BSc. Microbiology

SEMESTER 1

INTRODUCTION TO MICROBIAL WORLD

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**(a).**Development of microbiology as a discipline, Spontaneous generation *vs.* biogenesis, development of various microbiological techniques, concept of fermentation **(b)**.Establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following scientists : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty. **(c).** Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. **(d).** Differences between prokaryotic and eukaryotic microorganisms. Morphology of acellular microorganisms (Viruses, Viroids,	**(a).** Demonstrate the basic concept of microbiology as a subject, how it developed, techniques used **(b).** Enumerate basic idea of medical microbiology, immunology and environmental microbiology, role of important scientists and their discoveries **(c).** Enumerate the taxonomical classification	**(a).** To cover general introductory concepts in microbiology **(b).** To cover the main idea behind development of specialised field in microbiology and role of scientists involved **(c).** To cover both 5 kingdom and 3 kingdom classification	**(a).** didactic, Student interactive session **(b).** group discussion, didactic **(c).** Teachers seminar, group discussion	**(a).** 3 hours **(b).** 5 hours **(c).** 5 hours

	Prions) and cellular microorganisms (Bacteria, Algae, Fungi and Protozoa).	**(d).** Reproduce distinguishing features between prokaryotic and eukaryotic cells. Define acellular and cellular microbes with examples	**(d).** To make them extinguish between different cell types, define acelllar and cellular microbes with proper examples	**(d).** Student interactive session, didactic	**(d).** 7 hours
2	**(a).** Brief introduction to eubacteria, archaebacteria (extremophiles).	**(a).**Demonstrate general characteristics of bacteria with specific examples	**(a).** Explain characteristics of bacteria belonging to eubacteria, chlamydiae, rickettsiae, mycoplasma and archaebacteria	**(a).** Didactic, teachers seminar	**(a).** 3 hours
	(b). General characteristics and structure of the following: TMV, T4 and □□phage, lytic and lysogenic cycles.	**(b).**Enumerate salient features of TMV, T4 and lambda phage,lytic and lysogenic cycles	**(b).** To cover important viruses and bacteriphages	**(b).** Didactic, group discussion	**(b).** 5 hours
	(c). History of phycology. General characteristics of algae including occurrence, thallus organization, pigments, flagella, and vegetative, asexual and sexual reproduction.	**(c).** Demonstrate history of phycology, salient features of algae and life cycles	**(c).** To cover historical aspects of phycology as a subject, general features of algae, different life cycles of algae	**(c).** Student interactive session, didactic	**(c).** 7 hours
	(d). Historical developments in the field of mycology 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.	**(d).** Reproduce and explain history of mycology, salient features of fungi and life cycles	**(d).** To cover historical aspects of mycology as a subject, general features of fungi, different life cycles of fungi	**(d).** Teachers seminar, didactic, group discussion	**(d).** 8 hours

	(e). General characteristics of protozoa - *Amoeba, Paramecium and Giardia*	**(e).** Enumerate general features of protozoa with specific examples	**(e).** To cover in detail – amoeba, paramecium, giardia	**(e).** Student interactive session, didactic	**(e).** 5 hours

SEMESTER 1

MYCOLOGY AND PHYCOLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**(a).** General classification and economic importance of fungi with examples in agriculture, environment, industry, medicine, food, bioremediation (of wood, paper, textile, leather), mycotoxins	**(a).** Reproduce and explain classification of fungi along with its importance across different fields	**(a).**To cover basic points of fungi, its classes and applications in detail	**(a).** didactic, student interactive session	**(a).**7 hours
	(b). Life cycle, structure and occurrence – Cellular slime molds , True slime mold	**(b).**Demonstrate the life cycle of slime molds and its occurrence pattern	**(b).**To cover fungi classes-slime molds life cycle and occurrence and the different types	**(b).** Didactic, group discusion	**(b).**5 hours
	(c). Oomycetes, Chytridiomycetes , Zygomycetes	**(c).** Enumerate the life cycle of Oomycetes, Chytridiomycetes , Zygomycetes and its occurrence pattern	**(c).** To cover fungi classes-Oomycetes, Chytridiomycetes , Zygomycetes life cycle and occurence **(d).** To cover fungi	**(c).** didactic, student interactive session	**(c).** 6 hours

	(d). Ascomycetes, Basidiomycetes , Deuteromycetes	**(d).** Enumerate the life cycle of Ascomycetes, Basidiomycetes , Deuteromycetes and its occurrence pattern	classes- Ascomycetes, Basidiomycetes , Deuteromycetes life cycle and occurence	**(d).** Group discussion, problem based learning	**(d).**6 hours
2	**(a).** General classification and economic importance of algae with examples in agriculture, environment, industry and food **(b).** Life cycle, thallus organisation and occurrence - Chlorophyceae ,Charophyceae **(c).**Diatoms , Xanthophyceae **(d).** Phaeophyceae Rhodophyceae: Cyanobacteria	**(a).**Reproduce and explain algae classification in detail with examples of uses in various fields **(b).**Enumerate in detail thallus org and occurrence - Chlorophyceae ,Charophyceae **(c).** Enumerate in detail thallus org and occurrence - Diatoms , Xanthophyceae **(d).** Demonstrate in detail thallus org and occurrence - Phaeophyceae Rhodophyceae: Cyanobacteria	**(a).**To cover algae classess in detail with focus on uses in agriculture, environment, food and industry **(b).**To cover Chlorophyceae ,Charophyceae in detail- structure, life cycle and occurence **(c).** To cover Diatoms , Xanthophyceae in detail- structure, life cycle and occurence **(d).** To cover in detail- Phaeophyceae Rhodophyceae: Cyanobacteria structure, life cycle and occurence	**(a)** didactic, student interactive session **(b).** didactic, group discussion **(c).** Group discussion, student interactive session **(d).** Didactic, problem based learning	**(a).** 8 hours **(b).**10 hours **(c).**8 hours **(d).**10 hours

SEMESTER 1

CHEMISTRY

Time: 45 hours

S.no (Theory 1)	**Topic**	**Learning objective(At the end of the session student should be able to)**	**Teaching guidelines**	**Methodology**	**Time**
1	**(a).** Bohr's theory and its limitations, dual behaviour of matter and radiation, de-	**(a)** Understand quantization of energy and determine electronic	**(a).** To discuss dual behaviour of matter, de Broglie's equation	**(a).** Group discussion, Student interactive session	**(a). 4 hrs**

	Broglie's relation, Heisenberg Uncertainty principle. , Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. **(b).** Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. **(c).** VB Approach Shapes of some inorganic molecules, VSEPR and hybridization. Hydrogen bonding. **(d).** properties of s, p, d, block elements in periodic table	configurations of atoms and ions. **(b).** Explain the types of chemical bonding- ionic, covalent and ionic character in covalent bonds and determine the energetics of bond formation by using Born-Haber's cycle. **(c).** determine the shapes of different molecules with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements. **(d).** differentiate the characteristic physical and chemical properties of s, p and d block elements.	and rules to fill up electrons in an atom, in detail. **(b).** Explain chemical bonding in atoms and molecules and discuss the concept of polarizing power and polarizability to explain Fajan's rule. **(c).** To teach by explaining more practical learning with theoretical knowledge **(d).** to cover general trends and all the properties of s, p and d block elements down the group and across the period in detail.	**(b).** group discussion, problem solving method **(c).** student interactive session and problem based learning. **(d).** Teacher's seminar	**(b).** **4 hrs** **(c).** **3 hrs** **(d).** **3hrs**

2	**(a).**Introduction of acid, bases, Ionization of weak acids and bases in aqueous solution, ionic product of water, Strong, moderate and weak electrolytes, degree of ionization (**b**). pH scale, common ion effect, Buffer solutions. Solubility and solubility product of sparingly soluble salts -applications of solubility product principle. **(c).** Rate, order and molecularity of a reaction, rate constants of first and second order reactions, half -life period. **(d).** influence of temperature on reaction rate, activation energy, determination of order of a reaction.	**(a).**Explain degree of ionization and the differences between strong, moderate and weak electrolytes **(b).** Understand acidic and basic character on the basis of pH scale and apply the concept of solubility product in quantitative analysis. **(c).** Determine the rate and order of a reaction and differentiate between order and molecularity of a reaction. **(d).**Describe how the temperature and activation energy is related in determining the rate and order of a chemical reaction.	**(a).** discuss the types of electrolytes on the basis of their extent of dissociation and practice more problems. **(b).** To cover pH and solubility product by doing examples of their applications. **(c).** To cover general introductory concepts in kinetics that includes rate, molecularity, order and half -life period of a reaction. **(d**). To cover Arrhenius equation and explain the relation of rate of a reaction with temperature	**(a**). problem base learning. **(b).** students interaction session. **(c).** group discussion and problem based learning. **(d).** student interaction session.	**(a).** **2 hrs** **(b).** **1 hr** **(c).** **2 hrs** **(d).** **2 hrs**
3.	**(a).** Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis. Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance). Structure	**(a).** Explain bonding and electron effects and reactive intermediates	**(a).** To cover more about reactive intermediates and and electronic effects	**(a).** Group discussion, Student interactive session	**(a).** 3 hours

	and stability of reactive intermediates (carbocations, carbanions and free radicals). **(b)**. Relative strength of carboxylic acids (aliphatic, aromatic and halo-substituted aliphatic), alcohols, phenols and nitro-phenols. Relative basic strength of amines (aliphatic and aromatic). **(c).** Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). **(d).** Threo and erythro; D and L; *cis* - *trans* nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).	**(b).** Demonstrate examples of acidity and basicity fectors **(c).**Demonstration of isomers and isomerism factors **(d).** Naming of organic compounds and optical activity study of organic compounds	**(b).** To teach more by example method and explanation of general trends and exception as well **(c).** To cover isomerism by doing examples and some aspects of isomerism **(d).** To teach by explaining more practical learning with theoretical knowledge	**(b).** group discussion, problem solving method **(c).** Seminar,Assignment, group discussion **(d).** Student interactive session	**(b).** 3 hours **(c).** 3 hours **(d).** 3 hours
4.	**(a).** Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose **(b).** Mutarotation, ascending and descending in monosaccharides. Structure of	**(a).**Demonstrate general characteristics of carbohydrates and sugars with specific examples **(b).**Enumerate salient features of sacchrides	**(a).** Explain characteristics of sacchrides belonging to all categories **(b).** To cover important monosacchrides	**(a).** Student interactive session, teachers seminar **(b).** group discussion	**(a).** 3 hours **(b).** 3 hours

	disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation. **(c).**Classification, and General Properties of amino acids, *Preparation of Amino Acids:* Strecker synthesis, using Gabriel's phthalimide 20 synthesis. Zwitter ion, Isoelectric point and Electrophoresis. ninhydrin test **(d).** Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins. Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme).	**(c).** Demonstrate details & salient features of amino acids and properties **(d).** Study of peptides and synthesis and degradation techniques of peptides	and polysacchrides **(c).** To cover general features of amino acids **(d).** To cover peptides and synthesis and degradation techniques of peptides	**(c).** Student interactive session **(d).** Teachers seminar, group discussion	**(c).** 3 hours **(d).** 3 hours

SUBJECT: COMMUNICATION SKILL AND PERSONALITY DEVELOPMENT

1st Semester

S.no	Contents	Learning objectives (At the end of session the student should be able to)	Teaching Guidelines (To Cover)	Methodology	Time

1.	**Introduction:** Communication ,Types of communication ,principles of Communication, Barriers in Communication	**At the end** of the session students will understand the basic concept of communication, its need in current scenario & how communication is important for a doctor or a medical person.	Very Brief Description of communication & its importance. How to overcome from barriers to communication? Effect & side effect of communication. Kinds of communication, process of communication, channel of communication. Cross culture and organizational communication	, Student interactive session class topic presentation, group presentation & picture & cue cards reading.	10hr
		At the end of the session students will have clear concept of different kinds & the uses of communication. And methods & strategies or effective communication.	Enumerate and explain Physical Methods of Communication Uses of technical devices in modern communication	Oral explanation using Student interactive session Self notes & important notes from syllabus covered books. Tutorials	10hr
2.	**Review of Grammar:** Types of Sentence, Parts of Speech in brief, Transformation and Synthesis of Sentences, Verb and Tense Forms, Voice. Direct & Indirect speech. Phonetics	**At the end** of the session students will have basic knowledge of. Sentence & its kind. Parts of speech & their uses for correct writing. Change the sentences from one form to another. Verbs & their uses for correct tense. Change the sentences from direct to indirect Phonetics	Explain very briefly about all kinds of sentences Enumerated Parts of Speech briefly. Explain very briefly Simple compound & complex sentences Describe the verbs, present, past & perfect participle. Enumerated tense & its kind. Explain very briefly Active & passive voice. Enumerated direct & indirect speech with its changing methodology from one sentence to another. Explain very briefly the phonetic mode of language & importance in current	Oral explanation using Student interactive session . Tutorials Group Discussion Class exercise Hard & soft copy practice. Student's class presentation. Individual & group presentation.	10hr

			scenario.		
3.	**Vocabulary:** Medical Terminology , Idioms and Phrases, Common Errors, Use of Dictionary for Learning to Pronounce, **Word Formation** : by adding Prefixes & Suffixes	**At the end** of the session students will have basic knowledge of medical terminology. Sentence formation by Idioms and Phrases Correction of the sentences. Use of Dictionary for language learning & proper understanding of their pronounce. Word formation & vocabulary building by Prefix & Suffix.	Explain very briefly about all medical terminology & its kind & uses. Enumerated Idioms and Phrases, Explain very briefly Simple compound & complex sentences & their correction. Describe the verbs, present, past & perfect participle with an appropriate use. Enumerated tense & its kind. Enumerated prefix &suffix with its changing methodology from one sentence to another.	Oral explanation using Student interactive session Class Lectures Tutorials Written practices. (Hard & soft) Group Discussion Class exercise Hard & soft copy practice. Student's class presentation. Individual & group presentation.	10hr
4.	**Spoken English:** Audience Psychology & Presentation Skills Using Non-verbal Communication Interview techniques Discussion Debate Telephonic Conversation	**At the end** of the session students will be able to understand different audience psychology. They will understand presentation skills & art of best presentation to present during conference (National & International). Certain exercises for verbal & non-verbal communication & its importance in medical education. Interview & its need in modern professionalism, its kind & how to attend an interview? Group discussion & its need in modern hospital scenario.	What is psychology? Need of psychology. Importance & methodology of verbal & non-verbal communication in medical. Communication important for doctors. Interview strategies & their need in modern scenario. Difference b/w GD and Debate. Need of telephonic communication. Its kind, importance & necessary for doctors.	Oral explanation & Student interactive session class topic presentation, group presentation & picture & cue cards reading. Class GD & debate , Class interview activities & student's individual presentation. Class telephonic communication & interview activities.	20hr

		Debate and its need What is telephonic communication? How is this important in current medical & other hospital field?			
5.	**Writing Skills:** Précis Writing, Letter Writing, C V Writing, Listening, Reading, Comprehension (Exercise of prescribed short answers) Preparation of Report, Note Taking Note Making	**At the end** of the session students will be able to understand written communication & its importance in current scenario. To understand different forms of written communication : Précis, Letter, CV writing & Resume writing. Report writing & its need in current medical scenario. Need of note making & note taking.	**Briefly** cover the following topics: How to write a letter & a good précis? Need of good writing skills for a doctor & nursing staff. Improve reading & listening skills. Short paragraph & note making. Prepare good hospital note Patient's communication. Dialogue b/w a patient, a doctor and a nursing staff.	Oral explanation by: Student interactive session Class Lectures, Certain written exercises. Application, letter ,précis, cv & other forms of Written communication Practices. (Hard & soft) Group Discussion Class exercise class, Individual & group presentation. A dialogue b/w faculty and students related to hospital communication & routine working activities.	20hr

2nd Semester

BACTERIOLOGY

Time: 50 hours

S.no (Theory 2)	**Topic**	**Learning objective(At the**	**Teaching guidelines**	**Methodology**	**Time**

		end of the session student should be able to)			
1	**(a).** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. 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. **(b).** Effect of antibiotics and enzymes on the cell wall. Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids and endospore: structure, formation, stages of sporulation. **(c).** 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 **(d).** Sterilization and Disinfection: Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of	**(a).** Demonstrate the concept of bacterial cell components for both gram positive and gram negative and archaea bacteria in detail **(b).**Reproduce and explain the chemical structure of bacterial cell wall and membranes, Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids and endospore **(c).**Demonstrate concepts of bacterial nutrition in detail, all types of media used in microbiology **(d).**Reproduce and explain all concepts of	**(a).**To explain cell size, arrangement and cell components of gram positive, gram negative and archaea bacteria **(b).** To explain the bacterial cell wall and cell membrane in detail with special focus on structure, function and chemical composition. Features of Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids and endospore **(c).** To cover all concepts of bacterial nutrition and requirements, culture media used for bacterial growth **(d).**To discuss techniques used	**(a).** Didactic, students seminar **(b).** Didactic, group discussion **(c).** Student interactive session, didactic	**(a).** 5 hours **(b).**5 hours **(c).** 8 hours

	microbial control: disinfectants, types and mode of action **(e).** Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate	sterilization and disinfection- different methods in detail, types and mode of action **(e).**Enumerate bacterial reproduction and growth patterns- generation time and specific growth rate	in microbiology lab regarding sterilization and disinfection, methodology and types in detail **(e).** Discuss asexual method of reproduction in bacteria, explain growth rate concepts in detail	**(d).** Group discussion, teachers seminar **(e).** Student interactive session, didactic	**(d).** 8 hours **(e).** 4 hours
2	(a). Archeae: General characteristics, phylogenetic overview. Methanogens- *Methanobacterium.* Thermophiles- *Thermococcus, Pyrococcus*. Halophiles- *Halobacterium, Halococcus* (b). Eubacteria: Morphology, pathogenesis and economic importance of following groups - Gram negative: Chlamydiae, Spirochetes, Rickettsia, Rhizobium, Agrobacterium, Neisseria, Enterobactericeae	(a).Enumerate salient features and phylogeny of archaea bacteria in detail- halogens, methanogens (b).Demonstrate fully the morphology, pathogenesis of all important groups belonging to gram negative bacteria in detail (c). Enumerate the morphology, pathogenesis of all important groups belonging to gram	**(a).**Discuss general characters of archae bacteria along with phylogeny- focus on specific groups (b).To cover gram negative bacteria and discuss important groups under it focussing on morphology, pathogenesis and economic importance	**(a).** Student interactive session, didactic (b). Student seminar, didactic	(a). 5 hours (b). 5 hours

	family, Pseudomnas, Vibrio, Salmonella, Haemophilus, Helicobacter, Camplylobacter (c). Eubacteria Gram positive: Staphylococcus, Streptococcus, Mycoplasma, Clostridium, Lactobacillus, Bacillus, Corynebacterium, Mycobacterium, Listeria, Actinomyces, (d). Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; An overview of scope of Microbiology	positive bacteria in detail (d).Demonstrate all isolation techniques of bacteriology, storage and preservation, culture methods, overview of scope of microbiology as a subject	(c). To cover gram positive bacteria and discuss important groups under it focussing on morphology, pathogenesis and economic importance (d).To cover all methods in isolation, culture, storage and preservation of bacteria in detail. Overview on scope of microbiology	(c). Student interactive session, didactic (d). Group discussion, teachers seminar	(c). 5 hours (d). 5 hours

SEMESTER 2

VIROLOGY

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**(a).** History of viruses, definition of viruses, general properties of viruses, viroids, virusoids, satellite viruses and prions. Classification and	**(a).**Reproduce and explain virus-general feature, viriods, types with examples. Classification system in detail	**(a).**To cover salient feature of viruses, virions, prions in detail along with detailed classification of	**(a).** didactic, teachers seminar	**(a).** 7 hours

	nomenclature of viruses **(b).** Capsid symmetry, enveloped and non-enveloped viruses. TMV, T4 phage, Hepatitis B virus, Picornavirus, rhabdovirus, Hepatitis B, retrovirus, influenza virus. **(c).** Isolation, cultivation of viruses **(d).** Applications of virology	 **(b).**Demonstrate structure of viruses, detail study of specific virus with examples **(c).**Enumerate virus isolation and culture methods in detail **(d).**Enumerate use of virus across various fields	viruses, pathogenesis of viruses in detail **(b).**To cover the structural aspect of virus anatomy, example virus in detail **(c).**To cover the process of isolation, purification and cultivation of virus with proper diagrams **(d).**To cover virus applications in detail	 **(b).** didactic, student interactive session **(c).** Group discussion, didactic **(d).** Didactic, problem based learning	 **(b).** 10 hours **(c).** 6 hours **(d).** 4 hours
2	**(a).** Definition, structure and cycle of T4 and lambda phage, **(b).** Viral multiplication Types of oncogenic DNA and RNA viruses. Concepts of oncogenes, proto oncogenes**,** tumor suppressor genes. **(c).** Transmission, prevention and control of viral diseases: Persistent and non-persistent mode. Antiviral compounds, interferons and viral vaccines.	**(a).**Demonstrate concept of bacteriophages in detail with focus on t4 and lambda phage **(b).**Enumerate virus replication process, cellular interactions and concept of oncogenes, proto oncogenes**,** tumor suppressor genes in detail **(c).** Demonstrate viral disease – prevention and control, antiviral compounds in detail with examples	**(a).**To cover all concepts of bacteriophages in detail **(b).**To discuss viral replication, concept of oncogenes as a whole concept. **(c).** To cover viral disease concept in detail, antiviral compounds, interferons and vaccines used	**(a).** Oral explanation with power point presentation **(b).** Oral explanation with power point presentation, didactic **(c).** didactic, student interactive session	**(a).** 10 hours **(b).** 9 hours **(c).** 4 hours

SEMESTER 2

CELL BIOLOGY

Time: 50 hours

S.no (Theory 2)	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**(a).** Prokaryotic and eukaryotic cells, cell size and shape, molecules of cell, cell membranes and cell proteins.	**(a).** Enumerate basic cell structure of prokaryotes and eukaryotes	**(a).** To discuss about cell components of prokaryotes and eukaryotes	**(a).** Didactic, Student interactive session,	**(a).** 4 hours
	(b). Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, transport across nuclear envelope,	**(b).** Demonstrate structure of the nucleus in detail with diagrammatic representation	**(b).**To cover the nuclear envelope, pore and nucleus in general	**(b).** Group discussion, students seminar	**(b).** 4 hours
	(c). Chromatin: molecular organization, nucleolus and rRNA processing	**(c).**Reproduce the overview of cell organisation focussing on chromatin and rRNA processing	**(c).**To cover chromatin organisation and rRNA processing in detail	**(c).** Teachers seminar, didactic	**(c).** 5 hours
	(d). The endoplasmic reticulum, golgi apparatus, lysosomes, mitochondria, chloroplast, peroxisomes	**(d).**Demonstrate in detail the cell organelles with diagramatic definitions	**(d).**To cover all features of cell organelles, their structure and function with diagrams	**(d).** Group discussion, tutorials	**(d).** 3 hours
2	**(a).** Structure and organization of actin filaments; actin, myosin and cell movement;	**(a).** Enumerate the overall process of cell movement in detail	**(a).** To cover actin filaments, cell movement and microtubules	**(a).** Oral explanation with power point presentation	**(a).** 5 hours

	intermediate filaments; microtubules **(b).** Mechanism of vesicular transport. **(c).** The plasma membrane structure; Transport of small molecules, Endocytosis **(d).** Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions	 **(b).**Demonstrate cellular activity i.e vesicular transport across membranes **(c).**Enumerate structure and function of plasma membrane, transport system, and endocytosis mechanism **(d).** Demonstrate cell wall of bacteria and eukaryotes, and cell to cell interactions in detail	 **(b).**To cover the process of transport of specific molecules across cell membrane **(c).**To cover functions of plasma membrane, endocytsis method in detail **(d).**To discuss cell wall in detail- bacteria and eukaryotes, cell interactions	 **(b).** didactic, student interactive session **(c).** Didactic, Problem based learning **(d).** Group discussion, Teachers seminar	 **(b).** 3 hours **(c).** 3 hours **(d).** 2 hours
3	**(a).** Tools and Techniques of cell biology: Microscopic- Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy; Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy. **(b).** Analytical- Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis	**(a).**Demonstrate all techniques in microscopy, types of microscopes in detail **(b).**Reproduce and explain techniques involved in flow cytometry in detail	**(a).**To cover methods in microscopy and all types of microscopes **(b).**To cover all aspects of analytical flow cytometry, its applications	**(a).** didactic, student interactive session **(b).** didactic, problem based learning	**(a).**4 hours **(b).**3 hours

	(c). Separation-Sub-cellular fractionation-differential and density gradient centrifugation; Chromatography-paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).	**(c).**Demonstrate the process of centrifugation, chromatography-types and methodology in detail	**(c).** To cover in detail the process of centrifugation, chromatography and focus on its types and methods	**(c).** didactic, student interactive session	**(c).** 2 hours
4	**(a).** Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.	**(a).**Enumerate cell signalling pathways and molecules involved in the process	**(a).**To cover cell signal molecules and pathways involved in detail along with cell surface receptors	**(a).** Group discussion, student interactive session	**(a).** 2 hours
	(b). Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization.	**(b).**Reproduce and explain cell cycle mechanism in eukaryotes-mitosi, meiosis and fertilisation	**(b).**To discuss all aspects of cell cycle in eukaryotes in detail	**(b).** didactic, problem based learning	**(b).** 3 hours
	(c). Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning	**(c).**Enumerate cell death, renewal and cloning process in detail	**(c).**To cover cell death process, maintainence, embryonic cells and cloning therapeutics	**(c).** Didactic, student seminar	**(c).** 4 hours
	(d). Cancer and mutation: Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment-molecular approach. Mutation, types of	**(d).**Demonstrate concepts of cancer, genes involved, treatment, mutation and its types	**(d).**To cover the topic of cancer-genes, causes, treatment. Mutation and types	**(d).** Didactic, teachers seminar	**(d).** 3 hours

	mutation.				

SEMESTER 2

SUBJECT: ENVIRONMENTAL SCIENCE

S.No	Contents	Learning Objectives (at the end of the course, the student shall be able to)	Teaching Guidelines	Teaching Methodology	Time
1	**Multidisciplinary Nature of Environmental Studies** **Natural Resource**	Know the true nature of Environment	Emphasis should be on holistic approach the environment	, Seminars and Audio-visuals	15
2	**Ecosystems** **Biodiversity and its Conservation**	Learn about the inter-relationships of living and non-living matrices	To make students understand the life and life phenomena	, Seminars and Audio-visuals	15
3	**Environmental Pollution**	Students will have scientific knowledge about chemistry of pollution, its abatement and treatment technologies	Pollution should be taught in a scientific way rather than a generalized way	Seminars and Audio-visuals	15
4	**Social Issues and the Environment** **Human Population and the Environment**	Understand the social impact on environment and vice-versa	Impacts of social issues on should be dealt gravely in form of socio-economic as well as environmental aspect	Student interactive session Seminars and Audio-visuals	15

SEMESTER 3

MICROBIAL ECOLOGY

TIME: 50 HOURS

S.no (Theory 1)	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	(a). Microorganisms habitat and their role in biogeochemical cycles and succession pattern	(a). Reproduce and explain *Terrestrial Environment*: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats	(a). To cover Terrestrial Environment and Aquatic Environment in detail	(a) didactic, problem based learning	(a).5 hours
	(b). Atmosphere: Stratification of the Atmosphere, Aeromicroflora, 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.	(b).Demonstrate habitats and atmosphere in detail, Animal Environment Extreme Habitats	(b).To cover habitats and atmosphere in detail, Animal Environment Extreme Habitats- Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity	(b). didactic, student interactive session	(b).7 hours
	(c). *Carbon cycle, Nitrogen cycle* Ammonification, nitrification, denitrification & nitrate reduction. *Phosphorous cycle*: Phosphate immobilization and phosphate	(c).Enumerate Carbon cycle Nitrogen cycle		(c). didactic, student	

	solubilization. *Sulphur Cycle* Microbes involved in sulphur cycle. (d). Succession of microbial communities in the decomposition of plant organic matter	Phosphorous cycle Sulphur Cycle in detail (d).Enumerate succession methods in microbes with examples	(c).To cover Carbon cycle Nitrogen cycle Phosphorous cycle Sulphur Cycle along with examples (d).To cover Succession of microbial communities in the decomposition of plant organic matter	interactive session, group discussion (d).didactic, group discussion	(c).8 hours (d).6 hours
2	(a). Microbe–Microbe Interactions (b). Microbe–Plant Interactions (c). Microbe–Animal Interactions	(a). Demonstrate Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents (b).Reproduce and explain Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic-biofertilizers) (c).Enumerate role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont	(a).To cover in detail-Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents (b).To cover Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic-biofertilizers) (c).To cover role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont in detail	(a). didactic, problem based learning (b). didactic, student interactive session, group discussion (c). Student seminar, didactic	(a). 7 hours (b). 10 hours (c).7 hours

SEMESTER 3

MOLECULAR BIOLOGY I

TIME: 50 HOURS

S.no (Theory 2)	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	(a). DNA as the carrier of genetic information, key experiments establishing-The Central Dogma, DNA	(a). Demonstrate DNA structure in detail, and protein synthesis	(a). To cover all aspects of DNA along with protein synthesis	(a) didactic, student interactive session	(a)7 hours

	Double helix, Genetic code, Direction of Protein Synthesis, Genomics. DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, salient features of double helix (b). Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. (c). RNA Structure, Organelle DNA - mitochondria and chloroplast DNA. Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome (d). Chromatin structure- Euchromatin, Heterochromatin-	(b)Enumerate DNA- types, topology, organisation of DNA, viruses (c).Enumerate in detail - RNA Structure, Organelle DNA - mitochondria and chloroplast DNA. Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome in detail manner (d).Reproduce and explain chromatin in detail	process with schematic representations (b). To cover Types of genetic material, denaturation and renaturation, cot curves. DNA topology (c).To discuss RNA and organelles in detail and Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome (d). To cover the entire concept of chromatin in detail	(b). didactic, student seminar (c). didactic, problem based learning (d). Group discussion and didactic	(b). 8 hours (c).8 hours (d). 4 hours
2	(a). Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming (b). Various models of DNA replication	(a). Enumerate DNA synthesis and replication in detail (b).Demonstrate DNA replication	(a).To cover DNA synthesis and replication in detail along with diagrams (b).To cover DNA replication models in a detailed	(a). Didactic, teachers seminar, student interactive session (b). Group discussion and	(a).8 hours (b).8 hours

	including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. (c). Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins. Replication Errors, DNA Damage and their repair.	models in a detailed structure with examples (c).Reproduce all enzymes involved in DNA replication along with accessory proteins involved. DNA Damage and their repair	structure with examples (c).To cover enzymes involved in DNA replication along with accessory proteins involved. DNA Damage and their repair	didactic (c). didactic, student interactive session	 (c).7 hours

SEMESTER 3
MICROBIAL PHYSIOLOGY AND METABOLISM I

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	**(a).** Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve **(b)** Measurement of cell numbers, cell mass and metabolic activity. Temperature -temperature ranges for microbial growth, classification based on temperature ranges and adaptations **(c).** pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure	**(a).** Enumerate growth kinetics in detail, types of culture- batch and continous, growth curve in detail **(b).**Demonstrate the concept of cell mass and measurement and temperature ranges in growth, classification **(c)** Reproduce and explain effect of pH and adaption methods, water activity, oxygen concentration along with pressure and	**(a).**To cover the concept of growth of microbes, culture types and growth curve in detail with schematic representation **(b).**To cover details of cell mass and measurement, temperature ranges **(c).**To discuss effect of pH, water activity, oxygen concentration along with pressure and radiation in detail	**(a).** didactic, student interactive session **(b).** Group discussion, problem based learning **(c).** didactic, student interactive session	**(a).** 10 hours **(b).**8 hours **(c).**7 hours

		radiation			
2	(a). Diffusion - Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron (b). Chemolithotrophic metabolism- Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogen oxidizing bacteria and methanogens. (c). Phototrophic metabolism - Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, (d). physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Carbondioxide fixation: Calvin cycle and reductive TCA cycle.	(a). Demonstrate the concept of diffusion, translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron in detail (b).Enumerate in detail the concept of Chemolithotrophic metabolism with examples (c). Reproduce and explain in detail the concept of Phototrophic metabolism with examples along with examples of pigments and absorption spectrum (d). Enumerate in detail light reactions, cyclic and non-cyclic photophosphorylation, Calvin cycle and reductive TCA cycle.	(a). To discuss diffusion, active and secondary active transport, Group translocation and transport across membranes (b).To discuss Chemolithotrophic metabolism along with the Physiological groups involving Hydrogen oxidizing bacteria and methanogens (c). To discuss Phototrophic metabolism along diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments (d).to discuss light reactions, cyclic and non-cyclic photophosphorylation, Calvin cycle and reductive TCA cycle in detail in flowchart form	(a). didactic, student seminar (b). Group discussion, didactic (c). didactic, student interactive session (d).didactic, teachers seminar	(a).8hours (b). 6 hours (c).6hours (d).5 hours

SEMESTER 3

SUBJECT: FUNDAMENTALS OF COMPUTER SCIENCE

Sr No	Topic	Learning Objectives	Teaching Guidelines	Methodology	Time
1.	**To describe the various Characteristics**	What are computers, Application areas, Characteristics & limitations Evolution of computers,	Introduction about computers To study its various characteristics Applications and its limitations Classification of computer on basis	Discussion, Student interactive session , Exercises followed with	7

		Classification & generations of computers, Data representation in computer memory (numbering systems). Computers Architecture /Organization: Basic architecture, Functional Block diagram, Types of computers, Performance parameters	of Purpose, signal and size and portability. Evolution of computer from 1st generation to fourth generation. Some description about fifth generation. Functional Block Diagram of computer.	discussion	
2	**Word Processing Software**	Basic knowledge of Word Processing Software. To study Various functions of MS Word: Alignments, Bookmarks, Hyperlink, Cross Reference, Header, Footer etc.	To study about MS Word processing software. Alignments,hyperlink,watermark,bookmarks,etc	Lecture Discussion, Student interactive session , Exercises followed with discussion and practicals performed by students	8
3	**To study the various components of a system in detail.**	Input & output devices. External Interfaces (Ports) & Concept of Device Drivers, Memory Devices.	To study the various input devices used :Keyboard,mouse,OMR,OCR,MICR,BCR,Scanner etc.	Student interactive session Discussion, PowerPoint presentation, Exercises followed with discussion	3
4	**CPU structure**	CPU their generations and performance parameters Primary (Main) Memories (RAM, ROM, Types of RAM and ROM Cache Memory, Register, Storage Evaluation Criteria, Memory Capacity)	To study the internal structure of CPU: Registers, ALU, Motherboard, HD, Memory, Cache, and Virtual Memory.	Student interactive session Discussion, PowerPoint presentation, Exercises followed with discussion	9
5	**Secondary storage Devices**	Secondary Storage Devices: (Magnetic Disk, Floppy and Hard Disk, USBs, Optical Disks CD-ROMs). To study the MS PowerPoint.	TO study the various Secondary storage devices: Magnetic Disk, Optical Disk, Flash memory To cover how to make PowerPoint presentation ,Use transition effects,videos,audios,custom animation etc.	Discussion, Student interactive session , Exercises followed with discussion and practicals performed by students.	1

6	**Output devices**	Various types of output devices	To cover what are Monitor, Its types, Printer: Dot matrix, Daisy wheel. Line printer, Laser printer, Thermal Printer, Ink Jet printers etc.	Discussion, Student interactive session , Exercises followed with discussion	3
7	**Softwares,Types**	System Software (Machine Level Languages, Operating Systems, Device Specific Drivers)	TO cover the types of Software, Languages and their types (High level and low level language.)	Discussion, Student interactive session , Exercises followed with discussion	1
8	**Opearating system**	Operating System: Booting/Start up Procedure of machines, Introduction to Operating System Functions and Classification of Operating Systems. Basic introduction to DOSUNIX/LINUX OS, and Windows TO study HTML and Basic Tags of HTML	To cover the definition of operating system, its types and what are the various functions and types of operating system. Basic introduction about Interfaces: its types character user and graphical user interface (DOS and Windows) Basic introduction about linux,Unix operating system To study the various HTML tags(Bold tags,Italic,Underline,Marquee,Img, anchor)	Discussion, Student interactive session , Exercises followed with discussion	25
9	**Types of Network and Topologies of networks**	Data Communication, Network devices and networks	Network devices (Hub, Switches, Modems, Routers etc), LAN, LAN topologies, WAN, MAN, Internet: Introduction,Internet ,extranet and Intranet	Discussion, Student interactive session , Exercises followed with discussion	4
10	**Basics of internet**	Basics of E-mail, Web browsers Structure of Universal Resource Locator, Domains ,IP address, Backbone network, Network connecting devices, HTTP,DNS, Network Security and Search Engine.	Basics of E-mail, Web browsers (IE, Google Chrome, Mozilla), Structure of Universal Resource Locator, Domains (.com, .in, .country specific, .org and rationale behind them), IP address, Backbone network, Network connecting devices, HTTP	Discussion, Student interactive session , Exercises followed with discussion	20

		TO study Spreadsheet Software	DNS, Network Security and Search Engine. TO cover the various MS Excel Formulas and preparation of spreadsheets.		

SEMESTER 4
GENETICS AND GENOMICS I

TIME: 50 HOURS

S.no (Theory 1)	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time

1	(a). Mendel's work on transmission of traits, genetic variation, molecular basis of genetic information. Interrelation between the cell structure and the genetics function. Mitosis, Meiosis (explaining Mendel's ratios). (b). Principles of Inheritance, Chromosome theory of inheritance, Pedigree analysis, Incomplete dominance and codominance. Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance (c). Linkage and crossing over, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.	(a).Enumerate Mendel's introduction to genetic concepts in detail (b).Demonstrate principles of Inheritance, Chromosome theory of inheritance, Pedigree analysis, Incomplete dominance and codominance. Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked (c).Enumerate concepts of Linkage and crossing over, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.	(a).To cover Mendel's work on transmission of traits, genetic variation, molecular basis of genetic information. Interrelation between the cell structure and the genetics function. Mitosis, Meiosis (explaining Mendel's ratios). (b).To cover principles of Inheritance, Chromosome theory of inheritance, Pedigree analysis, Incomplete dominance and codominance. Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked in detail (c).To cover in detail Linkage and crossing over, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.	(a). didactic, student interactive session, group discussion (b). Oral explanation along with power point presentation, didactic, group discussion (c). didactic, student interactive session, group discussion	(a).10 hours (b). 10 hours (c).8 hours
2	(a). Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, (b). Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method	(a). Enumerate concepts of : Chromosomal Mutations, Gene mutations- Induced versus Spontaneous mutations, Back versus Suppressor mutations (b).Demonstrate molecular basis of Mutations in relation to UV light and chemical mutagens,	(a).To cover concepts of Chromosomal Mutations, Gene mutations- Induced versus Spontaneous mutations, Back versus Suppressor mutations in detail (b).To cover Molecular basis of Mutations in relation to UV light and chemical mutagens,	(a). didactic, problem based learning	(a).9 hours

		Detection of mutations: CLB method, Attached X method (c).Enumerate concepts of : DNA repair mechanisms. Chromosomal mechanisms, Environmental factors effecting sex determination, Barr bodies, Dosage compensation	Detection of mutations: CLB method, Attached X method in detail (c).To cover DNA repair mechanisms. Chromosomal mechanisms, Environmental factors effecting sex determination, Barr bodies, Dosage compensation in detail with diagram representation	(b). didactic, group discussion and problem based learning (c). didactic, student interactive session	(b). 7 hours (c).6 hours

SEMESTER 4
PLANT PATHOLOGY

Time: 50 hours

S.no (Theory 3)	**Topic**	**Learning objective(At the end of the session student should be able to)**	**Teaching guidelines**	**Methodology**	**Time**
3	(a). Microbial Pathogenicity (b).Genetics of Plant Diseases	(a). Demonstrate in detail- 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). (b). Enumerate concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.	(a).To cover virulence factors of pathogens in detail- replicase, coat protein, silencing suppressors in disease development (b). To cover Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance in detail	(a). teachers seminar, group discussion (b). didactic, student interactive session	(a).10 hours (b).10 hours

4	(a). Concept of plant disease- microbial plant diseases -, types of plant pathogens, pathogenicity, symptoms, economic losses. Principles & practices involved in the management of plant diseases by different methods., diseases.	(a). Reproduce definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens in detail	(a).To cover definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens in detail	(a). didactic, student interactive session, group discussion	(a).8 hours
	(b). Important diseases caused by fungi	(b).Demonstrate fungal diseases: *Albugo candida* *Erysiphe graminis* *Peronospora destructor* *Puccinia graminis tritici* *Claviceps purpurea* *Ustilago nuda* *Phytophthora infestans* *Fusarium oxysporum f.sp. lycopersici* *Colletotrichum falcatum* *Alternaria solani*	(b).To cover fungal diseases: *Albugo candida* *Erysiphe graminis* *Peronospora destructor* *Puccinia graminis tritici* *Claviceps purpurea* *Ustilago nuda* *Phytophthora infestans* *Fusarium oxysporum f.sp. lycopersici* *Colletotrichum falcatum* *Alternaria solani*	(b). Oral explanation along with power point presentation, student seminar, group discusion	(b).8 hours
	(c). Important diseases caused by phytopathogenic bacteria and phytoplasmas	(c).Enumerate diseases by phytopathogenic bacteria and phytoplasmas- Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus Aster yellow, citrus stubborn	(c).To cover diseases by phytopathogenic bacteria and phytoplasmas- Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus,Aster yellow, citrus stubborn in detail with examples	(c). didactic, student interactive session, problem based learning	(c).7 hours
	(d). Important diseases caused by viruses & viroids	(d). Reproduce and explain diseases by virus and viriods:Potato spindle tuber, coconut cadang cadang,Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro	(d).To cover diseases by virus and viriods:Potato spindle tuber, coconut cadang cadang,Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro	(d). didactic, student seminar	(d). 7 hours

SEMESTER 4
MOLECULAR BIOLOGY II

Time: 50 hours

S.no (Theory 2)	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	(a). Mechanism of Transcription (Prokaryotes and Eukaryotes) - RNA Polymerase and the transcription unit,	(a)Demonstrate Transcription (Prokaryotes and Eukaryotes) with proper diagrammatic representation	(a).To cover and discuss Transcription (Prokaryotes and Eukaryotes) with proper diagrammatic representation	(a). Problem based learning and didactic, student seminar	(a).9 hours
	(b). Translation (Prokaryotes and Eukaryotes) Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases.	(b). Enumerate Translation (Prokaryotes and Eukaryotes) with proper diagrammatic representation	(b).To cover Translation (Prokaryotes and Eukaryotes) with proper diagrammatic representation	(b). didactic, student interactive session	(b). 10 hours
	(c).Proteins involved in initiation, elongation and termination of polypeptides. Inhibitors of protein synthesis	(c).Reproduce and explain Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis in detail	(c).To cover Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis	(c). didactic, teachers seminar	(c).6 hours
2	(a). Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons.	(a). Demonstrate Transcription Regulation in Prokaryotes with examples from *lac* and *trp* operons	(a). To cover transcription Regulation in Prokaryotes with examples from *lac* and *trp* operons	(a). Oral explanation along with power point presentation and didactic	(a). 9 hours
	(b).Eukaryotes: Conserved mechanism of regulation,	(b). Enumerate Conserved	(b).To cover Conserved mechanism of regulation,	(b). Problem	(b). 10 hours

	Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing	mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing in detail	Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing	based learning, student interactive session	
	(c). Regulation of translation: translation-dependent regulation of mRNA and Protein Stability. Regulatory RNAs: Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation	(c).Demonstrate regulation of translation: translation-dependent regulation of mRNA and Protein Stability. Regulatory RNAs: Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation	(c).To cover Regulation of translation: translation-dependent regulation of mRNA and Protein Stability. Regulatory RNAs: Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation in detail	(c). didactic, student interactive session, group discussion	(c).6 hours

SEMESTER 4

MICROBIAL PHYSIOLOGY AND METABOLISM II

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	(a). Enzymes:Importance, structure and classification of enzymes. Apoenzyme and cofactors. Prosthetic group, coenzyme and metal cofactors. Active site and its salient features. Mechanism of enzyme	(a).Demonstrate enzyme structure, classification Apoenzyme and cofactors. Prosthetic group, coenzyme and metal cofactors. Active site and its salient features. Mechanism of enzyme	(a). To cover enzyme concept in general, active site and salient features, mechyanism of enzyme action	(a). Student seminar, group discussion, didactic	(a) 7 hours

	action (b). Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, Michaelis-Menten kinetics, Lineweaver-Burke plot. (c). Effect of pH and temperature on enzyme activity. Enzyme unit, specific activity, turnover number. Irreversible and reversible inhibition: competitive and non-competitive inhibition. (d). Enzyme regulation. Synthesis: introduction of enzyme induction and repression. Activity: allostery, covalent modification and feedback inhibition. Multienzyme: pyruvate. dehydrogenase complex, isozymes: lactate dehydrogenase	action in detail (b).Enumerate Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, enzyme kinetics in general (c).Demonstrate in general concept of - Effect of pH and temperature on enzyme activity. Enzyme unit, specific activity, turnover number. Irreversible and reversible inhibition: competitive and non-competitive inhibition. (d). Reproduce and explain enzyme regulation in detail with focus on Activity: allostery, covalent modification and feedback inhibition. Multienzyme: pyruvate. dehydrogenase complex, isozymes: lactate dehydrogenase	(b). To cover topics of Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, Michaelis-Menten kinetics, Lineweaver-Burke plot. (c).To discuss effect of pH and temperature on enzyme activity. Enzyme unit, specific activity, turnover number. Irreversible and reversible inhibition: competitive and non-competitive inhibition with diagrams (d).To cover synthesis: introduction of enzyme induction and repression. Activity: allostery, covalent modification and feedback inhibition. Multienzyme: pyruvate. dehydrogenase complex, isozymes: lactate dehydrogenase	(b). Didactic, problem based learning (c). didactic, group discussion (d). didactic, student interactive session	(b). 7 hours (c). 8 hours (d). 8 hours
2	(a). Concept of aerobic respiration, anaerobic respiration and fermentation. Central metabolic pathways: EMP pathway, ED pathway, PP pathway, and TCA cycle (b). Anaplerotic reactions, gluconeogenesis, glyoxylate cycle. Mitochondrial and bacterial electron transport. Oxidation-reduction potential and energetic of electron transport. Components of respiratory chain, and their inhibitors.	(a).Enumerate biochemical cycles: Concept of aerobic respiration, anaerobic respiration and fermentation. Central metabolic pathways (b). Reproduce and explain anaplerotic reactions, gluconeogenesis, glyoxylate cycle. Mitochondrial and bacterial electron transport. Oxidation-reduction potential and energetic of electron transport. Components of respiratory chain, and their	(a). to discuss and elaborate on biochemical cycles: Concept of aerobic respiration, anaerobic respiration and fermentation and pathways (b).To cover Anaplerotic reactions, gluconeogenesis, glyoxylate cycle. Mitochondrial and bacterial electron transport. Oxidation-reduction potential and energetic of electron transport. Components of respiratory chain, and	(a). didactic, student seminar, group discussion (b). problem based learning, teachers seminar	(a).5 hours (b).5 hours

		inhibitors in detail	their inhibitors in detail		
	(c). Anaerobic respiration, denitrification, nitrate/nitrite respiration. Oxidative phosphorylation: ATP synthesis and ATP synthase. Uncouplers, inhibitors and ionophores. Chemical coupling, conformational coupling and chemiosmotic hypotheses	(c).Demonstrate Anaerobic respiration, denitrification, nitrate/nitrite respiration. Oxidative phosphorylation: ATP synthesis and ATP synthase, coupling and uncoupling concept.	(c).To cover Anaerobic respiration, denitrification, nitrate/nitrite respiration. Oxidative phosphorylation: ATP synthesis and ATP synthase, coupling and uncoupling concept in details with diagrammatic representation	(c). didactic, group discussion	(c).4 hours
	(d). Fermentations: alcohol fermentation, Pasteur effect, lactate and butyrate fermentation, Fermentation balances, branched versus linear fermentation pathways.	(d).Enumerate fermentation in detail with specific examples	(d).To cover concept of fermentation and various types with examples	(d). didactic, student interactive session	(d).3 hours
	(e). Nitrogen Fixation - Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. Nitrogen fixers and mechanism of nitrogen fixation, properties of nitrogenase, and ammonia	(e).Enumerate Nitrogen Fixation - Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. Nitrogen fixers and mechanism of nitrogen fixation, properties of nitrogenase, and ammonia	(e). To cover concept of Nitrogen Fixation - Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, Nitrogen fixers and mechanism properties of nitrogenase, and ammonia	(e). didactic, student seminar, group discussion	(e). 3 hours

SEMESTER 5
GENETICS AND GENOMICS II

Time: 50 hours

S.no	Topic	Learning objective(At the end of the session student should be able to)	Teaching guidelines	Methodology	Time
1	(a). Conjugation; Transformation; Transduction, Recombination.	(a). Reproduce concept of Conjugation; Transformation; Transduction, Recombination	(a).To cover Conjugation; Transformation; Transduction, Recombination with diagrams	(a). student seminar, teachers seminar	(a).10 hours

	(b). Prokaryotic transposable elements- IS elements, Composite transposons, Uses of transposons	(b).Enumerate Prokaryotic transposable elements- IS elements, Composite transposons, Uses of transposons with proper examples	(b).To cover Prokaryotic transposable elements- IS elements, Composite transposons, Uses of transposons in detail	(b). didactic, problem based learning	(b).10 hours
	(c). Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment	(c).Reproduce and explain Human genome project; Evolution and Comparative Genomics. Bioinformatics, Gene and protein databases; Sequence similarity and alignment in detail	(c).To discuss concept of human genome project and evolutionary genetics in detail	(c). didactic, problem based learning	(c).10 hours
2	(a). Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and systembiology	(a). Demonstrate all concepts of Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and systembiology	(a).To cover concepts of Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and systembiology in detail manner	(a). didactic, student seminar, group discussion	(a).10 hours
	(b). Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation	(b).Enumerate Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation in detail	(b).To cover and discuss Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation in detail with examples	(b). didactic, student interactive session group discussion	(b). 10 hours

SEMESTER 5
IMMUNOLOGY

Time: 50 hours

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

		student should be able to)			
1	(a). History of immunology (b). Introduction to immune cells and organs (c).Antigens and antibodies	(a). Reproduce 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 . (b).Enumerate concept of Innate and Adaptive immunity; 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 (c). Demonstrate characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.	(a).To cover contributions of Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa (b).To cover to immune cells and organs in detail with diagrams (c).To cover concepts of - Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants Structure, Types, Functions and Properties of antibodies; Antigenic determinants on	(a). didactic, student interactive session (b). didactic, student interactive session, group discussion (c).didactic, teacher seminar, problem based learning	(a). 9 hours (b). 10 hours (c).9 hours

			antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.		
2	(a). Major histocompatibility complex (b). Complement system, immune response (c).Immunologica-l disorders	(a).Enumerate Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways) (b). Reproduce and explain concept of Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation. 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 (c). Demonstrate types of autoimmunity and hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens. (d). Enumerate principles of Precipitation, Agglutination,	(a). To cover MHC concept and systemin detail (b). To cover Complement systemand immune response in detail with diagrams (c).To cover Immunologica-l disorders- focus on specific examples (d).To cover all techniques used in immunologica assays with diagrams and examples	(a). didactic, student seminar, group discussion (b). didactic, problem based learning (c). didactic, student interactive session, student seminar	(a). 7 hours (b). 5 hours (c).5 hours

	(d).Immunologica-l techniques	Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR		(d). didactic, teacher seminar, group discussion	(d). 5 hours

SEMESTER 5

FOOD AND DAIRY 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	(a). Food as a substrate (b). food preservation	(a). Reproduce in detail Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora (b).Enumerate 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 (c).Demonstrate Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned	(a).To cover Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora in detail (b). To cover 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 in detail (c).To cover Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods in detail	(a) didactic, problem based learning (b). group discussion, student seminar, didactic	(a). 6 hours (b). 9 hours

	(c). Microbial spoilage (d). fermented foods	Foods. (d).Enumerate concepts of 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.	manner (d).To cover 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.	(c). didactic, student interactive session (d). didactic, group discussion, student seminar	(c).5 hours (d). 10 hours
2	(a). Food borne diseases (b). Food sanitation and water potability	(a).Enumerate 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* (b).Demonstrate concepts of Treatment and safety of drinking (potable) water, methods to detect potability of water samples: standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms ; Membrane filter technique and; Presence/absence tests in detail	(a).To cover 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* (b).To cover Treatment and safety of drinking (potable) water, methods to detect potability of water samples: standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms; Membrane filter technique and ; Presence/absence tests	(a). student seminar, group discussion (b) didactic, student interactive session	(a). 10 hours (b). 10 hours

SEMESTER 5
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	(a). Introduction to biotechnology (b). Basic DNA cloning	(a). Enumerate milestones in genetic engineering and biotechnology (b).Explain Simple cloning of DNA fragments, Vectors: Definition and properties. *E. coli* expression vectors- lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors. Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation in detail	(a). To cover milestones in genetic engineering and biotechnology in detail (b).To cover Simple cloning of DNA fragments, Vectors: Definition and properties. *E. coli* expression vectors- lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors. Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation	(a). didactic, student interactive session, student seminar (b). didactic, teacher seminar, group discussion	(a). 10 hours (b). 14 hours
2	(a). Tools of recombinant DNA technology- Hosts	(a).Demonstrate in detail *Agrobacterium*-mediated delivery *E. coli* strains; Yeast (*Saccharomyces cerevisiae, Pichia pastoris*); Fungi (*Penicillium, Aspergillus*); Mammalian cell lines - names and genotypes.	(a). To cover concepts- *Agrobacterium*-mediated delivery *E. coli* strains; Yeast (*Saccharomyces cerevisiae, Pichia pastoris*); Fungi (*Penicillium, Aspergillus*); Mammalian cell lines - names and genotypes.	(a). didactic, student interactive session, group discussion	(a). 9 hours

	(b). Tools of recombinant DNA technology-enzymes	(b).Reproduce in detail - Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease (c).Enumerate Cloning Vectors- Definition and	(b).To cover Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease (c).To cover concepts- Cloning Vectors- Definition and Properties. Plasmid vectors- pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs. *Mammalian Expression Vectors*- SV40, Vaccinia, Retroviral promoter based vectors. (c). To cover Cloning Vectors- Definition and Properties. Plasmid vectors-pBR and	(b). didactic, problem based learning	(b).10 hours

	(c). Vectors	Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs. *Mammalian Expression Vectors*-SV40, Vaccinia, Retroviral promoter based vectors.	pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs. *Mammalian Expression Vectors*-SV40, Vaccinia, Retroviral promoter based vectors.	(c). Teachers seminar, didactic, student interactive session	(c).7 hours

SEMESTER 6
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	(a). Microflora of human body	(a).Reproduce and explain microflora of Skin, throat, gastrointestinal tract, urogenital tract.	(a). to cover in detail microflora of Skin, throat, gastrointestinal tract, urogenital tract.	(a). didactic, student interactive session, student seminar	(a). 8 hours
	(b). Host pathogen interaction	(b).Enumerate definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection	(b). To cover Definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection in detail	(b). didactic, student interactive session**,** problem based learning	(b). 8 hours
	(c). Sample processing	(c).Demonstrate concepts of collection, transport and culturing of clinical samples	(c).To cover Collection, transport and culturing of clinical samples	(c). didactic, group discussion	(c). 6 hours
	(d). Diagnostic tools,	(d)Demonstrate principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). Mechanism of action of	(d). To cover principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes). Mechanism of action of important chemotherapeutic agents. Principles of	(d). didactic, student interactive session, student seminar	(d). 8 hours

	antimicrobial agents	important chemotherapeutic agents. Principles of drug resistance in bacteria.	drug resistance in bacteria.		
2	(a). Bacterial Diseases	(a).Enumerate in detail: *Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi, Shigella dysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponema pallidum*	(a). To cover *Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and paratyphi, Shigella dysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberculosis, Treponema pallidum*	(a). didactic, student interactive session, group discussion	(a). 7 hours
	(b). Protozoan diseases	(b)Enumerate in detail Malaria, Kala-azar, and Toxoplasmosis	(b).To cover Malaria, Kala-azar, and Toxoplasmosis	(b). group discussion, teacher seminar	(b). 3 hours
	(c).Viral diseases	(c).Reproduce in detail Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description of bird and swine flu, Dengue, AIDS, Viral cancers. An overview of emerging viral diseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura, Chikungunya.	(c).To cover Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description of bird and swine flu, Dengue, AIDS, Viral cancers. An overview of emerging viral diseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura, Chikungunya with references	(c). group discussion, didactic, student seminar	(c).7 hours
	(d).Fungal diseases	(d).Demonstrate different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses	(d). To cover Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses in detail	(d). didactic, student interactive session	(d).3 hours

SEMESTER 6
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	(a). Introduction, fermentation and fermentors (b). Overview of industrial fermentation-measurement of parameters, isolation of strains, media and ingredients	(a). Enumerate concepts- Brief history and developments in industrial microbiology. Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations. Components of a typical bioreactor, types of bioreactors- Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. (b).Demonstrate pH, temperature, dissolved oxygen, foaming and aeration. Primary and secondary screening, strain development, preservation and maintenance of industrial strains. Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.	(a). To cover Brief history and developments in industrial microbiology. Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations. Components of a typical bioreactor, types of bioreactors- Laboratory, pilot-scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. (b).To cover and discuss - pH, temperature, dissolved oxygen, foaming and aeration. Primary and secondary screening, strain development, preservation and maintenance of industrial strains. Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.	(a). didactic, student seminar, group discussion (b) didactic, problem based learning, group discussion	(a). 10 hours (b). 14 hours
2	(a). Downstream processing	(a).Enumerate Filtration, centrifugation, cell disruption, solvent	(a).To cover Filtration, centrifugation, cell disruption, solvent	(a). didactic, student interactive session, problem	(a). 13 hours

		extraction, precipitation and ultrafiltration, lyophilization, spray drying	extraction, precipitation and ultrafiltration, lyophilization, spray drying	based learning (b) didactic, group discussion, student seminar	
	(b). Microbial production of industrial products	(b).Reproduce and explain citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations	(b).To cover Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations in detail		(b).13 hours

SEMESTER 6
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	(a). Gene delivery	(a). Demonstrate Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium*-mediated delivery in detail	(a).To cover Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium*-mediated delivery	(a). didactic, student interactive session	(a).8 hours
	(b). Amplification of nucleic acids	(b).Reproduce in detail Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction	(b)To cover Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction in detail	(b). didactic, teachers seminar, group discussion	(b).8 hours
	(c). Analytical methods	(c).Enumerate Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony	(c).To cover Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations.	(c). didactic, student interactive session, problem based learning	(c).8 hours

	(d). DNA typing	hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays in detail (d).Enumerate DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display with diagrams	Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays (d).To discuss concepts in - DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display with diagrams	(d). Oral explanation with power point presentation, didactic, group discussion	(d).5 hours
2	(a). Construction of genomic libraries (b). DNA sequencing (c). Product of DNA technology	(a). Demonstrate in detail- Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR (b).Enumerate Maxam-Gilbert's and Sanger's method. Automated sequencing (c).Enumerate Human genome sequencing project. Human protein replacements- insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal	(a).To cover Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR along with diagrams (b)To cover Maxam-Gilbert's and Sanger's method. Automated sequencing in detail (c).To cover Human genome sequencing project. Human protein replacements- insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal in detail	(a). didactic, student interactive session (b). didactic, student seminar, group discussion (c). didactic, student interactive session, problem based learning	(a).8 hours (b). 6 hours (c).7 hours

SEMESTER 6

SUBJECT: RESEARCH METHODOLOGY AND BIOSTATISTICS

S.No	Contents	Learning objectives (At the end of session the	Teaching Guidelines	Methodology	Time

		student should be able to)	**(To cover**		
1	**Introduction** Meaning, definition, and characteristics of statistics	To understand the basic concept of statistics.	• Importance of the study of statistics • Branches of statistics • Statistics and health science including nursing • Parameters and estimates • Descriptive and inferential statistics • Variables and their types • Measurement scales	Student interactive session	**10**
2	**Tabulation of Data**	Be able to summarize data and present it using tables and graphs.	• Raw data, the array, frequency distribution • Basic principles of graphical representation Types of diagrams - histograms, frequency polygons, smooth frequency polygon, cumulative frequency curve, Normal probability curve	Student interactive session through Power point presentation	**10**
3	**Measures of Central Tendency**	Understand the meaning, uses applications, practical approach and guidelines for the use of various measures of central tendency.	• Definition and calculation of mean for ungrouped and grouped data • Meaning, interpretation and calculation of median ungrouped and grouped data • Meaning and calculation of mode • Comparison of the mean, and mode • Guidelines for the use of various measures of central tendency	Student interactive session by using slides and discuss case studies with examples	**15**
4	**Measures of Variability**	• Understand the meaning of standard deviation . • Differentiate between sample and population variance and standard deviation.	• Introduction: Uses, applications and practical approach • The range, the average deviation or mean deviation • The variance and standard deviation • Calculation of variance and standard deviation for ungrouped and grouped data • Properties and uses of variance and standard deviation	Student interactive session with Power point presentation and Exercises followed with examples	**15**
5	**Sampling Techniques**	• Define the basic sampling methods and how to use sampling methods to	• Introduction: Uses, applications and practical approach • Criteria for good samples • Application of sampling in	Student interactive session with Power	**10**

		choose data.	Community • Sampling Methods, Sampling and Non-sampling errors • Sampling variation and tests of significance	point presentation and Exercises followed with examples	