SCHOOL OF ENVIRONMENTAL BIOLOGY
CENTRE FOR BIOTECHNOLOGY & MICROBIOLOGY STUDIES,
A.P.S.UNIVERSITY, REWA (M.P.)

B.Sc. (Hon's) Microbiology

PROGRAMME OUTCOME

PO#	PROGRAMME OUTCOME
PO1	Bachelor course in Microbiology offers the basic concepts of microbiology, pathology, histological aspects, growth , metabolism and their physiology im microbial world and bioinformatics with their environmental applications.
PO2	The main objective of this degree course is to produce graduates with enhanced skills, knowledge and research aptitude to carry out higher studies, entrepreneurship or research and development in the various health, research and industrial areas.
PO3	Develop proficiency in application of current trends of microbial relationship with humans to their environmental interaction. Prepares the students for immediate entry to the workplace with sound theoretical, experimental knowledge in the area of health and pharmaceuticals, biochemicals, biofuel, environment related, food and dairy, cosmetics, biopolymers and related multidisciplinary fields.
PO4	Overall, the course offers basic foundation in microbiology which enables the students to understand the concepts in biochemistry of microbial growth, microbiology in daily life , genetic engineering and related industrial technology.
PO5	Students will be able to design, execute, record and analyse the results of experiments in field of microbiology, genomics, Recombinant DNA technology, biochemistry, microbiology and genetic engineering.
PO6	Students will be able to work effectively in a group in the classroom, laboratory, industries and fieldbased situations.
PO 7	Become efficient in using standard operating procedures and will be well versed with the regulations for safe handling and use of chemicals as well as IPR and biosafety issues related to experiments in field of biochemistry, microbiology and genetic engineering.

(Program Outcomes)

PSOs

(Program Specific Outcomes)

PSO #	**PROGRAMME SPECIFIC OUTCOME**
PSO 1	Critical Thinking- Students will demonstrate an understanding of major concepts in all disciplines of biology, biochemistry, biotechnology microbiology and bioinformatics. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.
PSO 2	Effective Communication- Development of various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively.
PSO 3	Social Interaction- Development of scientific outlook not only with respect to science subjects but also in all aspects related to life
PSO 4	Effective Citizenship- Imbibe moral and social values in personal and social life leading to highly cultured and civilized personality.

Course Outcome (COs)

S.No.	Course Name	Course Code
	Semester-I	
101	Cell Biology and Microbial World	C1
	Course Outcome	
CO1	Develop an understanding of the Cytoskeleton, Microtubules, microfilaments and Cell Membrane.	
CO2	Distinguish between the cellular organization of prokaryotic and eukaryotic cells	
CO3	Would demonstrate a clear understanding of the signal transduction, secondary messengers.	
CO4	Would have deeper understanding of cell at structural and functional level.	
CO5	Would have broad knowledge on the molecular interaction between cells.	
102	**Animal Biodiversity 1**	C2
	Course Outcome	
CO1	To understand diversity in animal kingdom	
CO2	will be able to understand role of protozoa in human and bacterial disease	
CO3	Study of Insects belongs to largest Phyllum Arthropoda and associated diseases.	
CO4	Student will be able to identify the zoological samples belongs to different phyllums.	
CO5	Students will study the habitat and adaptations found in organisms.	
103	**Chemistry -1**	**GEC1**
	Course Outcome	
C01	Students will be informed about atomic structure	
C02	After studying this course students will have better understanding of chemical bonding	
C03	Students will be informed about periodic table and s p d block elements	
C04	Students will be aware about thermodynamics and solid state	
104	**Environmental Studies**	**AECC1**

	Course Outcome	
C01	Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.	
C02	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methonogenic, acetogenic and fermentive bacteria	
C03	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	
C04	Have basic understanding of Enrichment of ores by microorganisms (gold, copper, and Uranium), Environmental significance of Genetically modified microbes, plants and animals.	
C05	Students will be aware from the diversity ratios of natural resources	
	SEMESTER -II	
201	**Bacteriology and Systematic**	C3
	Course Outcome	
C01	Will aware from the classification and taxonomy of bacteriology.	
C02	DNA replication and regulation in prokaryotes and eukaryotes	
C03	Transcription in prokaryotes and eukaryotes, Translation in prokaryotes and eukaryotes	
C04	Post translation and transcriptional mechanism.	
C05	Gene expression in prokaryotes using Lac operon and Trp operon.	
202	**Animal Biodiversity 2**	**C4**
	Course Outcome	
CO1	To understand higher animal kingdom	
CO2	will be able to understand phyllum chordata	
CO3	Study of mammals	
CO4	Student will be able to identify the zoological samples belongs to different phylum.	

CO5	Will be aware from physiology of species.	
203	**Chemistry 2**	**GEC2**
	Course Outcome	
C01	Students will be informed biomolecules	
C02	After studying this course students will have better understanding of carbohydrate lipid protein	
C03	Students will be informed about structure of DNA/RNA	
C04	students will be aware about thermodynamics and solid state	
CO5	students will aware from biomolecules	
204	**English**	**AECC2**
	Course Outcome	
C01	To enhance all the four communication skills in the students-- listening, speaking, reading and writing.	
C02	To familiarize the students with the nature and importance of effective communication skills in their professional life.	
C03	To make the students capable of actively participating in various individual/group communications such as group discussion, debate, meeting, presentation etc.	
C04	To enrich the vocabulary of the students to make them efficient communicators.	
CO5	To strengthen the Grammar of the students.	
	SEMESTER-III	
301	**Advanced Instrumentation: Principle and Application**	**C5**
	Course Outcome	
C01	Concept of electromagnetic radiation, absorption spectrum, Beer's law and Lamberts law, Principle, working and applications of spectrophotometer and AAS	
C02	Concepts of chromatography and concept of partition coefficient	
C03	Principle, methodology and application of various chromatographic techniques	
C04	Centrifugation and Electrophoresis-Principles and applications	
CO5	Importance of radioactivity in biological studies, GM counters and	

	Scintillation counting.	
302	**Basic Biochemistry**	**C6**
	Course Outcome	
C01	Have a strong foundation of basics of botany. Study of physiology of plants.	
C02	The students will get proper knowledge about the media preparation for In-vitro propagation of plants and different aseptic techniques used during preparation.	
C03	The students will learn the role of techniques haploid plant production and its significance.	
C04	The students will learn about the protoplast isolation and somatic hybridization of protoplast and its application.	
C05	The students will learn about the transgenic plants and different strategies to make recombinant and its application.	
303	**Genetic Engineering and Advanced Microbiology**	**GEC3**
	Course Outcome	
C01	Characteristic of Enzymes, enzyme inhibition and kinetics	
C02	Carbohydrate metabolism, significance of glycolysis and ETC, untreated diabetes	
C03	Lipid metabolism and production of ketone bodies	
C04	CO4 Protein metabolism, role of urea cycle and errors of protein metabolism	
C05	Basics Biomolecules and secondary metabolism	
304	**Microbial Diagnostics and Public Health**	**SEC1**
	Course Outcome	
C01	Understand the basics of industrial fermentation technology	
C02	Have knowledge of fermentation medium and sterilization techniques	
C03	Have knowledge of Industrial fermentation process, types of fermentation	
C04	Know the process development, upstream and downstream processing	
C05	Understand the production of Industrial fermented products	
	SEMESTER-IV	
401	**Immunology**	**C7**
	Course Outcome	

C01	Know the history and scope of Immunology.	
C02	Understand the types of Immunity: Passive, Active, Innate and Acquired immunity, Humoral and Cell Mediated Immunity and the cell and organs of immune responses and their functions, B & T cells.	
C03	Have basic knowledge of Antigens as haptens, epitopes and Factors influencing immunogenicity, and Antibodies as their Structure, types, production and functions of immunoglobulins also about Clonal selection theory and Antigen Antibody reactions as Precipitation, Immunoelectrophoresis, Haem-agglutination, RIA and ELISA.	
C04	Comprehend Histocompatibility, structure of MHC class I, II & III antigens and their mode of antigen presentation, MHC restriction Complement system: Components, Classical and alternate pathways of complement activation, Hypersensitivity, Autoimmunity	
C05	Understand Passive and Active immunization, Types of Vaccines: Inactivated, Attenuated, Recombinant and Sub Unit Vaccines, Peptide and DNA Vaccines	

402	**Microbial Physiology and Metabolism**	**C8**
	Course Outcome	
CO1	Study of Basics of microbiology & Basics of Recombination in Prokaryotes	
CO2	General Classification of microbes	
CO3	Basics of Control of Microorganisms	
CO4	Study of bacteriophages and microbes in extreme environments and microbial interactions	
CO5	Know the process development, upstream and downstream processing	
403	**Human Microbial Diseases**	**GEC4**
	Course Outcome	
CO1	Get knowledge about classification of pathogenic microbes, protozoal parasites, and medical bacteriology.	
CO2	Get to know about viral diseases and medical mycology and preventive measures.	
CO3	To understand how blood cell are formed, blood cancer, about brain as well as brain tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue	

	and TB.	
CO4	To understand various therapeutics measures including antibiotics.	
CO5	To get knowledge about medico-legal aspects of medical biotechnology	
404	**Food Fermentation Technology**	**SEC2**
	Course Outcome	
C01	Understand the basics of industrial fermentation technology	
C02	Have knowledge of fermentation medium and sterilization techniques	
C03	Have knowledge of Industrial fermentation process, types of fermentation	
C04	Know the process development, upstream and downstream processing	
CO5	Understand the production of Industrial fermented products	
	SEMESTER -V	
501	**Virology**	**C9**
	Course Outcome	
C01	Students get proper knowledge about the DNA manipulative enzymes: Restriction enzymes and DNA ligases, and Gene cloning vectors.	
C02	learn about screening and selection of recombinant host cells, Gene Libraries, cloning techniques, Expression of cloned DNA	
C03	Learn about the basics of Electrophoretic techniques, Polymerase chain reaction (PCR), Site directed mutagenesis (SDM), Nucleic acid sequencing: Blotting techniques.	
C04	Students will have knowledge of Application of r-DNA technique in human health, Production of Insulin, Production of recombinant vaccines: Hepatitis B, Production of human growth hormone.	
CO5	Will aware from types of viral infection.	
502	**Plant Pathology and Disease Management**	**DSE1**
	Course Outcome	
C01	Have knowledge of the Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of	

	sugar to alcohol Gasohol.	
C02	Comprehend the Structural and Functional dynamics of microbes, their diversity, activity and growth, community profiling their uses as biosensors, bioreporters, Microchips. Also know about Methanogenesis: methonogenic, acetogenic and fermentive bacteria- technical processes and conditions	
C03	Gain insight on Bioremediation and Phytoremediation of soil & water contaminated with oil spills, heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by micro-organisms, Degradation of aromatic and chlorinated hydrocarbons and petroleum products.	
C04	Have knowledge of treatment of municipal waste and Industrial effluents, Biofertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil, algal and fungal biofertilizers (VAM).	
CO5	Will have the knowledge of heavy metals and detergents and use of microbes in degradation of lignin and cellulose using and of pesticides and other toxic chemicals by micro-organisms,	
503	**Microbial Quality Control in Food and Pharmaceutical Industries**	**SEC3**
	Course Outcome	
C01	Students get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells. Have knowledge of Production and Applications of monoclonal antibodies, and Transgenic Animals	
C02	gain knowledge about Primary Culture, cell lines and Secondary Culture, transformed animal cells and continuous cell lines. Monolayer formation, Synchronization.	
C03	learn about transfection of animal cell lines, Selectable makers and Transplantation of Cultural Cells. Microinjection, In vitro fertilization and Stem cell technology.	
CO4	Learn about the product formation and recovery a techniques.	
C05	Learn about the basics of expression of Cloned proteins in animal cell and Production of Vaccines in animal Cells.	
	Field Project & Training-1	

	(Bioprocess Technology)	
	Course outcome	
CO1	Bioprocess technology itself is very important and job oriented branch of Biotechnology. The student will be aware of fermentation and its basics	
CO2	The student will have hands on experience in drug/antibiotic production at industrial level.	
CO3	The student will be able to understand product formation	
.CO4	The student will understand the industrial production of commercial products	
CO5	The student will have hands on experience in amino acid ,enzyme etc production at industrial level.	
	SEMESTER-VI	
601	**Medical and Veterinary Microbiology**	**C10**
	Course Outcome	
C01	Student will learn how a single cell becomes an organized grouping of cells that is then programmed at specific times to become specialized for certain tasks.	
C02	While embryonic development involves a series of highly controlled and coordinated steps, cancer exhibits a lack of cellular control. Understanding the key regulatory pathways behind development may point the way towards therapies designed to modulate disrupted pathways.	
C03	Part of the "nature vs. nurture" paradigm involves non-genetic mechanisms that play a role in switching on and off various genes during development. IRP scientists are at the forefront of research into the importance of chromatin and epigenetics in many aspects of development and disease, including potential uses in gene therapies.	
CO4	Students will learn research into the importance of chromatin and epigenetics in many aspects of development and disease, including potential uses in gene therapies.	
CO5	Understanding the key regulatory pathways behind development may point the way towards therapies designed to modulate disrupted pathways.	
602	**Microbial Enzyme Technology**	**DSE2**
	Course Outcome	

C01	Study of basics of Forensic sciences Human DNA quantitation Miniaturization and automation	
C02	Alternative genetic markers & Compromised DNA evidence	
C03	Mitochondrial DNA and Non-human DNA	
C04	Y-chromosome analysis, Microbial analysis, Sperm detection and separation	
CO5	Students will learn enzyme activity during reaction	
603	**Microbiological Analysis of Air, Water and Soil**	**DSE3**
	Course Outcome	
C01	Get knowledge about classification of pathogenic air microbes, protozoal parasites, and medical bacteriology.	
C02	Get to know about viral diseases and medical mycology and air water and soil	
C03	To understand how blood cell are formed, blood cancer, about brain as well as brain	
C04	tumour. Pathology of AIDS, Japanese encephalitis, yellow fever, dengue and TB.	
CO5	Students will be aware different microbiological Analysis of Air, Water and Soil	
604	**Field Project & Training 2** **(Genomics & Proteomics)**	
	Course Outcome	
C01	This course will consolidate the learning, knowledge and skills in the area of genomics and proteomics that have already taken place as well as developing the capability of the students to undertake and complete an academic research to apply what is learned in theory.	
C02	The course will develop the critical thinking, , problem solving, research and communication skills of the participants.	
C03	They will be able to raise a research question, answer it and write about its	

	findings	
C04	Development of crucial skills among the participants will help them in boosting their employability	
CO5	They will develop the capability of the students to undertake and complete an academic research.	
	SEMESTER-VII	
701	**Microbial Genetics and Molecular Biology**	**C11**
	Course Outcome	
CO1	To describe the different models of enzyme catalysis and the mechanisms for its assessment	
CO2	To explain various methods for identifying active site residues	
CO3	To illustrate the several methods for the enzyme regulation	
CO4	To appreciate the applicability of enzymology in various industries for growth and sustainability	
CO5	To develop skill for analyzing kinetic data of enzyme substrate reaction	
702	**Bioethics & Bio-safety**	**DSE4**
	Course Outcome	
CO1	Students will learn about the basics of ethics related to research.	
CO 2	To evaluate, understand and become aware of the risk factors and ethical issues associated with inbreeding in humans and pre-natal diagnosis of genetic diseases.	
CO3	Students will be informed about the safety measures and levels of laboratory.	
CO4	Students will be aware about the ethical issues and laws associated with laboratory and research	

CO5	Student will also able to know the difficulties level of patients in research	
	Research Methodology	
CO1	To enable to promulgate the understanding of formulating, pursuing and analyzing research benefitting human development	
CO2	To sensitize students regarding the ethics of conducting research by enabling in-depth understanding of plagiarism	
CO3	To impart necessary traits to analyze, compare, logically criticize and evaluate biological data	
CO4	To developing competitive acumen to use modern-age computer programs to analyze and represent research data	
CO 5	To be able to develop and elevate skills of scientific writing to present research interpretations in a form of research paper, presentation, book chapters and short communication	
	Field Project & Training	
CO1	The students will be supervised to go to the fields of their interest and learn the basics of research work	
C03	They will be able to raise a research question, answer it and write about its findings	
C04	Development of crucial skills among the participants will help them in boosting their employability	
	SEMESTER-VIII	
801	**Agriculture, Food and Dairy Microbiology**	**C12**
	Course outcome	
CO1	Importance of agriculture food and dairy products development .	

CO2	Role of microbes in development of products	
CO3	Production of genetic and recombinant vaccines.	
CO4	Production and uses of monoclonal antibodies	
CO5	Basics of gene therapy and research in the area	
	Biostatistics & Bioinformatics	C13
CO1	To expose students to use computational power to evaluate biological information	
CO2	Acquire skills to retrieve information from biological data-bases, analyze it and further remodel protein and genes to create their phylogeny	
CO3	To impart necessary traits to analyze, compare, logically criticize and evaluate biological data	
CO4	To developing competitive acumen to use modern-age computer programs to analyze and represent research dat	
CO5	Will learn different methods to analyze results of research and further remodel to create their phylogeny	
	Research Project	
CO1	students would be able to learn how to design the objectives or experiment.	
CO2:	students would be able to learn the different techniques through experimental design.	
CO 3:	students would be able to analyze the data through statistical software.	
CO 4:	students would be able to gain the knowledge of basic research.	
CO5:	students would be able to think independently in various research areas and design of experiment so that they will absorb in various pharmaceutical industries and research lab in the country and abroad.	

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BSc Microbiology SEM-1st				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C1	Cell Biology and Microbial World	Major	06
2	MB-C2	Plant Diversity-1	Minor	06
3	MB-GEC 1	Chemistry-1	GEC	04
4	MB-AECC 1	Environmental Studies	AECC	04
BSc Microbiology SEM-2nd				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C3	Bacteriology and Systematic	Major	06
2	MB-C4	Plant Diversity-2	Minor	06
3	MB-GEC 2	Chemistry-2	GEC	04
4	MB-AECC 2	English	AECC	04
BSc Microbiology SEM-3rd				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C5	Advanced Instrumentation: Principle and Application	Major	06
2	MB-C6	Basic Biochemistry	Minor	06
3	MB-GEC3	Genetic Engineering and Advanced Microbiology	GEC	04
4	MB-SEC1	Microbial Diagnostics and Public Health	SEC	04
BSc Microbiology SEM-4th				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C7	Immunology	Major	06
2	MB-C8	Microbial Physiology and Metabolism	Minor	06
3	MB-GEC4	Human Microbial Diseases	GEC	04
4	MB-SEC2	Food Fermentation Technology	SEC	04

BSc Microbiology SEM-5th				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C9	Virology	Major	06
2	MB-DSE1	Plant Pathology and Disease Management	DSE	04
3	MB-SEC3	Microbial Quality Control in Food and Pharmaceutical Industries	SEC	04
		Field Project and Training 1(Bioprocess Technology)		06
BSc Microbiology SEM-6th				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C10	Medical and Veterinary Microbiology	Major	06
2	MB-DSE2	Microbial Enzyme Technology	DSE	04
3	MB-DSE3	Microbiological Analysis of Air, Water and Soil	DSE	04
		Field Project and Training 2(Genomics and Proteomics)		06
BSc Microbiology SEM-7th				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C11	Microbial Genetics and Molecular Biology	Major	06
2	MB-DSE4	Bio-safety and IPR	DSE	04
3		Research Methodology		04
		Field Project and Training 3(…….)		06
BSc Microbiology SEM-8th				
S.No.	**Paper Code**	**Paper Name**	**Paper Category**	**Credit**
1	MB-C12	Agriculture, Food and Dairy Microbiology	Major	06
2	MB-C13	Biostatistics and Bioinformatics	Minor	04
3		Research Project		10

Abbreviation:

CC-Core Course (Major/Minor) DSE- Discipline Specific Elective GEC- Generic Elective Course
SEC- Skill Enhancement Course AECC- Ability Enhancement Compulsory Course

Details of the Courses
CORE COURSES (CC)
CC1: Cell Biology and Microbial World
CC2: Plant Diversity-1
CC3:Bacteriology and Systematics
CC4: Plant Diversity-2
CC5: Advanced Instrumentation: Principle and Application
CC6: Basic Biochemistry
CC7: Immunology
CC8: Microbial Physiology and Metabolism
CC9: Virology
CC10: Medical and Veterinary Microbiology
CC11: Microbial Genetics and Molecular Biology
CC12: Agriculture, Food and Dairy Microbiology
CC13: Biostatistics and Bioinformatics
CC14:Advanced Microbiology

ABILITY ENHANCEMENT COMPULSORY (AECC) COURSES
AECC1: Environmental Science
AECC2: Communication Skills (English/MIL)

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)
DSE 1:Plant Pathology and Disease Management
DSE 2: Microbial Enzyme Technology
DSE 3: Microbiological Analysis of Air,Water and Soil
DSE 4: Biosafety and IPR

GENERIC ELECTIVE COURSE (GEC)
GEC1: Chemistry-1
GEC2: Chemistry-2
GEC3: Genetic Engineering and Advanced Microbiology
GEC4: Human Microbial Diseases

SKILL ENHANCEMENT COURSE (SEC): Any Two
SEC1: Microbial Diagnostics and Public Health
SEC2: Food Fermentation Technology
SEC3: Microbial Quality Control in Food and Pharmaceutical Industries

Course Learning Outcomes
&
Contents of the Courses
CORE COURSES (CC)

CC1:Cell Biology and Microbial World (6 Credits)		
Unit – 1:	Introduction, Scope and Importance, History of Cytology. Prokaryotic cell, Eukaryotic cell (Plant and Animal Cell). Structure and functions of Cell wall, Plasma membrane**:** (simple diffusion, facilitated diffusion, active transport, endocytosis, pinocytosis, phagocytois, and exocytosis), mitochondria, chloroplast, Endoplasmic reticulum,(Endoplasmic reticulum targeting proteins, protein folding and processing in ER, Targeting of lysosomal protein.), Golgi complex(Protein Glycosylation within the Golgi), Ribosome, Lysosome and Inracellular digestion, Nucleus and nucleolus. Chromosomes structure and its types. Lampbrush and Polytene Chromosomes.	
Unit – 2:	Cell cycle- mitosis and meiosis. Cell Motility and Shape : Structure and function of microfilaments and Intermediate Filaments. Molecular Mechanisms of Cell-Cell Adhesions. Extracellular Matrix of animals, Cell signaling. Introduction and application of stem cells.General introduction of Cancer, Apoptosis and necrosis. **Techniques in cell biology:** chromosomal banding techniques. Principles and applications of light microscope and electron microscope (Scanning and transmission). Karyotyping and Idiogram.	
Unit – 3:	History and Scope of microbiology and introduction to the microbial world. Germ theory of disease, Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff and Edward Jenner. Binomial Nomenclature, Baltimore classification.,Molecular identification(16S rRNA typing), Haeckel's Three Kingdom system, Whittaker's five kingdom and Carl Woese's three Domain classification systems and their utility.	

Unit – 4:	Difference between prokaryotic and eukaryotic microorganisms **A. General characteristics** of different groups: **B. Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Archaebacteria, Algae, Fungi and Protozoa), **C. Wall-less forms** - MLO (mycoplasma and spheroplasts), with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. Actinomycetes with special reference to its application in medicine, Agriculture and industry.	
Unit – 5:	**Bacterial Cell organization** Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. **Cell-wall:** Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes. **Cytoplasm:** Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids Endospore: Structure, formation, stages of sporulation.	

CC2: Plant Diversity-1 (6 Credits)		
Unit – 1	**Fungi**: General Characteristics, classification, cellular & thallus organization, cell ultra- structure, Cell wall and nutritional requirements of fungi. Historical developments in the field of Mycology including significant contributions of eminent mycologists.,asexual reproduction, sexual reproduction, General features, structure, nutrition, reproduction and life cycle of different fungi group – Phycomycetes :*Allomyces*(Chytridiomycota), *Phytophthora(*Oomycota*)* Zygomycetes : *Mucor* Ascomycetes: *Aspergillus, Peziza*, Basidiomycetes: *Puccinia, Alternaria, Agaricus*, Deuteromycetes: *Cercospora,Fusarium*	
Unit – 2	Heterothallism and Para- sexuality. Sex hormones in fungi, Lichens: Classification, occurrence, systematic position, mode of nutrition, reproduction and economic importance. Role of fungi in biotechnology, Application of fungi in foodindustry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Myco -proteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biodeterioration Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides). Mushroom and its cultivation.	
Unit – 3	Algae: General characteristics and evolution of algae. Occurrence, habitat a thallus organization, algal cell ultra-structure, pigments, flagella, eye- spot food reserves and vegetative, asexual and sexual reproduction. Classification of algae. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Chlorophyta - *Volvox, , Chara.* Xanthophyta**:** *Vaucheria.* Bacillariophyta: Pennate and centric Diatoms. Phaeophyta: *Ectocarpus.*	

	Rhodophyta: *Polysiphonia* Introduction to cyanobacteria , occurrence, salient features, thallus organization and reproduction in Nostoc. Applications of algae in agriculture, industry, environment and food *(Chlamydomonas*, *Chlorella*, Diatoms, *Microcystis*, *Oscillatoria*, *Spirulina*, *Anabaena*, *Nostoc*, *Rivularia* and *Scytonema)* Mass cultivation of algae as a source of protein.	
Unit – 4	General characters and classification of Bryophyta Hepaticopsida : *Marchantia* Anthoceropsida : *Anthoceros* Bryopsida : *Polytricum*	
Unit – 5	Pteridophyta : Important Characteristics and Classification Psilophytopsida : *Rhynia* Lycopsida : *Lycopodium* Sphenopsida : *Equisetum*	

Reference Books

1 Alexopoulus, C.J., Mims,C.W. and Blackwel, M, Introductory Mycology. John Wiley, New York.

2. Mehrotra, R.S. and K.R.Aneja An Introduction to Mycology. New Age International Press, New Delhi.

3. Webster, J. Introduction to fungi. Cambridge University Press. Cambridge, U.K. (1985).
4. Bessey E.A. Morphology and Taxonomy of fungi. Vikas Publishing House Pvt. Ltd., New Delhi.
5. Jhon Webster and R W S Weber. Introduction to Fungi. Cambridge University Press2007.
6. A. V. S. S. .Sambamurty. A Textbook of Algae. I.K. International Publishing House Pvt.Limited, 2010
7. H.D. Kumar and H.N. Singh.A Textbook on Algae (Macmillan international collegeedition)

GEC 1: Chemistry-1 THEORY COURSE (Credits)		
Unit – 1:	**Atomic Structure:** Idea of de Broglie matter wave, Heisenberg uncertainty principle, atomic orbitals, Quantum numbers, shapes of s, p, d orbitals, Trends in periodic table and applications in predicting and explaining the physical and chemical behaviors. Atomic radii, ionic radii, ionizationenergy, electron affinity and electro negativity.	
Unit – 2:	**Chemical Bonding**: Valence bond theory and its limitations ,directional characteristics of covalentbond, various types of hybridization and shapes of simple inorganic molecules and ions, Valence shell electron pair repulsion (VSEPR) theory to NH3 , H3O+,SF4, and H2O MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, Weak interactions, Hydrogen bonding, van der Waal forces.	
Unit – 3:	**Different States**: Structural differences between - solids, liquids and gases. Intermolecular forces, Definition of space lattice, unit cell. Bragg's equation. crystal structure of NaCl, KCl and CsCl, Ideal and non ideal solutions, methods of expressing concentration of solutions, Acid-Base concept. **s - Block elements**: Comparative study, diagonal relationships, salient features of Hydrides, Solvation and complexation tendencies. **p-Block elements:** Comparative study of groups 13–17 elements, compounds like hydrides, oxides, halides of group 13-16, basic properties of halogens, inter halogens and polyhalides. **Chemistry of d- blocks elements**: First transition series -Properties of the elements of the first transition series, stability of their oxidation states, coordination number. Second and Third transition series – General characteristics, comparative treatments with their 3d-analogues in respect of ionic radii, oxidation state and magnetic property.	
Unit – 4:	Thermodynamics- Principles, The Hender-Hasselbatch equation, of thermodynamics, Enthalpy, Second law of thermodynamics, Entropy free energy, chemical equilibrium, law of mass sction, principle Law of Thermodynamics, Concept of Entropy and enthalpy, Kirchhoff's equation, calculation of w,q, ΔU, ΔH.	
Unit – 5:	Chemical kinetics & its scope, Rate of reaction, factors influencing the rate of reactions, zero order, second order, pseudo order, half life & mean life, various theories of chemical kinetics, Arrhenious equation & catalysis.	

AECC 1: Environmental Studies THEORY COURSE (4 Credits)		
Unit – 1:	The multidisciplinary nature of Environmental Studies, Definitions, scopes & importance, need forpublic awareness. Natural resources:, renewable & non renewable resources, natural resources & associated problems of forest, water, minerals, food, energy & land resources. Conservation of natural resources, Environmental Ethics:, issues & possible solutions, water conservation, rain water harvesting & watershed management, resettlements & rehabilitation of peoples.	
Unit – 2:	**Ecosystems**; Concept of an ecosystem, structure & function of an ecosystem, energy flow in the ecosystem, ecological succession, food chain, food webs & ecological pyramids. Types, characteristic features, structure & function of following ecosystem; forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystem (ponds, streams, lakes, rivers, oceans, estuaries etc.)	
Unit – 3:	Concepts of Biodiversity**:** Definition of Genetic species & ecosystem diversity, biogeographical classification of india- value of diversity: consumptive use, productive use, social, ethical, Aesthetic & option values. Biodiversity at global, national & local levels. Hotspot of diversity, threats to biodiversity: habitat loss, poaching of wild life, man wild life conflicts. Endangered & endemic species of india, conservation of biodiversity.	
Unit – 4:	Definition of environmental pollution, causes, effects, & control measures of air, water, soil, marines, thermal & noise pollution. Climate Change: global warming, acid rain, ozone layer depletion & nuclear accidents. Solid Waste management: causes, effect & control measures of urban & industrial wastes. Role of an individual in prevention of pollution.	
Unit – 5:	Disaster managements: Floods, earthquakes, cyclones, & landslides. Waste lands reclamation, Consumerism & waste product. Population explosion: family welfare programmes, environment & human health, HIV/AIDS: Role of information technology in environmental & human health. Environmental legislation: environment protection act. Air(prevention & control of pollution) Act. Water (prevention & control of pollution) Act. Wild life protection Act. Forest conservation Act.	

BSc Microbiology SEM-2 C3: Bacteriology & Systematic		
Unit 1	**Methods of studying microorganism**; Staining techniques: simple staining, Gram staining, negative staining and acid-fast staining. **Sterilization techniques** (physical & chemical sterilization). **Culture media**: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media, Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation of pure cultures.	
Unit 2	Nutritional requirements in bacteria and nutritional categories; **Reproduction in Bacteria** Concept of Amitosis. Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.	
Unit 3	**Bacterial Systematics** Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria	
Unit 4	**Important archaeal and eubacterial groups No. of Hours: 16 Archaebacteria**: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)	
Unit 5	**Important eubacterial groups** **Eubacteria:** Morphology, metabolism, ecological significance and economic importance of following groups: ***Gram Negative:*** Non proteobacteria: General characteristics with suitable examples Alpha proteobacteria: General characteristics with suitable examples Beta proteobacteria: General characteristics with suitable examples Gamma proteobacteria: General characteristics with suitable examples Delta proteobacteria: General characteristics with suitable examples Epsilon proteobacteria: General characteristics with suitable examples Zeta proteobacteria: General characteristics with suitable examples ***Gram Positive:*** Low G+ C (Firmicutes): General characteristics with suitable examples High G+C (Actinobacteria): General characteristics with suitable examples ***Cyanobacteria*:** An Introduction	

C4:Plant Diversity-2		
Unit 1	**Gymnosperm:-** General characters and Classification of Gymnosperms. Heterospory and Origin of Seed Habit. Diversity of Gymnosperm: Geological Time Scale and Fossilization. Fossil Gymnosperms: *Lyginopteris* and *Lagenostoma. Morphology, Anatomy Reproduction and life cycle,of Cycas, Pinus and Ephedra.*	
Unit 2	**Angiosperms-:** Origin and Evolution of Angiosperms. Terminology for plant description in semi technical language: Principles and rules of Botanical Nomenclature, Herbarium and Botanical gardens; Classification of Angiosperms: Bentham and Hooker, Hutchinson, and Engler & Prantals Modern trends inTaxonomy	
Unit 3	**Taxonomy:** Diagnostic characteristics and Economic Importance of Families – Ranunculaceae, Brassicaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Asteraceae, Asclepiadaceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Poaceae.	
Unit 4	**Plant Physiology: -** Plant Water Relations: Properties of water, Importance of water in plant life, Diffusion, Osmosis & Osmotic relation to plant cell. Water Absorption, Ascent of Sap. Transpiration: Structure & Physiology of Stomata, Mechanism of Transpiration, Factors affecting the rate of transpiration. **Photosynthesis:-** Chloroplast, Photosynthetic pigments, Red drop, Emerson' effect, Concept of two Photosystems, Light reaction, Dark reaction – Calvin cycle, Hatch & Slack cycle, CAM cycle, Factors affecting rate of photosynthesis & Photorespiration.	
Unit 5	**Embryology:** Concept of flower as a modified shoot. Structure of Anther, Microsporogenesis and Male Gametophyte. Structure of Pistil, Ovules, Megasporogenesis and Development of Female Gametophyte (Embryo Sac) and its types. Pollination– Mechanism and Agencies of Pollination, Pollen Pistil interactions and Self incompatibility. Double Fertilization and triple fusion. Development and types of endosperm and its morphological nature, Development of Embryo in Monocot and Dicot. Fruit development and maturation. Seed structure and dispersal. Mode of Vegetative Propagation.	

GEC2: Chemistry-2		
Unit 1	Structure of Organic compounds, bond length, bond angle, Hydrogen bond, Resonance, Electroniceffects, inductive, Mesomeric, Electromeric & Hyperconjugation. Nucleophiles and Electrophiles, Reaction intermediates Carbonium ions, Carbanions, Free radicals and Carbenes, Homolytic fissionand Heterolytic fission.	
Unit 2	Introduction, Nomenclature, Isomerism, Preparation and General Properties of Aliphatic hydrocarbons, Alkanes, Alkenes and Alkynes, Cycloalkanes,	
Unit 3	Introduction, Nomenclature, Preperation and general properties of Alcohols, Phenols, Aldehydeand Ketones. Aromaticity.	
Unit 4	Carbohydrates (monosaccarides, diasaccarides and polysaccharides): classification and general properties, Glucose and fructose (open chain and cyclic structure), Overview of primary, secondary, tertiary and Quaternary structure of proteins. Introduction, glycerides, synthetic detergents, Introduction, classification of amino acids.	
Unit 5	Stereochemistry: Simple molecules , Hybridization, conformation & configuration, Geometrical isomerism, optical isomerism, Chirality, Enantiomers and optical activity	

AECC2: English		
Unit 1	**Introduction**: Theory of Communication, Types and modes ofCommunication	
Unit 2	**Language of Communication**: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication	
Unit 3	**Speaking Skills**: MonologueDialogue Group Discussion Effective Communication/ Mis- CommunicationInterview Public Speech	
Unit 4	**Reading and Understanding** Close Reading Comprehension Summary Paraphrasing Analysis and Interpretation Translation (from Indian language to English and vice-versa)Literary/Knowledge Texts	
Unit 5	**Writing Skills** Documenting Report Writing Making notesLetter writing	

C5:Advanced Instrumentation: Principle and Application		
Unit 1	**Microscopy:** Bright field and dark field microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.	
Unit 2	**Chromatography:** Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity Chromatography, GLC, HPLC.	
Unit 3	**Electrophoresis:** Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.	
Unit 4	**Spectrophotometry:** Principle and use of study of absorption spectra of bio molecules. Analysis of bio molecules using UV and visible range. Colorimetry and turbidometry.	
Unit 5	**Centrifugation:** Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and Ultracentrifugation.	

C6: Basic Biochemistry		
Unit 1	**Concept of bio-molecules -** Building blocks of life, Macromolecules.	

	Concept of Bioenergetics - First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds, ATP, amino acids the building blocks of proteins. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. General formula of amino acid and concept of zwitterion. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, alanine and D-glutamic acid.	
Unit 2	**Carbohydrate: Families of monosaccharides** – aldoses and ketoses, trioses tetroses, pentoses, and hexoses. Stereo isomerism of monosaccharides, epimers, mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, sugar derivatives, glucosamine. Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, polysaccharides, storage polysaccharides, starch and glycogen. Structural polysaccharides, cellulose, peptidoglycan and chitin	
Unit 3	**Protein:** Primary, secondary, tertiary and quaternary structures. Enzymes: Structure of enzyme, Apoenzyme and cofactors, prosthetic group-TPP, coenzyme -NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Effect of pH and temperature on enzyme activity. **Enzyme inhibition**:competitive- sulfa drugs; non-competitive-heavy metal salts.	
Unit 4	**Lipids:** Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, general structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals,cofactors, prostaglandins, Introduction to lipid micelles, monolayers, bilayers	
Unit 5	Nucleic acids and vitamins. Biosynthesis of nucleotides. Base composition. A+T and G+C rich genomes. Structure and functions of DNA and RNA. Basic concept of nucleic acids protein interactions. Concept and types of vitamins and their role in metabolism.	

GEC3: Genetic Engineering and Advanced Microbiology

Unit 1	**Introduction to genetic engineering**: Restriction modification systems: Mode of action, applications of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: DNA polymerases.Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases. **Cloning**: Use of linkers and adaptors: Transformation of DNA: Chemical method, Electroporation**.**	
Unit 2	**Methods of DNA, RNA and Protein analysis**: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis,SDS-PAGE, and Western blotting. **Cloning Vectors:** Plasmid vectors: pBR and pUC series, Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs, Expression vectors: *E.coli*lac and T7, promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors	
Unit 3	**DNA Amplification and DNA sequencing**: PCR: Basics of PCR, RT-PCR, Real-TimePCR Genomic and cDNA libraries: Preparation and uses, Genome sequencing Sanger's method of DNA Sequencing: traditional and automated sequencing	
Unit 4	**Application of Genetic Engineering and Biotechnology:** Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery. **Products of recombinant DNA technology**: Products of human therapeutic interest - Insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavosavo tomato, Gene therapy, Recombinant vaccine, Protein engineering	
Unit 5	**Metagenomics:** Metagenomics of viral metagenome, metatranscriptomics,metaproteomics and metabolomics. Understanding bacterial diversity using metagenomics approach, **Biofilms**: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance. Quorum sensing in bacteria, Microbiomes and importance of microbial communities, VBNC (viable but not culturable bacteria). Genetically modified organisms and their uses. Modern methods of rapid identification of microbes (PCR, mass spectrometry, fluorescence based techniques). CRISPR-Cas system.	

SEC1: Microbial Diagnostics and Public Health		
Unit 1	**Importance of Diagnosis of Diseases**:Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associatedclinical samples for diagnosis	
Unit 2	**Collection of Clinical Samples :**How to collect clinical samples (oralcavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.	
Unit 3	**Direct Microscopic Examination and Culture.Examination of sample by staining -** Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa- stained thin blood film for malaria. Preparation anduseofculturemedia-Bloodagar,Chocolateagar,Lowenstein-Jensenmedium,MacConkey agar, Distinct colony properties of various bacterial pathogens.	
Unit 4	**Serological and Molecular Methods:** **Serological Methods**-Agglutination,ELISA immunofluorescence, **Nucleic acid based methods** - PCR, Nucleic acid probes. **Kits forRapid Detection of Pathogens**:Typhoid, Dengue and HIV, Swine flu.	
Unit 5	**Testing for Antibiotic Sensitivity in Bacteria:** Importance, Determination of resistance /sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method	

C7:Immunology

Unit 1	**Immunity and Immune response**: Innate immune and characteristics of adaptive immune Responses, Hematopoiesis. Anatomical organization of Immune System: Primary Lymphoid Organs, Secondary Lymphoid Organs.Cell of immune system: Mononuclear cells and granulocyte, Antigen presenting cells, lymphocytes and their subsets.	
Unit 2	**Inflammation**: mediator and the process, cell-adhesion molecules and their role inInflammation, role of anaphylatoxins, granulocyte in inflammatory Process .Major histocompatibility systems:	
Unit 3	**Antigen:** Properties, types and determinants of antigenicity, Heptanes: Factor affecting immunogenicity, Super antigen. **Antibody:** Nature, Types and Structure of Immunoglobulin and Their Functions. Antigen-Antibody interaction avidity and affinity.	
Unit 4	**Monoclonal antibodies**: production, characterization and application . Compliment System, components, Activation pathway and regulation. Hypersensitivity and its types.	
Unit 5	**Autoimmunity and Immunodeficiency SyndromeVaccines:** Active and passive immunization. **Immunotechniques**: Immunodifusion, Immunoprecipitation, ELISA, RIA.	

C8:Microbial Physiology and Metabolism

Unit 1	Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve. Microbial growth in response to environment - Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultativeanaerobe),barophilic.	
Unit 2	**Microbial growth in response to nutrition and energy** – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Passive and facilitated diffusion. Primary and secondary active transport, concept of uniport, symport and antiport Group translocationIron uptake	
Unit 3	Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway TCA cycle. Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors. Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and hetero fermentative pathways), concept of linear and branched fermentation pathways	
Unit 4	Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction). Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and Cyanobacteria	
Unit 5	Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction). Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.	

GEC4: Human Microbial Disease		
Unit1	**Human Diseases**:Infectious and non-infectious diseases, microbial and non-microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections Sign and Symptoms of common diseases	
Unit2	**Microbial diseases:** Respiratorymicrobialdiseases,gastrointestinalmicrobialdiseases,Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, **Sexually transmitted diseases:** Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.	
Unit3	**Therapeutics of Microbial diseases :**Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains.	
Unit4	**Treatment using antiviral agents**: Amantadine, Acyclovir, Azidothymidine. Concept of HAART. **Vaccines:** Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context	
Unit5	**Prevention of Microbial Diseases:** General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.	

SEC2: FOOD & FERMENTATION TECHNOLOGY		
Unit1	Brief history and developments in industrial microbiology. Sources of industrially important microbes and methods for their isolation, preservation and maintenance	

	of industrial strains, strainimprovement, **Crude and synthetic media**; molasses, corn- steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. **Fermentation & Types of fermentation processes** - Solid-state and liquid-state(stationary and submerged) fermentations; batch, fed-batch (e.g. baker's yeast) and continuous fermentations. Components of a typical bio-reactor, **Types of bioreactors**-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, **Measurement and control of fermentation parameters** - pH, temperature, dissolved oxygen, foaming and aeration	
Unit2	**Down-stream processing**; Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Microbial cells as food. SCP -mushroom cultivation,	
Unit3	**Microbial production of industrial products** (micro-organisms involved,media, fermentationconditions, downstream processing and uses)- Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12. Enzymes (amylase, protease, lipase) wine, beer. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes(glucose isomerase and penicillin acylase). Role of Microbes in Medicine and textile industry.	
Unit4	**Fermented Foods:** Definition, types, advantages and health benefits, fermented foods used by Common public, domestication, **Milk Based Fermented** Foods**:** Dahi, Yogurt, Buttermilk (Chhachh) and cheese: Preparation of inoculums, types of microorganisms and production process.	
Unit5	**Grain Based Fermented Foods:** Soy sauce, Bread, Idli and Dosa: Microorganisms and production process, Preparation and preservation. **Vegetable Based Fermented Foods:** Pickels, Saeurkraut: Microorganisms and production process. Preparation and preservation methods **Fermented Meat and Fish:**Types, microorganisms involved, fermentation process Probiotic Foods:Definition, types, microorganisms and health benefits .	
C9: VIROLOGY		
Unit1		

	Virology: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin; Structure of Viruses. Viral taxonomy- Classification and nomenclature of different groups of viruses. Baltimore system of classification.	
Unit2	Isolation, purification and cultivation of bacterial viruses. Study of one step growth curve of bacterial viruses. Types of bacteriophages, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage. T even, T odd ϕX174 and M13 phages.	
Unit3	**Modes of viral transmission:** Persistent, non- persistent, vertical and horizontal. Replication Assembly, maturation and release of viruses. Salient features of viral nucleic acid and the presence of unusual bases. Influenza and Hepatitis B virus, HIV, polio virus, Vaccinia virus, Rabies Virus. TMV, Cauliflower Mosaic Virus.	
Unit4	Introduction to oncogenic viruses. Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes.	
Unit5	Antiviral compounds and their mode of action Interferon and their mode of action; Viral vaccines; Introduction to use of viral vectors in cloning and expression, and gene therapy.	

DSE1: PLANT PATHOLOGY AND DISEASE MANAGEMENT

Unit1	**Concept of plant disease**- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. **Significant landmarks in the field of plant pathology**- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor,VanDer Plank, molecular Koch'spostulates .Contributions of eminent Indian plant pathologists.	
Unit2	Infection, invasion, colonization, dissemination of pathogens and perennation. Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle &disease pyramid, forecasting of plant diseases and its relevance in Indian context. **Microbial Pathogenicity:** Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes(photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).	
Unit3	**Genetics of Plant Disease*:*** Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance. **Defense Mechanisms in Plant**:Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological- cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones,oxidative bursts]	
Unit4	Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material. cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals. biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plant; genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes	

Unit5	**Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control.** White rust of crucifers- *Albugocandida*; Downy mildew of onion - *Peronospora destructor* Late blight of potato -*Phytophthorainfestans*; Powdery mildew of wheat – *Erysiphegraminis* Ergot of rye - *Clavicepspurpurea*; Black stem rust of wheat – *Pucciniagraministritici* Loose smut of wheat - *Ustilagonuda*; Wilt of tomato - *Fusarium oxysporum*f.sp. , *lycopersici* Red rot of sugarcane - *Colletotrichumfalcatum*; Early blight of potato - *Alternariasolani*; Angular leaf spot of cotton,bacterial leaf blight of rice, crowngalls, bacterial cankers of citrus; Aster yellow, citrus stubborn; Papaya ring spot,tomat oyellow leaf curl,banana bunchy top, rice tungro; Potato spindle tuber,coconut cadang cadang	

SEC3: Microbial Quality Control in Food & Pharmaceutical Industry		
Unit1	**Microbiological Laboratory and Safe Practices:Good laboratory practices** - Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL- 1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration	

Unit2	**Determining Microbes in Food / Pharmaceutical Samples**: Culture and microscopic methods - Standard plate count, Most probable numbers,Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products.	
Unit3	**Molecular methods to determine microbes in samples**- Nucleic acid probes, PCR based detection, biosensors. Enrichment culture technique, **Detection of specific microorganisms** - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar	
Unit4	Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)	
Unit5	**HACCP for Food Safety and Microbial Standards:** Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water	

C10: MEDICAL &VETERINARY MICROBIOLOGY

Unit1	**Normal microflora of the human body:** Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. **Host pathogen interaction**: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS. Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).	
Unit2	List of diseases of various organ systems and their causative agents. Symptoms, mode of transmission, prophylaxis and control of the diseases caused by Streptococcus pyogenes, *Mycobacterium,Haemophilus influenzae, tuberculosis, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficile*, and the viruses causing Polio, Herpes, Hepatitis, Dengue, AIDS, influenza and Japanese encephalitis.	
Unit3	Study of following animal diseases with respect to etiology, symptoms, mode of transmission, prophylaxis and control: FMD, swine flu, bird flu, Rabies, bovine tuberculosis, Marek's, ranikhet, brucellosis, distemper.	
Unit4	**Mycoses**: Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic mycoses: Candidiasis. Occurrence, habitat, morphology and reproduction of Protozoa. Structure and reproduction of important Protozoans- Entamoeba, Giardia, Trichomonas, Leishmania, Trypanosoma and Plasmodium	
Unit5	I**mmune system:** Structure and function of the cells, tissues and organs of immune system. **Types of immunity** - Humoral and cell-mediated, innate, acquired immunity. Complement system – function and pathways. **Antigens and Antibodies**: types, properties. Haptens, adjutants, **Immunoglobulins**: Structure types, Properties and their function - Theory of antibody production. Antigen-Antibody Interactions, Agglutination, Precipitation, Complement fixation test. Hypersensitivity reactions; IgE mediated Type I Hypersensitivity, Antibody-mediated cytotoxic (Type II) Hypersensitivity, Immune complex mediated (Type III) Hypersensitivity, DTH mediated (Type IV) Hypersensitivity.	

DSE2:MICROBIAL ENZYME TECHNOLOGY		
Unit1	**Basic concepts of Enzymes :** Nomenclature, classification, methods for determination of enzyme Activity. Isolation and purification of enzymes. **Enzyme kinetics**: Michaelis-Menten equation, effect of pH, substrate concentration, temperature and inhibitors. Isoenzymes and allosteric enzymes. Enzyme inhibition- competitive and non-competitive inhibition.	
Unit2	Enzymes from microbial sources, large scale production of enzymes, recovery of enzymes, enzyme purification methods - enzyme precipitation, separation by chromatography, enzyme reactors.	
Unit3	**Immobilized enzymes**:Physical and chemical methods of immobilizatio immobilization supports, kinetics of immobilized enzymes. Enzyme catalysis i apolar medium, reverse micellar entrapment of enzymes and its applications	
Unit4	**Application of enzymes**:synthesis of chemicals using enzymes, food technology and medicine.Enzymes in diagnostic assays. Enzyme electrodes, immunoenzyme techniques	
Unit5	**Microbial toxins**:Types, biochemical and molecular basis of toxin production, implications. Genetically engineered microbes, anti-HIV, anticancer, antifungal, antiplasmodial, anti- inflammatory compounds	

DSE3: Microbiological Analysis of Air ,Water And Soil		
Unit1	**Aero- microbiology**: Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens. Bio aerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and Fungi, Identification characteristics. **Control Measures**: Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration. Precipitation, chemical disinfection,	

	filtration, high temperature, UV light	
Unit2	**Water- microbiology:** Water borne pathogens, water borne diseases. Sample Collection, Treatment and safety of drinking(potable)water, **Methods to detect portability of water samples:** (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence test. **Liquid waste management**: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment	
Unit3	**Soil- microbiology:** Soil borne pathogens, soil borne diseases, Sampling of soil, sample collection **Solid Waste management**: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill). Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction Phosphorus cycle: Phosphate immobilization and solubilisation. Sulphur cycle: Microbes involved in sulphur cycle Other elemental cycles: Iron and manganese	
Unit4	Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inroganic (metals) matter, biosurfactants.	
Unit5	**Biological Interaction**: A. Microbe– Microbe Interactions- Mutualism, Synergis, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents. B. Microbe–Plant Interactions Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers) C. Microbe-Animal Interactions - Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as Symbiont	

C11: MICROBIAL GENETICS AND MOLECULAR BIOLOGY		
Unit 1	Importance of Genetics, Gene, allele, genotype and phenotype.	

	Mendelian laws of inheritance, Monohybrid cross, Law of Dominance and the law ofsegregation, Dihybrid cross and law of independent assortment. Interactions of genes, complementary genes, reversions , lethal genes, epistasis. Multiple alleles, Blood groups, Rh factor. **Sex** linked inheritance**:** X linkage, sex linkage in man, color blindness, Hemophilia (Bleeder's disease) and other genetic diseases. Characteristics of X linked inheritance. Y linked inheritance in Man, Inheritance of X-Y linked Genes. Human genetics (pedigree analysis, karyotypes and genetic disorder).	
Unit 2	Genome organization: *E. coli, Saccharomyces, Tetrahymena*. **Microbial Genetics**: **Transformation**- discovery, Griffith's experiment, mechanism of transformation; Factors affecting transformation process, Competence and development of competence in *S. Pneumonia.* **Transduction** – discovery, Lederberg and Tatum's experiment, mechanism and types of transduction- Generalized transduction, Specialized transduction, Sexduction and abortive transduction. **Conjugation-** discovery, experimental evidence, F-factor, F^+& Hfr,mechanism of conjugation, Cross between Hfr, F^+&F^- Conjugant and its application. Features of T4 genetics , Genetic basis of lytic *versus* lysogenic switch of phage lambda. Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Tiplasmids, linear plasmids, yeast- 2 ɜ plasmid, Plasmid replication and partitioning, Host range, plasmid- incompatibility, plasmid amplification, Regulation ofcopy number, curing of plasmids. Prokaryotic transposable elements – Insertion Sequences, compositeand non-composite transposons, Replicative and Non replicative transposition, Mutransposon.	
Unit 3	Molecular basis of life. Nucleic acids as genetic material. Structure of DNA and its alternative forms. Structure and Types of RNA. Enzymes, proteins and other factors involved in DNA replication. Mechanism of DNA replication in prokaryotes (enzymology and process)	
Unit 4	Prokaryotic gene expression: Prokaryotic transcription, Genetic code Prokaryotic translation. Regulation of gene expression: Operon concept (Lac and Trp operon) Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote	
Unit 5	Split genes, concept of introns and exons, RNA splicing, spliceosome machinery**,** concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance., Sporulation in *Bacillus,* Yeast mating type switching , Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.	

DSE4: BIOSAFETY & IPR

Unit1	. Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets &their types; Primary Containment for Biohazards; Biosafety Level of Specific Microorganisms AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.	
Unit2	Biosafety Guidelines: Biosafety guidelines and regulations(National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.	
Unit3	IntroductiontoIntellectualProperty:Patents,Types,Trademarks,Copyright&RelatedRights, Industrial Design and Rights, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – World Intellectual Property Rights Organization (WIPO)	
Unit4	Grant of Patent and Patenting Authorities: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; An introduction to Patent Filing Procedures; Patent licensing and agreement; Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner.	
Unit5	Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague , Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.	

RESEARCH METHODOLOGY		
Unit1	. **Identification and defining of the Research Problem:** Familiarization of research areas; Review of literature using appropriate resources – reviews, research papers, books and patents; Use of tools for searching literature through electronic databases; Defining a research problem.	
Unit2	**Experimental Approaches and Methodology** Experimental designs to address the research problem; different experimental strategies; Finalization of experimental design; Tools and techniques to execute experiments; Means to validate and analyze data;	
Unit3	**Ethics in Biological Research** Guidelines for Biosafety and Bioethics; Institutional Biosafety Committee – Handling of Genetically modified organisms, Institutional Human and Animal Ethics Committee - compliance, concerns and approval	
Unit4	**Presentation, Publication and Protection of Research Data.** Skills for scientific writing and research presentation – Term paper, Research project, Research report, Thesis, Research article and Review; Organization of the research document in to different sections (Introduction, Methodology, Results, Discussion, and Summary and Conclusions, Bibliography); Use of electronic tools for bibliographic formatting and checking Plagiarism; Oral presentation skills; Patents and Intellectual property rights	

Unit5	**Statistical analysis and Biosafety in research** Safety practices and disposal of Bio-waste in the laboratory; Radioactivity and safety precautions; Handling and disposal of flammable and hazardous chemicals. Use of statistical tools for analyzing the significance and interpretation of the data; Methods of recording observations and documentation	

C12:AGRICULTURE FOOD AND DAIRY MICROBIOLOGY		
Unit1	. History of Agricultural Microbiology; Microbes and their importance in maintenance of soil, Biogeochemical cycles, role of microbes in maintaining the fertility of soil. Bio fertilizers – Bacterial, - Azotobacter and vermiform compost. Soil microorganism -association with vascular plants- phyllosphere, Rhizobium, Rhizoplane associative nitrogen fixation. Biofertilizers- Cyanobacterial and Azolla.	
Unit2	Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Principles of food preservation: temperature, canning, drying, irradiation, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, citrates, benzoates nitrite and nitrates etc.	
Unit3	Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market. Utilization and disposal of dairy by-product – whey.	

Unit4	Food borne diseases (causative agents, foods involved, symptoms and preventive measures)- Food intoxications: Staphylococcus aureus, Clostridium botulinum and mycotoxins; Food infections: Bacillus cereus, Vibrio parahaemolyticus, Escherichia coli, Salmonellosis, Shigellosis, Yersinia enterocolitica, Listeria monocytogenes and Campylobacter jejuni	
Unit5	Food sanitation and control; HACCP, Indices of food sanitary quality and sanitizers. Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology. Genetically modified foods, Nutraceuticals, Biosensors in food, Applications of microbial enzymes in dairy industry [Protease, Lipases].	

C13: Biostatistics & Bioinformatics		
Unit1	Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	
Unit2	Probability classical & axiomatic definition of probability, Theorems on total and compound probability), Elementary ideas of Binomial, Poisson and Normal distributions.	
Unit3	Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square testfor goodness of fit and analysis of variance (ANOVA)	

Unit4	Correlation and Regression. Emphasis on examples from Biological Sciences.	
Unit5	Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis, Sequence Similarity Searches-BLAST,FASTA, Data Submission.	