M.Sc. Microbiology

1ST SEMESTER

GENERAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**Introduction to Microbiology**: Historical background and scope of Microbiology. Structure of prokaryotic and eukaryotic cell. Differences between Eubacteria, Archaebacteria and Eukaryotes. Salient features of different groups of microorganisms - bacteria, fungi, protozoa, virus and algae including mode of reproduction. Nutrition and Classification: Principles of microbial nutrition- Chemoautotrophs, chemoheterotrophs, photoautotrophs and photoheterotrophs.	Enumerate history of microbiology in detail along with Differences between Eubacteria, Archaebacteria and Eukaryotes. Salient features of different groups of microorganisms - bacteria, fungi, protozoa, virus and algae including mode of reproduction.	To cover basic concepts of introduction to microbiology as a subject	Student interactive session	10
2	**Viruses:** General characteristics, structure, and classification of viruses, Replication of viruses. Lytic and lysogenic cycle in bacteriophages. A Brief account of Retroviruses, Viroids, Prions	Demonstrate characteristics, structure, and classification of viruses,	To cover concepts of characteristics, structure, and classification of viruses	Group discussion	**10**

3	**Microbial Growth**: The definition of microbial growth. Growth in batch culture. Bacterial growth curve. Factors affecting microbial growth. Culture collection and maintenance of microbial cultures.	Demonstrate definition of microbial growth. Growth in batch culture. Bacterial growth curve. Factors affecting microbial growth	To make them understand microbial growth concepts in detail	Student seminar and SIS	10
4	**Control of Microorganism**: Control of Microorganism by physical and chemical agents. Antiseptics and disinfectants. Narrow and broad spectrum antibiotics. Antifungal antibiotics,Mode of action of antimicrobial agents. Antibiotic resistance mechanisms	Enumerate Control of Microorganism by physical and chemical agents.	To cover detailed description of Control of Microorganism by physical and chemical agents.	Student seminar	10
5	**Microbial Ecology**: Microbial flora of soil, Interaction among microorganisms in environment. Symbiotic associations, commensalism, mutualism, amensalism. Brief account of biological nitrogen fixation.	Reproduce concepts of Microbial flora of soil, Interaction among microorganisms in environment.	To cover detailed description o microbial ecology	Teachers seminar and SIS	10

1st semester

FOOD MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Development of food microbiology as a science, scope of food microbiology. Food as substrate for microorganisms, intrinsic and extrinsic factors affecting the growth of microbes, important microorganisms in food (molds, yeasts and bacteria) and their source (air, soil, water, plants and animals).	Demonstrate food microbiology as a science, scope of food microbiology.	To cover introductory concepts of ood microbiology	SIS	**10**
2	**Food contamination and spoilage:** Sources of food contamination. Principles of food spoilage; spoilage of cereals, sugar products, vegetables, fruits, meat and meat products, milk and milk products, fish and sea foods, poultry; spoilage of canned foods.	Enumerate Food contamination and spoilage with examples	To make them understand concept of food spoilage	Student seminar and group discussion	10
3	**Food-borne infections and intoxication:** Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- *Botulism, Staphylococcal.* Mycotoxins & their types	Demonstrate Food-borne infections and intoxication with specific examples of organisms	To cover important organisms causing Food-borne infections and intoxication	SIS and student seminar	10

	– aflatoxins, ochratoxins, fuminosins, trichothecenes, zealenone, ergot alkaloids; food borne outbreaks and lab testing procedures and Preventive measures. Brief account on diseases of Molds, Algae, Protozoa, Viruses.				
4	**Food preservation:** Principles and methods of food preservation- Physical (temperature, irradiation, drying, canning, Chemical (Organic acids, food additives. Class I and Class II preservatives), Biopreservation (Lacticacid bacteria). Food Packaging- Types of packaging materials, properties and benefits.	Enumerate Principles and methods of food preservation	To cover Principles and methods of food preservation	Focus GD	10
5	**Microbial and Fermented foods:** SCP-Nutritional & therapeutic importance, Fermented Vegetables (olives, cucumbers), Meat (sausages), Beverage (cocoa and coffee); Bread, Idli, Dairy foods (cheese). Production methods of Kefir, Yogurt, Acidophilus milk; Probiotics, Prebiotics and Synbiotics, Nutraceuticals, functional foods.	Enumerate important Microbial and Fermented foods with examples	To make them understand Microbial and Fermented foods and their importance	SIS	4
6	**Food and sanitation:** Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their	Reproduce and explain good hygiene practices with examples	To cover Food and sanitation: Good Hygiene	SIS and teacher seminar	6

	regulation, hazard analysis and critical control points (HACCP); GMP, plant sanitation – employees' health standard, waste treatment, disposal, quality control. Recent trends and development in food technologies in India.		Practices, Sanitation in manufacture and retail trade; food control agencies		

1ST SEMESTER

AGRICULTURAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Soil as a Habitat for Microorganisms: Nature and properties of soil. Distribution of various groups of microorganisms in soil, such as bacteria, fungi, protozoa, algae and viruses. Impact of environmental factors and global climate change on distribution of soil biota	Enumerate Soil as a Habitat for Microorganisms: Nature and properties of soil. Distribution of various groups of microorganisms	To cover Soil as a Habitat for Microorganisms: Nature and properties of soil. Distribution of various groups of microorganisms	SIS and student seminar	10
2	Microbial Transformations: Carbon cycle. Biodegradation of soil organic constituents- Degradation of cellulose, hemicelluloses and	Demonstrate Microbial Transformations: Carbon cycle. Biodegradation of soil organic constituents- Degradation of	To make them understand Microbial Transformations: Carbon cycle. Biodegradation of soil organic constituents-	Spot GD and SIS	10

	lignin. Humic substances in soil-Genesis, structure,composition and role in agriculture and environment. Role of microorganisms in cycling of nitrogen, phosphorus, sulphur, iron and manganese in soil-plant system. Environmental impact of biogeochemical cycles.	cellulose, hemicelluloses along with Environmental impact of biogeochemical cycles.	Degradation of cellulose, hemicelluloses, Environmental impact of biogeochemical cycles.		
3	**Plant-microbe interactions:** Mutualism, commensalism, parasitism, amensalism, synergism. Rhizosphere microorganisms-phyllosphere, rhizosphere effect, factors influencing rhizosphere microbes. Nodulation and Nitrogen fixation, PGPR,VAM.	Reproduce and explain Plant-microbe interactions: Mutualism, commensalism, parasitism, amensalism, synergism.	To cover Plant-microbe interactions: Mutualism, commensalism, parasitism, amensalism, synergism.	SIS and problem based learning	10
4	**Bioinoculants:** Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants-*Azotobacter*, α & β rhizobia, *Azospirillum*, Cyanobacteria, phosphate solubilising microorganisms, *Azolla*. *Mycorrhiza*, Biopesticides – types and applications	Enumerate Bioinoculants: Biofertilizer - types, production and quality control	To cover concepts of Bioinoculants: Biofertilizer - types, production and quality control	SIS and group discussion	10
5	**Plant pathology:** Recognition and entry of pathogens into host cells. Alteration of host	Enumerate Plant pathology: Recognition and entry of	To make them understand Plant pathology: Recognition and	Student seminar	6

	cell behaviour by pathogens. Mechanisms of disease establishment; enzymes, phytotoxins, growth regulators. involvement of elicitors; role of R and r genes in disease development. Molecular mechanisms of disease diagnosis. Resistance mechanisms in plants, Systemic resistance, resistance genes, phytoalexins, PR proteins, signalling mechanisms. Transgenic approaches for crop protection.	pathogens into host cells.	entry of pathogens into host cells.		
6	**Plant diseases: (Symptoms, etiology & control)** Diseases caused by a) Fungi: Wilt diseases, Downy mildews, Powdery mildews, Rusts, Smuts) b) Bacteria: (Bacterial wilt, Bacterial blight of rice, Angular leaf spot of cotton, Citrus canker) c) Mycoplasmal diseases: (Sandal spike, Grassy shoot of sugar cane) d) Viral diseases: (Banana bunchy top, Cucumber mosaic,Tobacco mosaic) e) Protozoa: (Hartrot of coconut, Phloem necrosis of coffee). f)Viroids: (Potato spindle tuber viroid). g)Parasitic plants: (Dodder, Mistletoes) h.) Post-harvest diseases	Demonstrate Plant diseases: (Symptoms, etiology & control) with examples	To cover Plant diseases: (Symptoms, etiology & control)	SIS	4

	and control measures. Integrated pest management.				

1st SEMESTER

INTRODUCTION TO BIOINFORMATICS

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Introduction to Bioinformatics Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Technologies used in Data Mining, Applications of Data Mining to Bioinformatics.	Enumerate Definition and History of Bioinformatics in detail	To cover concepts of Definition and History of Bioinformatics	SIS	12
2	Biological Databases Types: primary, secondary, specialized, Gen bank, Database searches: sequence retrieval systems; Similarity searching: BLAST, FASTA, Protein and nucleic acid databases, Structural data	Demonstrate Biological Databases Types: primary, secondary, specialized, Gen bank, Database searches	To make them understand Biological Databases Types: primary, secondary, specialized, Gen bank, Database searches	Student interactive session and GD	12

	bases.				
3	**Sequence Analysis** Collecting and storing the sequence, Sequence alignment, Pair wise alignment techniques, Dot matrix method, Multiple sequence alignment, CLUSTAL W and CLUSTAL X.	**To reproduce and explain Sequence Analysis** Collecting and storing the sequence, Sequence alignment, Pair wise alignment techniques, Dot matrix method, Multiple sequence alignment, CLUSTAL W and CLUSTAL X	**To cover concepts of sequence analysis**	**SIS and problem based learning**	**15**
4	Applications of Bioinformatics Phylogenetic analysis: phylogenetic tree: role in evolutionary studies and their types , Protein structure prediction: secondary structure, ExPASY,CFSSP, PSIPRED, Application tools: Motif and Domain prediction: PROSITE,Emotif, ProDom,Pfam, primer designing,	Enumerate Applications of Bioinformatics Phylogenetic analysis	To cover Applications of Bioinformatics Phylogenetic analysis	SIS	11

1ST SEMESTER

BIOETHICS AND SAFETY

Time: 30 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Biosafety and Biosecurity - Introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals.	Demonstrate Biosafety and Biosecurity - Introduction; historical background	To make them understand Biosafety and Biosecurity - Introduction; historical background	SIS	10
2	Definition of GMOs & LMOs; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan	Enumerate GMOs & LMOs; risk – environmental risk assessment and food and feed safety assessment;	To cover GMOs & LMOs; risk – environmental risk assessment and food and feed safety assessment;	GD and SIS	5
3	An overview of Patent laws in India. Patent Practice & Problems : Review of case law, public & international depositories,	Demonstrate An overview of Patent laws in India. Patent Practice & Problems	To cover an overview of Patent laws in India. Patent Practice & Problems	SIS and student seminar	5

	patentability of microorganisms,				
4	Genetic engineering. Social issues - public opinions against the microbial technologies. Ethical issues – ethical issues against the microbial technologies. Ethical issues in stem cell research.	To reproduce and explain Genetic engineering. Social issues - public opinions against the microbial technologies	To cover Genetic engineering. Social issues - public opinions against the microbial technologies	SIS	5
5	Ethics in genetic testing, cloning, GM foods and genetic therapy.	Demonstrate Ethics in genetic testing, cloning, GM foods	To cover concepts in Ethics in genetic testing, cloning, GM foods	SIS	5

2ND SEMESTER

MICROBIAL GENETICS

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Prokaryotic Genome: *E.coli* chromosome-coiled, supercoiled. Eukaryotic Genome: Structure of nucleus and chromosome, lamp brush chromosome, nucleosomes, Histones: types and their role, histone chaperons, solenoid model, Packaging of DNA, role of N-terminal tails, nuclear scaffold, role of proteins involved, nucleosome assembly.	Demonstrate Prokaryotic Genome: *E.coli* chromosome-coiled, supercoiled. Eukaryotic Genome in detail	To cover concepts of Prokaryotic Genome: *E.coli* chromosome-coiled, supercoiled. Eukaryotic Genome	SIS and student seminar	10
2	**Mutation:** Mutagenesis: definition, types of mutations, Molecular mechanism of mutations, Physical and chemical mutagenic agents. DNA repair mechanism - excision, mismatch, SOS, photo-reactivation, recombination repair and glycocylase system, site-directed mutagenesis, application of mutagenesis in strain improvement.	Enumerate Mutation: Mutagenesis: definition, types of mutations and DNA repair in detail	To make them understand Mutation: Mutagenesis: definition, types of mutations	SIS	10
3	Genetic recombination:	Demonstrate	To cover	SIS and	10

	Genetic recombination in bacteriophages and *E. coli*, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, generalized & specialized transduction, transformation and conjugation.	Genetic recombination: Genetic recombination in bacteriophages and *E. coli*, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases	Genetic recombination: Genetic recombination in bacteriophages and *E. coli*, synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases	Group discussion	
4	Gene transfer mechanisms: Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications.	Enumerate Gene transfer mechanisms: Bacterial transformation wit examples	To cover Gene transfer mechanisms: Bacterial transformation	Student seminar and SIS	10
5	Plasmids and Bacteriophages: Gene mapping of Plasmids: types, purification and application, Phage genetics, genetic organization, Life cycle and their uses in microbial genetics, Lytic phages and Lysogenic phages.	Reproduce and explain Plasmids and Bacteriophages: Gene mapping of Plasmids: types, purification and application, Phage genetics	To cover Plasmids and Bacteriophages: Gene mapping of Plasmids: types, purification and application, Phage genetics	SIS and student seminar	10

2ND SEMESTER

MOLECULAR BIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the	Teaching guidelines	Methodology	Time

		session student should be able to)			
1	**DNA Structure**: DNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Different forms of DNA, Properties of DNA, Renaturation and denaturation of DNA.	Demonstrate DNA Structure: DNA as genetic material, Chemical structure and base composition of nucleic acids	To cover DNA Structure: DNA as genetic material, Chemical structure and base composition of nucleic acids	SIS and student seminar	10
2	**DNA Replication**: General features of DNA replication, Enzymes and proteins of DNA replication, Models of replication, Prokaryotic and eukaryotic replication mechanism. Fidelity of DNA replication.	Enumerate DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication	To cover DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication	Problem based learning and SIS	10
3	**Transcription**: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5' capping, 3'polyadenylation and splicing).	To reproduce and explain Transcription: Mechanism of transcription in prokaryotes and eukaryotes with examples	To cover Transcription: Mechanism of transcription in prokaryotes and eukaryotes	Student seminar	10
4	**Translation**: Types of RNA, tRNA structure, RNA splicing and RNA editing. General features of the genetic code; Ribosome as the site of protein synthesis; Activation of amino acids; Initiation, elongation and termination of protein synthesis in prokaryotes	Demonstrate Translation: Types of RNA, tRNA structure, RNA splicing and RNA editing.	To cover Translation: Types of RNA, tRNA structure, RNA splicing and RNA editing.	SIS	12

	and eukaryotes. Post-translational processing of the polypeptide chains; Acylation, methylation, sulfation, phosphorylation and glycosylation				
5	Regulation of Gene Expression: Operon concept, Positive and negative control, lac and trp operon.	Enumerate Regulation of Gene Expression: Operon concept, Positive and negative control, lac and trp operon	To cover Regulation of Gene Expression: Operon concept, Positive and negative control, lac and trp operon	Student seminar and GD	8

2ND SEMESTER

MEDICAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Morphology,ultrastructure and nutrition of bacteria, Morphological characteristics of bacteria: Eubacteria and Archaeobacteria, Actinomycetes, Nutritional types of bacteria. Culture media: classification of media (Simple, complex and special media with example). Growth:	Demonstrate in detail Morphology,ultrastructure and nutrition of bacteria along with Pathogenic Bacteria: Morphological characteristics, pathogenesis and laboratory diagnosis With examples.	To cover Pathogenic Bacteria: Morphological characteristics, pathogenesis and laboratory diagnosis and Pathogenic Bacteria: Morphological characteristics, pathogenesis	SIS and student seminar	10

	Nutritional uptake, generation time, growth curve, factors affecting growth. Aerobic, anaerobic, batch, continuous and synchronous cultures. Pathogenic Bacteria: Morphological characteristics, pathogenesis and laboratory diagnosis of following pathogenic bacteria; *Staphylococcus, Streptococcus, Neisseria, Klebsiella, Proteus, Salmonella, Shigella, Virbrio, Campylobacter, Pseudomonas, Acinetobacter, Haemophilus, Bacillus, Clostridium, Mycobacterium, Actinomyces, Listeria, Mycoplasma, Rickettsiae, Chlamydiae*, Spirochetes.		and laboratory diagnosis		
2	Acellular entities- viruses, viriods and prions: Brief outline on discovery of viruses, origin of viruses, distinctive properties of viruses. Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA),structure and importance- Viroids, Prions.	Enumerate Acellular entities- viruses, viriods and prions: Brief outline on discovery of viruses, origin of viruses, distinctive properties of viruses. Morphology and ultrastructure of viruses	To cover Acellular entities- viruses, viriods and prions: Brief outline on discovery of viruses, origin of viruses, distinctive properties of viruses. Morphology and ultrastructure of viruses	SIS	10
3	Cultivation and assay of	Demonstrate	To cover	SIS and	10

	viruses : Cultivation of viruses in embryonated eggs, experimental animals and cell cultures (suspension cell cultures and monolayer cell cultures; cell lines and cell strains).Viral Pathogens: Brief account of viral diseases-Hepatitis, Herpes, Measles, Rabies, Polio, 10Rubella, HIV, SARS, Rotaviruses. Vaccinology: Active and passive immunization; Live, killed, attenuated, sub unit vaccines.	Cultivation and assay of viruses in detail	Cultivation and assay of viruses	group discussion	
4	**Mycology:**The morphology and reproduction in fungi. Classification of fungi Morphology, diseases caused and lab diagnosis of:-Opportunistic fungi - Cryptococcus, Candidiasis, Aspergillus, Zygomycetes. Fungi causing superficial mycoses- Ptyriasis versicolor, Tinea Nigra, Piedra. Dermatophytes. Subcutaneous mycoses, Dimorphic fungi –Anti-mycotic agents	Enumerate concepts of Mycology:The morphology and reproduction in fungi. Classification of fungi	To cover concepts in Mycology:The morphology and reproduction in fungi. Classification of fungi	SIS	10
5	Protozoa & Helminthology Morphology, life cycle, laboratory diagnosis of:Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma,Plasmodium, Toxoplasma, Coccidian parasite.	Demonstrate Protozoa & Helminthology Morphology, life cycle, laboratory diagnosis of specific examples	To cover Protozoa & Helminthology Morphology, life cycle, laboratory diagnosis	Student seminar	10

	Taenia, Echinococcus, Hymenolepis, Schistosomes, Wuchereria bancrofti				

2ND SEMESTER

MICROBIAL TECHNIQUES AND INSTRUMENTATION

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Isolation techniques of microorganisms: Isolation of pure cultures; dilution, spread plate, streak plate, pour plate, , colony morphology and other characteristics of cultures. Maintenance and preservation of pure cultures, culture collection center-national and international.Microscopy: Working principle of phase contrast microscopy, fluorescent microscopy, electron microscopy (TEM and SEM), confocal microscopy, fluorescent microscope.	Enumerate Isolation techniques of microorganisms and microscopy in detail	To cover Isolation techniques of microorganism and microscopy concepts	SIS	15
2	**Measurement of microbial growth:** Direct microscopic count, standard plate count, membrane filtration, MPN,	**Demonstrate Measurement of microbial growth:** Direct microscopic count, standard	**To cover Measurement of microbial growth:** Direct microscopic count, standard	**Group discussion**	**12**

	Indirect method: turbidity, metabolic activity and dry weight. Automated microbial identification system.	plate count, membrane filtration, MPN,	plate count, membrane filtration, MPN,		
3	**Spectrophotometry:** Principle and applications of spectrophotometer- UV/visible, fluorescence. **Spectroscopy:** Principle and applications ,Mass spectroscopy	Enumerate Spectrophotometry: Principle and applications	To cover Spectrophotometry: Principle and applications	SIS and student seminar	12
4	Chromatography: Principles and applications of Chromatography: Thin layer chromatography (TLC), Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography (GC) and High performance liquid chromatography[(HPLC). Electrophoresis: Definition, principles and applications; different types of Electrophoresis- PAGE, SDS-PAGE, Agarose gel electrophoresis.	Demonstrate Chromatography: Principles and applications with specific examples	To cover Chromatography: Principles and applications	Problem based learning and SIS	11

SEMESTER 3

INDUSTRIAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Introduction: Scope of Industrial Microbiology and fermentation technology. Study of industrially important micro-organisms and their preservation. Criteria for selection and strategies for strain improvement; maintenance and containment of recombinant organisms.	Demonstrate Introduction: Scope of Industrial Microbiology and fermentation technology.	To cover Introduction: Scope of Industrial Microbiology and fermentation technology.	SIS and student seminar	10
2	Fermentation process: Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture. Continuous culture, apparent viscosities; anti-foam agents.	Enumerate Fermentation process: Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture. Continuous culture	To cover Fermentation process: Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture. Continuous culture	SIS and teacher seminar	10
3	Fermentors: Basic features, design & components – Typical fermentor. Sterilization of fermentor, medium, air	Demonstrate Fermentors: Basic features, design & components	To cover concepts of Fermentors: Basic features,	Focus group discussion	10

	supply. Fermentation media: sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors and inducers. Specialized bioreactors (Photobioreactors)		design & components		
4	Solid state fermentation (SSF): Estimation of growth in SSF, concept of sterility. Factors influencing SSF, design of fermentor in SSF (Koji fermentor). Production of commercially important products by SSF.	Enumerate Solid state fermentation (SSF): Estimation of growth in SSF, concept of sterility	To cover Solid state fermentation (SSF): Estimation of growth in SSF, concept of sterility	SIS	10
5	Downstream processing: Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods, liquid extraction, membrane filtration, chromatography, drying devices, crystallization. Solvent recovery. Effluent treatment. Quality control of fermented products.	Reproduce and explain Downstream processing: Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods	To cover Downstream processing: Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods	SIS and student seminar	10

3RD SEMESTER

IMMUNOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system – T-cells, B-cells, lymphoid organ, spleen and bone marrow. Antigenic properties, T and B cell epitopes, chimeric peptides, macrophages, antigen-processing cells, eosinophils, neutrophils, mast cells and natural killer cells; immune responses – cell mediated and humoral, clonal selection and nature of immune response.	Demonstrate Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system in detail	To cover Immune System and immunity: History of immunology; innate and acquired immunity. Cells and organs involved in immune system	SIS	10
2	Antigen and antibodies: Types, structure and properties of antigens, haptens; adjuvant - antigen specificity. Immunoglobulins – structure, types and subtypes, properties,	Enumerate Antigen and antibodies: Types, structure and properties of antigens, haptens; adjuvant - antigen specificity. Immunoglobulins	To cover Antigen and antibodies: Types, structure and properties of antigens, haptens; adjuvant - antigen specificity. Immunoglobulins	Student seminar and SIS	10

	primary and secondary responses, Antibody diversity. Complement system – Structure, components, properties and functions, complement fixation and complement pathways, biological consequences. Inflammation-effector mechanisms.				
3	Antigen-antibody reactions: Agglutination, precipitation, immunoelectrophoresis, immunofluorescence, ELISA, RIA; Flow cytometry, Montaux test. Applications of these methods in diagnosis of microbial infections, autoimmunity mechanisms, altered antigens, systemic lupus erythematosus, Graves‟s diseases, rheumatoid arthritis, myasthenia gravis, multiple sclerosis. Concept of Immunodeficiency.	Demonstrate Antigen-antibody reactions: Agglutination, precipitation, immunoelectrophoresis, immunofluorescence, ELISA, RIA; Flow cytometry, Montaux test concepts	To cover Antigen-antibody reactions: Agglutination, precipitation, immunoelectrophoresis, immunofluorescence, ELISA, RIA; Flow cytometry, Montaux test	Teacher seminar and SIS	10
4	Hypersensitivity reactions: Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity.	Enumerate Hypersensitivity reactions: Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed	To cover Hypersensitivity reactions: Allergy, Type I- Anaphylaxis; Type II- Antibody dependent cell cytotoxicity, Type III- Immune complex mediated reactions, Type IV- delayed	GD and SIS	10

	Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines	type hypersensitivity	type hypersensitivity		
5	Major histocompatibility complex(MHC): Structure and functions of MHC and the HLA systems. Tissue typing methods for transplantations in humans; graft versus host reaction and rejection.Tumor immunology: tumor specific antigens, Immune response to tumors, immunodiagnosis of tumors – detection of tumor markers – alphafoetal proteins, carcinoembryonic antigen, Cancer therapeutics.	To reproduce and explain Major histocompatibility complex(MHC): Structure and functions of MHC and the HLA systems.	To cover Major histocompatibility complex(MHC): Structure and functions of MHC and the HLA systems.	SIS	6
6	Immunization: Common immunization practice, types of vaccines and its application. Edible vaccines. Production of Polyclonal and monoclonal antibodies; antibody engineering. Plantibodies.	Demonstrate Immunization: Common immunization practice, types of vaccines and its application	To cover Immunization: Common immunization practice, types of vaccines and its application	Student seminar	4

3RD SEMESTER

RECOMBINANT DNA TECHNOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Introduction: Principle of gene cloning, vectors: Plasmids: basis features, size and copy number, conjugation and compatibility, classification, Bacteriophage: basic feature, lysogeny, Restriction Enzymes: Types, Restriction Endonuclease, Blunt ends and Sticky ends, Ligation, Linkers and Adaptors.	Demonstrate Introduction: Principle of gene cloning, vectors: Plasmids: basis features, size and copy number, conjugation and compatibility, classification, Bacteriophage with examples	To cover Introduction: Principle of gene cloning, vectors: Plasmids: basis features, size and copy number, conjugation and compatibility, classification, Bacteriophage	Student interactive session	12
2	Isolation Sequencing and Synthesis of Genes: Methods of gene isolation, cloning of specific gene, application of gene cloning: DNA sequencing methods: Maxam Gilbert's and Sanger's dideoxy method, PCR: Polymerase Chain Reaction-Basic Principle , types and application of PCR in Biotechnology, Blotting techniques- Southern Blotting.	Enumerate Isolation Sequencing and Synthesis of Genes: Methods of gene isolation, cloning of specific gene, application of gene cloning: DNA sequencing methods	To cover Isolation Sequencing and Synthesis of Genes: Methods of gene isolation, cloning of specific gene, application of gene cloning: DNA sequencing methods	Group discussion	12

3	Proteins identification and characterization: Methods/strategies, protein isolation and purification, stability, SDS PAGE, 2-Dimensional gel electrophoresis: Methods including immobilized pH gradients (IPGs), western blotting.	Enumerate Proteins identification and characterization	To cover Proteins identification and characterization	Problem based learning and SIS	15
4	Application of RDT: Production of regulatory proteins (Interferon, Interleukins), vaccines (Hepatitis-B), hormones (insulin, somatostatin).	Explain Application of RDT: Production of regulatory proteins	To cover Application of RDT: Production of regulatory proteins	GD and student interactive session	11

SEMESTER 3

BIOCHEMISTRY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Carbohydrates: Structure and function, classification: mono-, di- and polysaccharides, glycoproteins. Metabolism of carbohydrates- Glycolysis, Citric acid cycle, Gluconeogenesis and Pentose phosphate pathways and their	Demonstrate Carbohydrates: Structure and function, classification in detail	To cover Carbohydrates: Structure and function, classification	SIS	12

	regulations.				
2	Lipids: Structure of fatty acids, Classification of lipids, essential fatty acids, Structure and functions of major lipids, subclasses-Acylglycerols, Phospholipids, Glycolipids, lipoproteins, Sphingholipids, and Steroids. Fatty acids: oxidation.	Enumerate Lipids: Structure of fatty acids, Classification of lipids, essential fatty acids, Structure and functions of major lipids, subclasses	To cover Lipids: Structure of fatty acids, Classification of lipids, essential fatty acids, Structure and functions of major lipids, subclasses	Group discussion	15
3	Proteins: Structure and classification of amino acids, non-protein and rare amino acids. Metabolism of amino acids, urea cycle. Structural organization of proteins, Protein secondary structure, tertiary structure, quaternary structure with examples, protein denaturing and renaturing. Role of chaperons in protein folding.	Enumerate Proteins: Structure and classification of amino acids, non-protein and rare amino acids. Metabolism of amino acids, urea cycle.	To cover Proteins: Structure and classification of amino acids, non-protein and rare amino acids. Metabolism of amino acids, urea cycle.	SIS and student seminar	12
4	Water: Structure, hydrogen bond,ionization of water, pH, osmosis,osmolarity, Henderson-Hasselbalch equation. Nucleic Acids: Structure and properties of nucleic acid bases,	To reproduce and explain Water: Structure, hydrogen bond,ionization of water, pH, osmosis,osmolarity, Henderson-Hasselbalch equation.	To cover Water: Structure, hydrogen bond,ionization of water, pH, osmosis,osmolarity, Henderson-Hasselbalch equation.	SIS and GD	11

	nucleosides and nucleotides. Biosynthesis and regulation of purines and pyrimidines.				

PHARMACEUTICAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Antibiotics and synthetic antimicrobial agents (Aminoglycosides, β lactams, tetracyclines) Antifungal antibiotics, antitumor substances. Peptide antibiotics, Chloramphenicol, Sulphonamides and Quinolinone antimicrobial agents. Chemical disinfectants, antiseptics and preservatives.	Demonstrate Antibiotics and synthetic antimicrobial agents	To cover Antibiotics and synthetic antimicrobial agents in detail	SIS	12
2	Mechanism of action of antibiotics (inhibitors of cell	Enumerate Mechanism of action of	To cover Mechanism of action of	Group discussion	12

	wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting. Drug delivery system in gene therapy Bacterial resistance to antibiotics. Mode of action of bacterial killing by quinolinones. Bacterial resistance to quionolinones. Mode of action of non – antibiotic antimicrobial agents.	antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting.	antibiotics (inhibitors of cell wall synthesis, nucleic acid and protein synthesis). Molecular principles of drug targeting.		
3	Microbial production and Spoilage of pharmaceutical products. Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase). DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines. Vaccine	To reproduce and explain Microbial production and Spoilage of pharmaceutical products. Manufacturing procedures and in process control of pharmaceuticals	To cover Microbial production and Spoilage of pharmaceutical products. Manufacturing procedures and in process control of pharmaceuticals	SIS and student seminar	15

	clinical trials.				
4	Regulatory practices, biosensors and applications in Pharmaceuticals Financing R&D capital and market outlook. IP, BP, USP. Government regulatory practices and policies, FDA perspective. Reimbursement of drugs and biologicals, legislative perspective.	Enumerate regulatory practices, biosensors and applications in Pharmaceuticals Financing R&D capital and market outlook.	To cover regulatory practices, biosensors and applications in Pharmaceuticals Financing R&D capital and market outlook in detail	SIS and GD	11

SEMESTER 3

SOIL MICROBIOLOGY

Time: 50 hours

S.no	**Topic**	**Learning objective(At the end of the session student should be able to)**	**Teaching guidelines**	**Methodology**	**Time**
1	Soil as a Habitat for Microorganisms: Nature and properties of soil. Various groups of microorganisms in soil, such as bacteria, fungi, protozoa, algae and viruses. Impact of environmental factors and global	Demonstrate Soil as a Habitat for Microorganisms: Nature and properties of soil. Various groups of microorganisms in soil, such as bacteria, fungi, protozoa, algae and viruses. Impact of environmental	To cover Soil as a Habitat for Microorganisms: Nature and properties of soil. Various groups of microorganisms in soil, such as bacteria, fungi, protozoa, algae and viruses. Impact of environmental	SIS and student seminar	10

	climate change on distribution of soil biota	factors and global climate change	factors and global climate change		
2	Microbial Transformations: Carbon cycle. Humic substances in soil-Genesis, structure, composition and role in agriculture and environment. Role of microorganisms in cycling of nitrogen, phosphorus, sulphur, iron and manganese in soil-plant system. Environmental impact of biogeochemical cycles.	Enumerate Microbial Transformations: Carbon cycle. Humic substances in soil-Genesis, structure, composition and role in agriculture and environment. Role of microorganisms in cycling of nitrogen, phosphorus, sulphur, iron and manganese in soil-plant system	To cover Microbial Transformations: Carbon cycle. Humic substances in soil-Genesis, structure, composition and role in agriculture and environment. Role of microorganisms in cycling of nitrogen, phosphorus, sulphur, iron and manganese in soil-plant system	SIS and teacher seminar	12
3	Microbial Interactions in Soil: Positive and negative interactions. Microbiology of rhizosphere.Biological nitrogen fixation. Symbiotic associations-Legume-rhizobial symbiosis, actinorhizal symbiosis, and associative symbiosis. Mycorrhizal associations. Soil enzyme activities: Origin and their significance.	Enumerate Microbial Interactions in Soil: Positive and negative interactions. Microbiology of rhizosphere.Biological nitrogen fixation. Symbiotic associations	To cover Microbial Interactions in Soil: Positive and negative interactions. Microbiology of rhizosphere.Biological nitrogen fixation. Symbiotic associations	SIS	12
4	Microbial Control and Bioinoculants: Microorganisms involved in	To reproduce and explain Microbial Control and Bioinoculants:	To cover Microbial Control and Bioinoculants: Microorganisms	student seminar	10

	biological control of plant diseases. Biocontrol agents and mechanisms of disease suppression. Plant growth promoting rhizobacteria. Production and use of microbial inoculants. Mycoherbicides.	Microorganisms involved in biological control of plant diseases. Biocontrol agents and mechanisms of disease suppression. Plant growth promoting rhizobacteria.	involved in biological control of plant diseases. Biocontrol agents and mechanisms of disease suppression. Plant growth promoting rhizobacteria.		
5	Biological indicators of soil health. Biodegradation of pesticides. Role of microorganisms in sustainable agriculture and organic farming.	Demonstrate biological indicators of soil health. Biodegradation of pesticides. Role of microorganisms in sustainable agriculture and organic farming	To cover biological indicators of soil health. Biodegradation of pesticides. Role of microorganisms in sustainable agriculture and organic farming	Group discussion	6

SEMESTER 4

ENVIRONMENTAL MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Scope of Environmental Microbiology: An overview of microbial niches in global environment. Microbes in terrestrial, aquatic and aerial environments. Microbes in the extreme environments and their adaptations- Thermophiles, psychrophiles, acidophiles, alkalophiles, halophiles and barophiles .Dispersal of microorganism-role of physical and biological factors. Microbial Degradation of Organic Pollutants: Degradation of xenobiotics-pesticides, Hydrocarbons. Bioremediation strategies for soils and waters polluted with heavy metals and organic pollutants. Phytoremediation of pollutants.	Demonstrate Scope of Environmental Microbiology: An overview of microbial niches in global environment. Microbes in terrestrial, aquatic and aerial environments. Microbes in the extreme environments and their adaptations along with Microbial Degradation of Organic Pollutants	To cover Scope of Environmental Microbiology: An overview of microbial niches in global environment. Microbes in terrestrial, aquatic and aerial environments. Microbes in the extreme environments and their adaptations along with Microbial Degradation of Organic Pollutants	SIS and GD	15
2	Microbiology of Wastewater and Solid Waste Treatment: Waste types-solid and liquid	Enumerate Microbiology of Wastewater and Solid Waste	To cover Microbiology of Wastewater and Solid Waste	Problem based learning and SIS	12

	waste their characterization, physical, chemical, biological. Aerobic, anaerobic, primary, secondary and tertiary treatments. Treatment schemes for effluents of industries including microbes used, and types of effluent treatment plants. Management of solid wastes. sanitary landfills. Bioconversion of solid waste and utilization as fertilizer-Composting and vermicomposting.	Treatment. Bioconversion of solid waste and utilization as fertilizer-Composting and vermicompostin g.	Treatment. Bioconversion of solid waste and utilization as fertilizer-Composting and vermicompostin g.		
3	Microbial Interaction in Rumen and Gastrointestinal Tract: Microbiology of silage making. Microbiology of termite and earthworm gut. Interaction of soil fauna and microflora in cycling of plant litter in forest ecosystem.	To reproduce and explain Microbial Interaction in Rumen and Gastrointestinal Tract: Microbiology of silage making. Microbiology of termite and earthworm gut. Interaction of soil fauna and microflora in cycling of plant litter in forest ecosystem.	To cover Microbial Interaction in Rumen and Gastrointestinal Tract: Microbiology of silage making. Microbiology of termite and earthworm gut. Interaction of soil fauna and microflora in cycling of plant litter in forest ecosystem.	Student seminar	12
4	Bio-fuels and Bio-mining: Bioethanol and future fuels-hydrogen, biodiesel. Biomining-Microbial leaching of low grade ores.	Enumerate Bio-fuels and Bio-mining: Bioethanol and future fuels-hydrogen, biodiesel. Biomining-Microbial leaching of low grade ores.	To cover Bio-fuels and Bio-mining: Bioethanol and future fuels-hydrogen, biodiesel. Biomining-Microbial leaching of low grade ores.	Teacher seminar and SIS	11

SEMESTER 4

MICROBIAL BIOTECHNOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Introduction: Principle, applications, economics and milestones in microbial technology	Demonstrate Introduction: Principle, applications, economics and milestones in microbial technology	To cover Introduction: Principle, applications, economics and milestones in microbial technology	SIS	10
2	Microbial products of industrially important metabolites for commercial use: a) Organic solvents – Alcohol and Glycerol b) Organic acids - Citric acids, Lactic acids, c) Amino acids - Glutamic acids, Lysine, Cyclic AMP and GMP d) Antibiotics - Penicillin, Streptomycin, Griseofulvin, e) Vitamins - B12, Riboflavin and Vitamin C	Enumerate Microbial products of industrially important metabolites for commercial use with exapmples	To cover Microbial products of industrially important metabolites for commercial use	Student seminar	15
3	Microbial enzymes:. Immobilized enzymes and cells: Techniques and	Enumerate Microbial enzymes:. Immobilized	To cover Microbial enzymes:. Immobilized	SIS and group discussion	15

	types of immobilization, industrial applications of immobilization: merits and demerits. Enzymes in - starch processing, food, textile, detergent, leather, breweries, pharmaceuticals, therapeutics, and diagnostics.	enzymes and cells: Techniques and types of immobilization, industrial applications of immobilization:	enzymes and cells: Techniques and types of immobilization, industrial applications of immobilization:		
4	Microbial Biotransformation: Biotransformation for the synthesis of steroids and sterols. Biosensors: Definition, characteristics of ideal biosensors, types of biosensors, biological recognition elements, transducers, application of biosensors.	To reproduce and explain Microbial Biotransformation: Biotransformation for the synthesis of steroids and sterols. Biosensors	To cover Microbial Biotransformation: Biotransformation for the synthesis of steroids and sterols. Biosensors	SIS and student seminar	10

SEMESTER 4

ENZYME TECHNOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	Classification of	Enumerate	To cover	SIS	12

	Enzymes, Enzymes vs Chemical catalyst, Enzyme nomenclature, units of activity, properties of enzymes, general mechanism of enzyme action, Extraction and purification of enzymes, Cofactors and coenzymes. Enzyme Specificity: Substrate and reaction specificity, Lock & key hypothesis, Induced Fit hypothesis	Classification of Enzymes, Enzymes vs Chemical catalyst, Enzyme nomenclature, units of activity, properties of enzymes, general mechanism of enzyme action	Classification of Enzymes, Enzymes vs Chemical catalyst, Enzyme nomenclature, units of activity, properties of enzymes, general mechanism of enzyme action		
2	Enzyme Kinetics: Factors affecting velocity of enzyme catalyzed reactions, Michaelis-Menten hypothesis, Transformation of Michaelis- Menten equation and determination of K_m and V_{max}, Enzymes inhibition i.e., reversible and irreversible inhibition, Competitive, Non-competitive and uncompetitive inhibition. Regulatory Enzymes: Allosteric enzymes.	Demonstrate Enzyme Kinetics: Factors affecting velocity of enzyme catalyzed reactions, Michaelis-Menten hypothesis, Transformation of Michaelis-Menten equation and determination of K_m and V_{max}, Enzymes inhibition	To cover Enzyme Kinetics: Factors affecting velocity of enzyme catalyzed reactions, Michaelis-Menten hypothesis, Transformation of Michaelis-Menten equation and determination of K_m and V_{max}, Enzymes inhibition	Student seminar and SIS	15
3	Enzyme Technology: Large scale production of enzymes: glucose	Enumerate Enzyme Technology: Large scale	To cover in detail Enzyme Technology: Large scale	SIS and GD	12

	isomerase, amylase, Uses of isolated enzymes in food and chemical industries, Therapeutic & medicinal use of enzymes.	production of enzymes: glucose isomerase, amylase	production of enzymes: glucose isomerase, amylase		
4	Protein Engineering: Concept and Methods, Site directed mutagenesis, Active site mapping, Nature of the active site, Identification of functional groups at the active site, Immobilization of enzymes and their applications in the industry.	Demonstrate protein Engineering: Concept and Methods, Site directed mutagenesis, Active site mapping, Nature of the active site, Identification of functional groups at the active site, Immobilization of enzymes	To cover protein Engineering: Concept and Methods, Site directed mutagenesis, Active site mapping, Nature of the active site, Identification of functional groups at the active site, Immobilization of enzymes	SIS	11

SEMESTER 4

APPLIED MICROBIOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time

1	Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.	Enumerate Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.	To cover Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.	SIS	8
2	Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists. Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition.	Demonstrate Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists.	Enumerate Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists.	Student seminar	10
3	Food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Principles of food preservation-Chemical preservatives and Food additives. Asepsis-Removal of microorganisms. Contamination and food spoilage: Cereals, sugar products, vegetables, fruits,	Demonstrate Food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Principles of food preservation-Chemical preservatives and Food additives	To cover concepts of Food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. Principles of food preservation-Chemical preservatives and Food additives	Group discussion	12

	meat and meat products, Fish and sea foods- poultry spoilage of canned foods.				
4	Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Ceram and butter bacteriology	Demonstrate Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products	To cover Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products	SIS	12
5	Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification	To reproduce and explain Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology	To cover Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology:	SIS	4

6	Concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution.	Demonstrate Concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution.	To cover Concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution.	Student seminar	4