or rise to the top. This process is widely used in various fields such as biology, chemistry, and industry for tasks like separating cells, purifying substances, and isolating particles.*** ***Learning Outcome: Centrifugation separates components based on density, leading to fractionation, concentration, purification, cell pelleting, and clarity of solutions.*** **PRACTICAL:** 6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).	6	1st week of april

Dr. Tanmay Ghosh

Assistant Professor of Microbiology

Dinabandhu Andrews College

Dr. Tanmay Ghosh (July -Dec 2019)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching Learning
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **Unit 2 Diversity of Microbial World:** B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions)and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. • Fungi Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins. ***Learning Objectives: The diversity of the microbial world serves several objectives, including ecosystem balance, nutrient cycling, disease regulation, and even industrial applications like biotechnology and biofuel production. Essentially, it's about maintaining the health and functionality of various environments, from soil to human bodies.*** ***Learning Outcome: The outcomes of microbial diversity contribute to the functioning and sustainability of ecosystems, human health, and the advancement of biotechnology and environmental science.*** **CC-2: BACTERIOLOGY** **THEORY:** **Unit 4 Growth and nutrition:** Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media ***Learning Objectives: The Objective of microbial growth and nutrition is essential for various fields, including***	6 4	1st – 2nd week of July 3rd week of July

	biotechnology, food safety, environmental science, and public health etc. ***Learning Outcome: The outcomes of studying microbial growth and nutrition have broad applications across various sectors, contributing to advancements in biotechnology, food safety, environmental sustainability, agriculture, healthcare, and industrial manufacturing.***		
	SEMESTER –3 **CC-5: VIROLOGY:** **THEORY:** **Unit 4 Viruses and Cancer:** Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes ***Learning Objectives: The objectives of virology are centered around advancing our knowledge of viruses to better prevent, diagnose, and treat viral infections and mitigate their impact on human and animal health.*** ***Learning Outcome: The outcomes of virology research have profound implications for human health, agriculture, biotechnology, and our understanding of the natural world.***	3	1st week of July
	Unit 5 Prevention & control of viral diseases: Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination ***Learning Objectives: The objectives of prevention and control of viral diseases are multifaceted and aim to mitigate the spread of the virus, reduce the burden of illness, and protect public health*** ***Learning Outcome: The outcomes of prevention and control efforts for viral diseases are wide-ranging and have far-reaching implications for public health, healthcare systems, and societal well-being. By investing in these efforts and prioritizing proactive measures, we can work towards a healthier and more resilient world.***	4	2nd week of July
	SEC-A: **1. Microbial Quality Control in Food and Pharmaceutical Industries** **Unit 1 Microbiological Laboratory and Safe Practices:** Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	4	3rd week of July

	Learning Objectives: The objectives of a microbiological laboratory are centered around ensuring accurate, reliable, and safe testing of samples for various purposes, including research, diagnosis, quality control, and environmental monitoring. Additionally, promoting safe practices within the laboratory environment is crucial to protect personnel, prevent contamination, and maintain the integrity of experimental results ***Learning Outcome: The outcomes of microbiological laboratories and the implementation of safe practices within them yield numerous benefits, both for the laboratory itself and for broader public health and safety.***		
	Unit 2 Determining Microbes in Food / Pharmaceutical Samples: Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products Molecular methods - Nucleic acid probes, PCR based detection, biosensors. ***Learning Objectives: Microbial quality control plays a critical role in upholding the safety, quality, and regulatory compliance of food and pharmaceutical products, ultimately benefiting both consumers and manufacturers.*** ***Learning Outcome: The outcomes of microbial quality control efforts in the food and pharmaceutical industries result in safer, higher-quality products, regulatory compliance, consumer satisfaction, and improved operational efficiency.***	4	4th week of july

Dr. Tanmay Ghosh (Jan -June 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Duration of Teaching Learning
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 2 Carbohydrates:** Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin ***Learning Objectives: Carbohydrates play vital roles in energy metabolism, metabolic regulation, digestive health, cellular structure, and physical performance, making them essential nutrients for maintaining optimal health and well-being.*** ***Learning Outcome: Outcomes of studying carbohydrates leads to advancements in nutrition, health, food science, biomedicine, agriculture, and environmental science, with broad implications for human health, industry, and sustainability.***	6	1st – 2nd week of march
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 3 Mechanisms of Genetic Exchange:** Transformation -Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr aLearning Objectives: nd F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers ***Learning Objectives: objectives of the mechanisms of genetic exchange has broad-ranging objectives, encompassing evolutionary biology, microbial genetics, biotechnology, ecology, public health, agriculture, and astrobiology. These objectives contribute to scientific advancements and have practical implications for various fields, including medicine, biotechnology, and environmental management.***	6	2nd – 3rd week of march

	Learning Outcome: *The outcomes of studying genetic exchange mechanisms contribute to scientific advancements, technological innovation, and sustainable practices across diverse fields, with profound implications for human well-being and environmental stewardship.* **CC-9: ENVIRONMENTAL MICROBIOLOGY** **PRACTICAL:** 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. 6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. 7. Isolation of Rhizobium from root nodules.		

Dr. Tanmay Ghosh (July -Dec 2020)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Date
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **Unit 2 Diversity of Microbial World:** B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions)and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. • Fungi Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins. ***Learning Objectives: The diversity of the microbial world serves several objectives, including ecosystem balance, nutrient cycling, disease regulation, and even industrial applications like biotechnology and biofuel production. Essentially, it's about maintaining the health and functionality of various environments, from soil to human bodies.*** ***Learning Outcome: The outcomes of microbial diversity contribute to the functioning and sustainability of ecosystems, human health, and the advancement of biotechnology and environmental science.*** **CC-2: BACTERIOLOGY** **THEORY:** **Unit 4 Growth and nutrition:** Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media ***Learning Objectives: The Objective of microbial growth and nutrition is essential for various fields, including biotechnology, food safety, environmental science, and public health etc.*** ***Learning Outcome: The outcomes of studying microbial growth and nutrition have broad applications across various sectors, contributing to advancements in biotechnology, food safety,***	6 4	1st – 2nd week of September 3rd week of October

	environmental sustainability, agriculture, healthcare, and industrial manufacturing.		
	SEMESTER –3 **CC-5: VIROLOGY:** **THEORY:** **Unit 4 Viruses and Cancer:** Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes ***Learning Objectives: The objectives of virology are centered around advancing our knowledge of viruses to better prevent, diagnose, and treat viral infections and mitigate their impact on human and animal health.*** ***Learning Outcome: The outcomes of virology research have profound implications for human health, agriculture, biotechnology, and our understanding of the natural world.***	3	1st week of August
	Unit 5 Prevention & control of viral diseases: Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination ***Learning Objectives: The objectives of prevention and control of viral diseases are multifaceted and aim to mitigate the spread of the virus, reduce the burden of illness, and protect public health*** ***Learning Outcome: The outcomes of prevention and control efforts for viral diseases are wide-ranging and have far-reaching implications for public health, healthcare systems, and societal well-being. By investing in these efforts and prioritizing proactive measures, we can work towards a healthier and more resilient world.***	4	2nd week of August
	SEC-A: **1. Microbial Quality Control in Food and Pharmaceutical Industries** **Unit 1 Microbiological Laboratory and Safe Practices:** Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration ***Learning Objectives: The objectives of a microbiological laboratory are centered around ensuring accurate, reliable, and safe testing of samples for various purposes, including research, diagnosis, quality control, and environmental monitoring. Additionally, promoting safe practices within the***	4	3rd Week of August

	Laboratory environment is crucial to protect personnel, prevent contamination, and maintain the integrity of experimental results ***Learning Outcome: The outcomes of microbiological laboratories and the implementation of safe practices within them yield numerous benefits, both for the laboratory itself and for broader public health and safety.*** **Unit 2 Determining Microbes in Food / Pharmaceutical Samples:** Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products Molecular methods - Nucleic acid probes, PCR based detection, biosensors. ***Learning Objectives: Microbial quality control plays a critical role in upholding the safety, quality, and regulatory compliance of food and pharmaceutical products, ultimately benefiting both consumers and manufacturers.*** ***Learning Outcome: The outcomes of microbial quality control efforts in the food and pharmaceutical industries result in safer, higher-quality products, regulatory compliance, consumer satisfaction, and improved operational efficiency.***	4	1st Week of September
	SEMESTER –5 **CC-11: FOOD AND DAIRY MICROBIOLOGY:** **THEORY:** **Unit 1 Foods as a substrate for microorganisms:** Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. ***Learning Objectives: The objectives of studying food as a substrate for microorganisms encompass understanding how microorganisms interact with food matrices, their growth dynamics, and their impact on food safety, quality, and shelf life.*** ***Learning Outcome: The outcomes of studying food as a substrate for microorganisms are multifaceted and have implications for food safety, quality, sustainability, and industry practices.*** **Unit 2 Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods ***Learning Objectives: The objectives of studying microbial spoilage of food are aimed at understanding the processes by which microorganisms deteriorate food quality, identifying the***	2 4	1st week of July 2nd week of July

	microorganisms involved, and implementing measures to prevent or minimize spoilage. ***Learning Outcome: The outcomes of studying microbial spoilage of food provide valuable insights into understanding, preventing, and managing food spoilage, which in turn contributes to maintaining food safety, quality, and sustainability.*** **Unit 3 Principles and methods of food preservation:** Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. ***Learning Objectives: The objectives of the principles of food preservation are aimed at maintaining the safety, quality, nutritional value, and shelf life of food products. These principles serve as guidelines for selecting and applying appropriate preservation methods to inhibit microbial growth, enzymatic activity, and chemical deterioration.*** ***Learning Outcome: The outcomes of employing the principles of food preservation are manifold, yielding benefits across various domains including food safety, economic efficiency, environmental sustainability, and public health.*** **Unit 4 Fermented foods:** Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. ***Learning Objectives: The objectives of food and dairy microbiology revolve around ensuring the safety, quality, and sustainability of food and dairy products through effective microbial management, innovation, and regulatory compliance.*** ***Learning Outcome: The outcomes of food and dairy microbiology contribute to a safer, healthier, and more sustainable food supply chain, benefiting consumers, producers, and society as a whole.*** **DSE-B:2. MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT:** **PRACTICAL:** 1. Study soil profile 2. Study microflora of different types of soils 3. Rhizobium as soil inoculants characteristics and field application	6 6	3rd week of July 1st – 2nd week of August

	4. Azotobacter as soil inoculants characteristics and field application 5. Design and functioning of a biogas plant 6. Isolation of cellulose degrading organisms		

Dr. Tanmay Ghosh (Jan _June 2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Date
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 2 Carbohydrates:** Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin ***Learning Objectives: Carbohydrates play vital roles in energy metabolism, metabolic regulation, digestive health, cellular structure, and physical performance, making them essential nutrients for maintaining optimal health and well-being.*** ***Learning Outcome: Outcomes of studying carbohydrates leads to advancements in nutrition, health, food science, biomedicine, agriculture, and environmental science, with broad implications for human health, industry, and sustainability.***	8	1st – 2nd week of April
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 3 Mechanisms of Genetic Exchange:** Transformation -Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers ***Learning Objectives: objectives of the mechanisms of genetic exchange has broad-ranging objectives, encompassing evolutionary biology, microbial genetics, biotechnology, ecology, public health, agriculture, and astrobiology. These objectives contribute to scientific advancements and have practical implications for various fields, including medicine, biotechnology, and environmental management.***	6	1st -2nd week of March

	Learning Outcome: The outcomes of studying genetic exchange mechanisms contribute to scientific advancements, technological innovation, and sustainable practices across diverse fields, with profound implications for human well-being and environmental stewardship. **CC-9: ENVIRONMENTAL MICROBIOLOGY** **PRACTICAL:** 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. 6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. 7. Isolation of Rhizobium from root nodules.		
	SEMESTER –6 **DSE-A:3. PLANT PATHOLOGY** **THEORY:** **Unit 1 Introduction and History of plant pathology:** Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists. ***Learning Objectives: The objective of introducing plant pathology is to understand the diseases that affect plants, their causes, symptoms, and management strategies. The history of plant pathology traces back to ancient times when humans first recognized plant diseases and sought ways to control them. From early observations to modern scientific research, plant pathology has evolved to become a crucial discipline in agriculture, ensuring food security and sustainable crop production.*** ***Learning Outcome: The outcome of introducing the history of plant pathology is to provide a foundation for understanding the development of the field and its significance in agriculture. By studying its history, we gain insights into how plant diseases have shaped human civilization, the progression of disease management techniques, and the ongoing efforts to combat new challenges in plant health. Understanding this***	3	1st week of February

	history helps us appreciate the importance of plant pathology in safeguarding global food security and promoting sustainable agriculture practices.		
	Unit 2 Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation. ***Learning Objectives: The stages in the development of a disease generally aim to understand its progression, identify risk factors, diagnose it early, develop effective treatments, and ultimately prevent or manage it to improve outcomes and quality of life for affected individuals. Each stage involves different goals, from basic research to clinical trials and public health interventions.*** ***Learning Outcome: The outcomes of stages in the development of a disease vary depending on the specific goals and interventions implemented at each stage. Generally, the outcomes aim to improve understanding, diagnosis, treatment, and prevention of the disease. These outcomes may include the identification of new biomarkers, the development of more effective therapies, the implementation of screening programs for early detection, and the establishment of public health policies aimed at reducing risk factors and improving overall population health. Ultimately, the goal is to improve patient outcomes, reduce morbidity and mortality, and enhance the overall quality of life for those affected by the disease.***	2	1st week of February
	Unit 3 Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context. ***Learning Objectives: The objective of plant disease epidemiology is to study and understand the factors that influence the occurrence, spread, and impact of plant diseases in order to develop effective management strategies.*** ***Learning Outcome: The outcome of plant disease epidemiology is the development of strategies to manage and control plant diseases, leading to improved crop health and productivity.***	4	2nd week of February
	Unit 4 Host Pathogen Interaction: A. Microbial Pathogenicity Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).	10	3rd – 4th week of February

	B. Genetics of Plant Diseases Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. Defense Mechanisms in Plants Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts]. ***Learning Objectives: The objective of host-pathogen interaction is for the pathogen to invade the host, replicate, and spread, while the host aims to recognize and eliminate the pathogen to maintain health and survival. It's essentially a battle between the two entities for dominance and survival.*** ***Learning Outcome: The outcomes of host-pathogen interactions can vary widely depending on factors such as the virulence of the pathogen, the immune response of the host, and the environment. Common outcomes include infection, where the pathogen successfully replicates within the host; clearance, where the host successfully eliminates the pathogen; chronic infection, where the pathogen persists within the host for an extended period; and disease, where the infection leads to noticeable physiological or pathological changes in the host. Additionally, interactions can also result in symbiosis, where both the host and pathogen benefit from the relationship, or commensalism, where the pathogen benefits without harming the host.*** **Unit 5 Control of Plant Diseases:** Principles & practices involved in the management of plant diseases by different methods, viz. regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes- bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes ***Learning Objectives: The primary objective of controlling plant diseases is to protect plant health and promote optimal growth by minimizing or eliminating the impact of pathogens and pests. This is vital for ensuring agricultural productivity, sustainability, and economic viability, as well as preserving biodiversity within both cultivated and natural ecosystems. Effective disease management strategies help maintain the supply of high-quality food, fiber, and ornamental plants,***	6	1st – 2nd week of March

	while reducing the need for chemical interventions that can have negative environmental impacts. ***Learning Outcome: The outcome of controlling plant disease can vary depending on the specific disease and the methods used for control. In general, effective control measures can help prevent the spread of disease, reduce crop losses, and improve plant health. This can result in increased crop yields, improved quality of produce, and overall better plant growth and productivity.*** **Unit 6 Specific Plant diseases:** Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control A. Important diseases caused by fungi White rust of crucifers - Albugo candida Downy mildew of onion - Peronospora destructor Late blight of potato - Phytophthora infestans Powdery mildew of wheat - Erysiphe graminis Ergot of rye - Claviceps purpurea Black stem rust of wheat - Puccinia graministritici Loose smut of wheat - Ustilago nuda Wilt of tomato - Fusarium oxysporumf.sp. lycopersici Red rot of sugarcane - Colletotrichum falcatum Early blight of potato - Alternaria solani B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro E. Important diseases caused by viroids: Potato spindle tuber, coconut cadangcadang ***Learning Objectives: The objective of plant diseases, from the perspective of the pathogens, is typically to obtain nutrients and resources from the host plant in order to support its own growth and reproduction. Pathogens can cause a variety of symptoms in plants, such as wilting, yellowing, lesions, and ultimately, reduced yield or even death of the plant. This allows the pathogen to thrive and spread to other plants, continuing its life cycle.*** ***Learning Outcome: Plant diseases can result in reduced yield, stunted growth, wilting, leaf spots, rotting, premature death of plants, transmission to other plants, and economic losses.*** **PRACTICAL:** 1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.	8	3^{rd} – 4^{th} week of March

	2. Study of important diseases of crop plants by cutting sections of infected plant material - Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.		

Dr. Tanmay Ghosh (July- Dec 2021)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Date
1.	**SEMESTER –1** **CC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY** **Unit 2 Diversity of Microbial World:** B. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions)and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. • Fungi Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins. ***Learning Objectives: The diversity of the microbial world serves several objectives, including ecosystem balance, nutrient cycling, disease regulation, and even industrial applications like biotechnology and biofuel production. Essentially, it's about maintaining the health and functionality of various environments, from soil to human bodies.*** ***Learning Outcome: The outcomes of microbial diversity contribute to the functioning and sustainability of ecosystems, human health, and the advancement of biotechnology and environmental science.*** **CC-2: BACTERIOLOGY** **THEORY:** **Unit 4 Growth and nutrition:** Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media ***Learning Objectives: The Objective of microbial growth and nutrition is essential for various fields, including biotechnology, food safety, environmental science, and public health etc.*** ***Learning Outcome: The outcomes of studying microbial growth and nutrition have broad applications across various sectors, contributing to advancements in biotechnology, food safety, environmental sustainability, agriculture, healthcare, and industrial manufacturing.***	6 4	1st – 2nd week of July 3rd week of July

	SEMESTER –3 **CC-5: VIROLOGY:** **THEORY:** **Unit 4 Viruses and Cancer:** Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes ***Learning Objectives: The objectives of virology are centered around advancing our knowledge of viruses to better prevent, diagnose, and treat viral infections and mitigate their impact on human and animal health.*** ***Learning Outcome: The outcomes of virology research have profound implications for human health, agriculture, biotechnology, and our understanding of the natural world.***	3	1st week of July
	Unit 5 Prevention & control of viral diseases: Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination ***Learning Objectives: The objectives of prevention and control of viral diseases are multifaceted and aim to mitigate the spread of the virus, reduce the burden of illness, and protect public health*** ***Learning Outcome: The outcomes of prevention and control efforts for viral diseases are wide-ranging and have far-reaching implications for public health, healthcare systems, and societal well-being. By investing in these efforts and prioritizing proactive measures, we can work towards a healthier and more resilient world.***	4	2nd week of July
	SEC-A: **1. Microbial Quality Control in Food and Pharmaceutical Industries** **Unit 1 Microbiological Laboratory and Safe Practices:** Good laboratory practices - Good laboratory practices, Good microbiological practices Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration ***Learning Objectives: The objectives of a microbiological laboratory are centered around ensuring accurate, reliable, and safe testing of samples for various purposes, including research, diagnosis, quality control, and environmental monitoring. Additionally, promoting safe practices within the laboratory environment is crucial to protect personnel, prevent contamination, and maintain the integrity of experimental results***	4	3rd week of July

	Learning Outcome: The outcomes of microbiological laboratories and the implementation of safe practices within them yield numerous benefits, both for the laboratory itself and for broader public health and safety. **Unit 2 Determining Microbes in Food / Pharmaceutical Samples:** Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products Molecular methods - Nucleic acid probes, PCR based detection, biosensors. ***Learning Objectives: Microbial quality control plays a critical role in upholding the safety, quality, and regulatory compliance of food and pharmaceutical products, ultimately benefiting both consumers and manufacturers.*** ***Learning Outcome: The outcomes of microbial quality control efforts in the food and pharmaceutical industries result in safer, higher-quality products, regulatory compliance, consumer satisfaction, and improved operational efficiency.***	4	3rd week of July
	SEMESTER –5 **CC-11: FOOD AND DAIRY MICROBIOLOGY:** **THEORY:** **Unit 1 Foods as a substrate for microorganisms:** Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. ***Learning Objectives: The objectives of studying food as a substrate for microorganisms encompass understanding how microorganisms interact with food matrices, their growth dynamics, and their impact on food safety, quality, and shelf life.*** ***Learning Outcome: The outcomes of studying food as a substrate for microorganisms are multifaceted and have implications for food safety, quality, sustainability, and industry practices.*** **Unit 2 Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods ***Learning Objectives: The objectives of studying microbial spoilage of food are aimed at understanding the processes by which microorganisms deteriorate food quality, identifying the***	2 4	1st week of February 1st week of February

	microorganisms involved, and implementing measures to prevent or minimize spoilage. ***Learning Outcome: The outcomes of studying microbial spoilage of food provide valuable insights into understanding, preventing, and managing food spoilage, which in turn contributes to maintaining food safety, quality, and sustainability.*** **Unit 3 Principles and methods of food preservation:** Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins. ***Learning Objectives: The objectives of the principles of food preservation are aimed at maintaining the safety, quality, nutritional value, and shelf life of food products. These principles serve as guidelines for selecting and applying appropriate preservation methods to inhibit microbial growth, enzymatic activity, and chemical deterioration.*** ***Learning Outcome: The outcomes of employing the principles of food preservation are manifold, yielding benefits across various domains including food safety, economic efficiency, environmental sustainability, and public health.*** **Unit 4 Fermented foods:** Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. ***Learning Objectives: The objectives of food and dairy microbiology revolve around ensuring the safety, quality, and sustainability of food and dairy products through effective microbial management, innovation, and regulatory compliance.*** ***Learning Outcome: The outcomes of food and dairy microbiology contribute to a safer, healthier, and more sustainable food supply chain, benefiting consumers, producers, and society as a whole.*** **DSE-B:2. MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT:** **PRACTICAL:** 1. Study soil profile 2. Study microflora of different types of soils 3. Rhizobium as soil inoculants characteristics and field application	6 6	2nd week of February 3rd week of February

	4. Azotobacter as soil inoculants characteristics and field application 5. Design and functioning of a biogas plant 6. Isolation of cellulose degrading organisms		

Dr. Tanmay Ghosh (Jan – June2022)

Topic Serial	Name of Topic with details of sub-topics	No. of classes	Date
	SEMESTER –2 **CC-3: BIOCHEMISTRY** **THEORY:** **Unit 2 Carbohydrates:** Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin ***Learning Objectives: Carbohydrates play vital roles in energy metabolism, metabolic regulation, digestive health, cellular structure, and physical performance, making them essential nutrients for maintaining optimal health and well-being.*** ***Learning Outcome: Outcomes of studying carbohydrates leads to advancements in nutrition, health, food science, biomedicine, agriculture, and environmental science, with broad implications for human health, industry, and sustainability.***	6	1st – 2nd week of April
	SEMESTER –4 **CC-8: MICROBIAL GENETICS** **THEORY:** **Unit 3 Mechanisms of Genetic Exchange:** Transformation -Discovery, mechanism of natural competence Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers ***Learning Objectives: objectives of the mechanisms of genetic exchange has broad-ranging objectives, encompassing evolutionary biology, microbial genetics, biotechnology, ecology, public health, agriculture, and astrobiology. These objectives contribute to scientific advancements and have practical implications for various fields, including medicine, biotechnology, and environmental management.***	6	1st -2nd week of March

	Learning Outcome: The outcomes of studying genetic exchange mechanisms contribute to scientific advancements, technological innovation, and sustainable practices across diverse fields, with profound implications for human well-being and environmental stewardship. **CC-9: ENVIRONMENTAL MICROBIOLOGY** **PRACTICAL:** 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. 6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil. 7. Isolation of Rhizobium from root nodules.		
	SEMESTER –6 **DSE-A:3. PLANT PATHOLOGY** **THEORY:** **Unit 1 Introduction and History of plant pathology:** Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists. ***Learning Objectives: The objective of introducing plant pathology is to understand the diseases that affect plants, their causes, symptoms, and management strategies. The history of plant pathology traces back to ancient times when humans first recognized plant diseases and sought ways to control them. From early observations to modern scientific research, plant pathology has evolved to become a crucial discipline in agriculture, ensuring food security and sustainable crop production.*** ***Learning Outcome: The outcome of introducing the history of plant pathology is to provide a foundation for understanding the development of the field and its significance in agriculture. By studying its history, we gain insights into how plant diseases have shaped human civilization, the progression of disease management techniques, and the ongoing efforts to combat new challenges in plant health. Understanding this***	3	1st week of February

	history helps us appreciate the importance of plant pathology in safeguarding global food security and promoting sustainable agriculture practices.		
	Unit 2 Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation. ***Learning Objectives: The stages in the development of a disease generally aim to understand its progression, identify risk factors, diagnose it early, develop effective treatments, and ultimately prevent or manage it to improve outcomes and quality of life for affected individuals. Each stage involves different goals, from basic research to clinical trials and public health interventions.*** ***Learning Outcome: The outcomes of stages in the development of a disease vary depending on the specific goals and interventions implemented at each stage. Generally, the outcomes aim to improve understanding, diagnosis, treatment, and prevention of the disease. These outcomes may include the identification of new biomarkers, the development of more effective therapies, the implementation of screening programs for early detection, and the establishment of public health policies aimed at reducing risk factors and improving overall population health. Ultimately, the goal is to improve patient outcomes, reduce morbidity and mortality, and enhance the overall quality of life for those affected by the disease.***	2	1st week of February
	Unit 3 Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context. ***Learning Objectives: The objective of plant disease epidemiology is to study and understand the factors that influence the occurrence, spread, and impact of plant diseases in order to develop effective management strategies.*** ***Learning Outcome: The outcome of plant disease epidemiology is the development of strategies to manage and control plant diseases, leading to improved crop health and productivity.***	4	2nd week of February
	Unit 4 Host Pathogen Interaction: A. Microbial Pathogenicity Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).	10	3rd – 4th week of February

	B. Genetics of Plant Diseases Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. C. Defense Mechanisms in Plants Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts]. ***Learning Objectives: The objective of host-pathogen interaction is for the pathogen to invade the host, replicate, and spread, while the host aims to recognize and eliminate the pathogen to maintain health and survival. It's essentially a battle between the two entities for dominance and survival.*** ***Learning Outcome: The outcomes of host-pathogen interactions can vary widely depending on factors such as the virulence of the pathogen, the immune response of the host, and the environment. Common outcomes include infection, where the pathogen successfully replicates within the host; clearance, where the host successfully eliminates the pathogen; chronic infection, where the pathogen persists within the host for an extended period; and disease, where the infection leads to noticeable physiological or pathological changes in the host. Additionally, interactions can also result in symbiosis, where both the host and pathogen benefit from the relationship, or commensalism, where the pathogen benefits without harming the host.*** **Unit 5 Control of Plant Diseases:** Principles & practices involved in the management of plant diseases by different methods, viz. regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes- bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes ***Learning Objectives: The primary objective of controlling plant diseases is to protect plant health and promote optimal growth by minimizing or eliminating the impact of pathogens and pests. This is vital for ensuring agricultural productivity, sustainability, and economic viability, as well as preserving biodiversity within both cultivated and natural ecosystems. Effective disease management strategies help maintain the supply of high-quality food, fiber, and ornamental plants,***	6	1^{st} – 2^{nd} week of March

	while reducing the need for chemical interventions that can have negative environmental impacts. ***Learning Outcome: The outcome of controlling plant disease can vary depending on the specific disease and the methods used for control. In general, effective control measures can help prevent the spread of disease, reduce crop losses, and improve plant health. This can result in increased crop yields, improved quality of produce, and overall better plant growth and productivity.*** **Unit 6 Specific Plant diseases:** Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control A. Important diseases caused by fungi White rust of crucifers - Albugo candida Downy mildew of onion - Peronospora destructor Late blight of potato - Phytophthora infestans Powdery mildew of wheat - Erysiphe graminis Ergot of rye - Claviceps purpurea Black stem rust of wheat - Puccinia graministritici Loose smut of wheat - Ustilago nuda Wilt of tomato - Fusarium oxysporumf.sp. lycopersici Red rot of sugarcane - Colletotrichum falcatum Early blight of potato - Alternaria solani B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro E. Important diseases caused by viroids: Potato spindle tuber, coconut cadangcadang ***Learning Objectives: The objective of plant diseases, from the perspective of the pathogens, is typically to obtain nutrients and resources from the host plant in order to support its own growth and reproduction. Pathogens can cause a variety of symptoms in plants, such as wilting, yellowing, lesions, and ultimately, reduced yield or even death of the plant. This allows the pathogen to thrive and spread to other plants, continuing its life cycle.*** ***Learning Outcome: Plant diseases can result in reduced yield, stunted growth, wilting, leaf spots, rotting, premature death of plants, transmission to other plants, and economic losses.*** **PRACTICAL:** 1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.	8	3^{rd} – 4^{th} week of March

	2. Study of important diseases of crop plants by cutting sections of infected plant material - Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.		