M.Sc Microbiology Syllabus

Faculty of Allied Health Sciences

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN M. Sc. MICROBIOLOGY

	CORE COURSES	SKILL ENHANCEMENT COURSE (SEC)	ELECTIVE DISCIPLINE SPECIFIC (DSE)
Semester-I			
1	C-MMB-01 General microbiology (Theory+Practical)	SEC-MMB-01 Bio ethics and safety	
2	C-MMB-02 Food microbiology (Theory+Practical)		
3	C-MMB-03 Agricultural Microbiology (theory and practical)		
4			DSE-MMB-01 Introduction to Bioinformatics (theory and practical)
Semester-II			
1	C-MMB-04 Microbial genetics (Theory and practical)		
2	C-MMB-05 Molecular biology (Theory+Practical)		
3	C-MMB-06 Medical Microbiology (Theory+practical)		
4		SEC-MMB-02 Microbial techniques and instrumentation	
5			DSE-MMB-02 Biostatistics and research methodology(theory)
Semester-III			
1	C-MMB-08 Industrial Microbiology (Theory+Practical)		
2	C-MMB-09 Immunology (Theory+Practical)		

3	C-MMB-10 Recombinant DNA Technology (Theory+practical)			
4		SEC-MMB-03 Biochemistry (Theory)		
5			DSE-MMB-03 (theory and Practical) Pharmaceutical Microbiology/ OR	DSE-MMB-04(theory and Practical) Soil Microbiology
Semester-IV				
1	C-MMB-11 Environmental Microbiology (Theory and practical)			
2			DSE-MMB-05 Microbial biotechnology(theory)/ OR	DSE-MMB-06 Enzyme technology (theory)
3			DSE-MMB-07 Applied Microbiology (theory)	
4		SEC-MMB-04 Dissertation		

M.Sc Microbiology

Scheme of examination

Semester I								
Paper	**Subject**	**Paper Code**	**Theory Examination**		**Practical Examination**		**Total Marks**	**Credits**
			Univ. Exam.	**Int. Assessment**	**Univ. Exam.**	**Int. Assessment**		
1	General microbiology		60	40	30	20	150	**4 + 2**
2	Food microbiology		60	40	30	20	150	**4 + 2**
3	Agricultural microbiology		60	40	30	20	150	**4+ 2**
4	Introduction to bioinformatics		60	40	30	20	150	**4 + 2**
5	Bio ethics and safety		30	20	-	-	50	**2**
	TOTAL		**270**	**180**	**120**	**80**	**650**	**26**
Semester II								
1	Microbial genetics		60	40	30	20	150	**4+ 2**
2	Molecular biology		60	40	30	20	150	**4+ 2**
3	Medical Microbiology		60	40	30	20	150	**4+2**
4	Biostatistics and research methodology		60	40	-	-	100	**4**
5	Microbial techniques and instrumentation		60	40	-	-	100	**4**
	TOTAL		**300**	**200**	**90**	**60**	**650**	**26**
Semester III								
1	Industrial Microbiology		60	40	30	20	150	**4+ 2**
2	Immunology		60	40	30	20	150	**4+ 2**
3	Recombinant DNA Technology and biotechnology		60	40	30	20	150	**4+2**
4	Pharmaceutical Microbiology/OR		90	60	-	-	150	**6**
	Soil Microbiology		90	60	-	-	150	**6**
5	Biochemistry		60	40	-	-	100	**4**

	TOTAL		**330**	**220**	**90**	**60**	**700**	**28**
Semester IV								
1	Environmental microbiology		60	40	30	20	150	**4+2**
2	Applied Microbiology		60	40	-	-	100	**4**
3	Microbial biotechnology/ OR Enzyme technology		60	40	-	-	100	**4**
4	Dissertation		-	-	90	60	150	**6**
	TOTAL		**180**	**120**	**120**	**80**	**500**	**20**

Marks Scheme(CBCS)

Semester-I					
S. No.	**Course Code**	**Course Title**	**Hrs/week**	**Total Marks**	**Credit**
1.	C-MMB-01	General microbiology	4	100	4
		Practical	4	50	2
2.	C-MMB-02	Food microbiology	4	100	4
		Practical	4	50	2
3.	C-MMB-03	Agricultural microbiology	4	100	4
		Practical	4	50	2
4	DSE-MMB-001	Introduction to bioinformatics	4	100	4
		Practical	4	50	2
5.	SEC-MMB-01	Bio ethics and safety	2	50	2
		Total	**34**	**650**	**26**

Semester-II					
S. No.	**Course Code**	**Course Title**	**Hrs/week**	**Total Marks**	**Credit**
1.	C-MMB-04	Microbial genetics (Theory)	4	100	4
		Practical	4	50	2
2.	C-MMB-05	Molecular biology (Theory)	4	100	4
		Practical	4	50	2
3.	C-MMB-06	Medical Microbiology (Theory)	4	100	4
		Practical	4	50	2
5	DSE-MMB-02	Biostatistics and research methodology	4	100	4
6	SEC-MMB-02	Microbial techniques and instrumentation	4	100	4
		Total	**32**	**650**	**26**

Semester-III					
S. No.	**Course Code**	**Course Title**	**Hrs/week**	**Total Marks**	**Credit**
1.	C-MMB-07	Industrial Microbiology	4	100	4
		Practical (self study report and seminar)	4	50	2

2.	C-MMB-08	Immunology	4	100	4
		Practical	4	50	2
3	C-MMB-09	Recombinant DNA Technology and biotechnology	4	100	4
		Practical	4	50	2
4.	DSE-MMB-03 DSE-MMB-04	Pharmaceutical Microbiology/OR Soil Microbiology	6	150	6
5	SEC-MMB-02	Biochemistry	4	100	4
		Total	**36**	**700**	**28**

Semester-IV					
S. No.	**Course Code**	**Course Title**	**Hrs/week**	**Total Marks**	**Credit**
1.	C-MB-10	Environmental microbiology	4	100	4
		Practical (report writing)	4	50	2
2.	DSE-MMB-04	Applied Microbiology	4	100	4
3	DSE-MMB-05 DSE-MMB-06	Microbial biotechnology/ OR Enzyme technology	4	100	4
.4	SEC-MMB-03	Dissertation	12	150	6
		Total	**28**	**500**	**20**

M.Sc. Microbiology

1ST SEMESTER

GENERAL MICROBIOLOGY

S.no	Topic	Domain	Hours
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.	Must to know	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	Must to know	**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.	Desirable to know	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	Must to know	10
5	**Microbial Ecology**: Microbial flora of soil, Interaction among microorganisms in environment. Symbiotic associations, commensalism, mutualism, amensalism. Brief account of biological nitrogen fixation.	Desirable to know	10

1st semester
FOOD MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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).	Must to know	**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.	Must to know	10
3	**Food-borne infections and intoxication:** Bacterial- *Brucella, Bacillus, Clostridium, Escherichia, Listeria;* Food intoxication- *Botulism, Staphylococcal.* Mycotoxins & their types – 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.	Must to know	10
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.	Desirable to know	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.	Nice to know	4
6	**Food and sanitation:** Good Hygiene Practices, Sanitation in manufacture and retail trade; food control agencies and their 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.	Must to know	6

1ST SEMESTER

AGRICULTURAL MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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	Must to know	10
2	Microbial Transformations: Carbon cycle. Biodegradation of soil organic constituents-Degradation of cellulose, hemicelluloses and 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.	Must to know	10
3	**Plant-microbe interactions:** Mutualism, commensalism, parasitism, amensalism, synergism. Rhizosphere microorganisms- phyllosphere, rhizosphere effect, factors influencing rhizosphere microbes. Nodulation and Nitrogen fixation, PGPR,VAM.	Must to know	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	Desirable to know	10
5	**Plant pathology:** Recognition and entry of pathogens into host cells. Alteration of host 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.	Desirable to know	6
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	Must to know	4

	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 and control measures. Integrated pest management.		

1st SEMESTER

INTRODUCTION TO BIOINFORMATICS

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	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 bases.	Must to know	12
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.	Must to know	**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,	Desirable to know	11

1ST SEMESTER

BIOETHICS AND SAFETY

Hours: 30 hours

S.no	Topic	Domain	Hours
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.	Must to know	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	Desirable to know	5
3	An overview of Patent laws in India. Patent Practice & Problems : Review of case law, public & international depositories, patentability of microorganisms,	Must to know	5
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.	Must to know	5
5	Ethics in genetic testing, cloning, GM foods and genetic therapy.	Must to know	5

2ND SEMESTER

MICROBIAL GENETICS

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	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.	Must to know	10
3	Genetic recombination: 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.	Must to know	10
4	Gene transfer mechanisms: Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications.	Desirable to know	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.	Desirable to know	10

2ND SEMESTER

MOLECULAR BIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	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.	Must to know	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).	Must to know	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 and eukaryotes. Post-translational processing of the polypeptide chains; Acylation, methylation, sulfation, phosphorylation and glycosylation	Must to know	12
5	Regulation of Gene Expression: Operon concept, Positive and negative control, lac and trp operon.	Desirable to know	8

2ND SEMESTER

MEDICAL MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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: Nutritional uptake, generation Hours, 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.	Must to know	10
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.	Must to know	10
3	Cultivation and assay of 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.	Desirable to know	10
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	Must to know	10
5	Protozoa & Helminthology Morphology, life cycle, laboratory diagnosis of:Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma,Plasmodium, Toxoplasma, Coccidian parasite. Taenia, Echinococcus, Hymenolepis, Schistosomes, Wuchereria bancrofti	Must to know	10

2ND SEMESTER

MICROBIAL TECHNIQUES AND INSTRUMENTATION

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	15
2	**Measurement of microbial growth:** Direct microscopic count, standard plate count, membrane filtration, MPN, Indirect method: turbidity, metabolic activity and dry weight. Automated microbial identification system.	Must to know	**12**
3	**Spectrophotometry:** Principle and applications of spectrophotometer- UV/visible, fluorescence. **Spectroscopy:** Principle and applications ,Mass spectroscopy	Must to know	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.	Desirable to know	11

SEMESTER 3

INDUSTRIAL MICROBIOLOGY

Hours: 50 hours

S.no	Topic		Hours
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.	Must to know	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.	Must to know	10
3	Fermentors: Basic features, design & components – Typical fermentor. Sterilization of fermentor, medium, air supply. Fermentation media: sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors and inducers. Specialized bioreactors (Photobioreactors)	Must to know	10
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.	Nice to know	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.	Desirable to know	10

3RD SEMESTER

IMMUNOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	10
2	Antigen and antibodies: Types, structure and properties of antigens, haptens; adjuvant - antigen specificity. Immunoglobulins – structure, types and subtypes, properties, primary and secondary responses, Antibody diversity. Complement system – Structure, components, properties and functions, complement fixation and complement pathways, biological consequences. Inflammation- effector mechanisms.	Must to know	10
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.	Must to know	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. Symptoms and Immunological methods of diagnosis of hypersensitive reactions. Lymphokines and cytokines	Desirable to know	10
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.	Desirable to know	6
6	Immunization: Common immunization practice, types of vaccines and its application. Edible vaccines. Production of Polyclonal and monoclonal antibodies; antibody engineering. Plantibodies.	Must to know	4

3RD SEMESTER

RECOMBINANT DNA TECHNOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	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.	Must to know	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.	Must to know	15
4	Application of RDT: Production of regulatory proteins (Interferon, Interleukins), vaccines (Hepatitis-B), hormones (insulin, somatostatin).	Desirable to know	11

SEMESTER 3

BIOCHEMISTRY

Hours: 50 hours

S.no	Topic	Domain	Hours
1	Carbohydrates: Structure and function, classification: mono-, di- and polysaccharides, glycoproteins. Metabolism of carbohydrates- Glycolysis, Citric acid cycle, Gluconeogenesis and Pentose phosphate pathways and	Must to know	12

	their 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.	Must to know	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.	Must to know	12
4	Water: Structure, hydrogen bond,ionization of water, pH, osmosis,osmolarity, Henderson-Hasselbalch equation. Nucleic Acids: Structure and properties of nucleic acid bases, nucleosides and nucleotides. Biosynthesis and regulation of purines and pyrimidines.	Nice to know	11

3rd SEMESTER

PHARMACEUTICAL MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	12
2	Mechanism of action of antibiotics (inhibitors of cell 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.	Must to know	12

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 clinical trials.	Desirable to know	15
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.	Nice to know	11

SEMESTER 3

SOIL MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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 climate change on distribution of soil biota	Must to know	10
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.	Must to know	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.	Must to know	12
4	Microbial Control and Bioinoculants: Microorganisms involved in biological control of plant diseases. Biocontrol agents and mechanisms of disease	Desirable to know	10

	suppression. Plant growth promoting rhizobacteria. Production and use of microbial inoculants. Mycoherbicides.		
5	Biological indicators of soil health. Biodegradation of pesticides. Role of microorganisms in sustainable agriculture and organic farming.	Nice to know	6

SEMESTER 4

ENVIRONMENTAL MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
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.	Must to know	15
2	Microbiology of Wastewater and Solid Waste Treatment: Waste types-solid and liquid 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.	Must to know	12
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.	Desirable to know	12
4	Bio-fuels and Bio-mining: Bioethanol and future fuels-hydrogen, biodiesel. Biomining-Microbial leaching of low grade ores.	Must to know	11

SEMESTER 4

MICROBIAL BIOTECHNOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
1	Introduction: Principle, applications, economics and milestones in microbial technology	Must to know	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	Must to know	15
3	Microbial enzymes:. Immobilized enzymes and cells: Techniques and types of immobilization, industrial applications of immobilization: merits and demerits. Enzymes in - starch processing, food, textile, detergent, leather, breweries, pharmaceuticals, therapeutics, and diagnostics.	Must to know	15
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.	Desirable to know	10

SEMESTER 4

ENZYME TECHNOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
1	Classification of 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	Must to know	12
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.	Must to know	15
3	Enzyme Technology: Large scale production of enzymes: glucose isomerase, amylase, Uses of isolated enzymes in food and chemical industries, Therapeutic & medicinal use of enzymes.	Desirable to know	12
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.	Nice to know	11

SEMESTER 4

APPLIED MICROBIOLOGY

Hours: 50 hours

S.no	Topic	Domain	Hours
1	Airspora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping air borne microorganisms.	Must to know	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.	Must to know	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, meat and meat products, Fish and sea foods- poultry spoilage of canned foods.	Desirable to know	12
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	Must to know	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	Must to know	4
6	Concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, Green revolution.	Desirable to know	4