

# Singhania University

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M.Sc. in Microbiology

Course Structure

Session200809

Semester – I

S. No.	Code	Name of Subject	
1	M.Sc.Micro.111	Bacteriology & Phycology	
2	M.Sc.Micro.121	Mycology & Virology	
3	M.Sc.Micro.131	Immunology	
4	M.Sc.Micro.141	Instrumentation & Its Biological Application	
5	Practical		

Semester – II

S. No.	Code	Name of Subject	
1	M.Sc.Micro.111	Industrial Microbiology & Food Microbiology	
2	M.Sc.Micro.121	RDNA Technology & Microbial Production of Recombinant Molecule	
3	M.Sc.Micro.131	Environmental Microbiology & Microbial Biodiversity	
4	M.Sc.Micro.141	Biochemistry & Microbial Physiology	
5	Practical		

Semester – III

S. No.	Code	Name of Subject	
1	M.Sc.Micro.111	Molecular Biology & microbial Genetics	

2	M.Sc.Micro.121	Biostatistics	
3	M.Sc.Micro.131	Medical microbiology	
4	M.Sc.Micro.141	Bioinformatics and computer application	
5	Practical		

## Semester – IV

Project (Industrial & Training Project)

## Semester – I

### BACTERIOLOGY AND PHYCOLOGY

#### Unit – I

Classification of microorganisms; Haeckel's three kingdom concept, Whittaker's five kingdoms concept. Modern trends in classification. Classification and salient features of Bacteria according to Bergey's manual of systematic Bacteriology

#### Unit – II

GramNegative Bacteria: Spirochaetes, Aerobic or microaerophilic curved rods, Aerobic rod and cocci, Facultative aerobic rods, Anaerobers, Rickettsias and chlamydias,

Anoxygenic phototrophs, Oxygenic phototrophs, 'Gliding bacteria, Sheathed bacteria Budding and/or appendages bacteria, and Chemolithotrophs.

Grampositive Bacteria :Cocci, Endospore forming bacteria, Regularly shaped rods, irregularly shaped rods, Mycobacteria, Actinomycetes.

Archaeobacteria: Methanotrophs, Halophiles, and Sulfurdependent archaeobacteria.

#### Unit – III

Morphology & ultrastructure of bacteria; morphological types, cell walls, cell walls synthesis, capsule, antigenic properties, cell membrane, Structure and functions of flagella, cilia, pili, chromosome, sporulation. Reserve food materials. Dormancy.

Cultivation of bacteria; anaerobic, aerobic culture media, growth curve, growth kinetics, batch, continuous culture, growth measurements, factors affecting growth, control of bacteriophysical and chemical agents. Types of bacteria on the basis of energy and nutritional requirement. Pure culture techniques (spread plate, pour plate, streak plate), preservation methods.

#### Unit IV

An introduction of Algae, General features and classification of algae. Occurrence, thallus organization and reproduction in chlorophyceae, euglenophyceae, phaeophyceae, pyrrophyceae and diatoms.

Algal ecology & biotechnology. Economic importance of algae. Lichen, ascolichen, basidiolichen, deuterolichen.

An Introduction to fungi, History, general features of fungi, Classification of fungi. Fungi and Ecosystem: Nutrition of fungi, Vitamin requirements, Saprophytism, parasitism, mutualism. Symbiotic associations of fungi: The Mycorrhizae and Lichens. Homothallic, Heterothallic, Heterokaryosis, The Parasexual cycle, Sex Hormones in Fungi. Fungi as insect symbiont. Mycotoxins and Mycotoxicoses. Attack on fungi by other microbes. Fungal diseases of Plants. Economic Importance of fungi.

#### Unit II

General Virology Brief outline on discovery of viruses, nomenclature and classification of viruses : distinctive properties of viruses; morphology & ultrastructure; capsids & their arrangements; types of envelopes and their composition viral genome, their types and structures; virus related agents (viroids, prions)

General methods of Diagnosis and serology Cultivation of viruses in embryonated eggs, experimental animals, cell cultures; Primary & secondary cell cultures; suspension cell cultures and monolayer cell cultures; cell lines and transgenic systems; serological methods hemagglutination & HAI; complement fixation; immunofluorescence methods, ELSA and Radioimmunoassays; assay of viruses physical and chemical methods (Protein, nucleic acid, radioactivity, trackers, electron microscopy) Infectivity assay ( plaque method, end point method)- Infectivity of plant viruses.

#### Unit - III

Bacterial viruses Bacteriophage structural organisation; life cycle; one step growth curve; transcription; DNA replication; eclipse phase; phase production; burst size; lysogenic cycle; bacteriophage typing; application in bacterial genetics; brief details on M13, Mu, T3, T4 and Lambda P1

Plant viruses Classifications and nomenclature; effects of viruses on plant; appearance of plants; histology, physiology and cytology of plants; common viruses of cyanobacteria, algae, fungi; life cycle; type species of plant viruses like TMV, Cauliflower Mosaic

Virus and Potato virusX; transmission of plant viruses with vectors and with out vectors; diagnostic techniques in seeds; seed stocks and diseased plants; Prevention of crop loss due to virusinfection virus free planting material; vector control

#### Unit – IV

Animal Viruses Classification and nomenclature of animal human viruses; epidemiology, lifecycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses Picorna, Ortho myxo, paramyxo, Toga and other arthropod viuses, Rohabdo, Rota HIV and other Oncogenic Viruses; DNA viruses; Pox, Herps, Adeno SV40; Hepatitis viruses, viral vaccines (conventional vaccines, genetic recombinant vaccines used in national immunisation programmes with examples, newer generation vaccines including DNA Vaccines with examples) interferons and antiviral drugs.

Historical background: Humoral and Cellular components of the immune system. Innate Immunity: Skin & mucosal surface, Physiological Barriers, Phagocytic barriers, Inflammation, Adaptive immunity.

Cells and Organs of Immune System: Lymphoid cells; stem cells, B and T Lymphocytes, Natural killer cells, Mononuclear phagocytes, Granulocytic cells. Organs: Thymus, Bone Marrow, Lymphatic system, Lymph nodes, Spleen.

#### Unit – II

Antigens and Antibodies:Antigens: Structure, properties, types, Epitopes, Haptens. Antibodies: Structure and function, Antibody mediated functions, Antibody classes and biological activities, Monoclonal Antibodies

AntigenAntibody Interaction:Precipitation reaction, Agglutination, Radioimmunoassay, ELISA, Western Blotting, Major Histocompatibility Complex, General structure and function of MHC, MHC Molecules and Genes, Antigen Processing and presentationT-Cell Receptors TCell Maturation and Differentiation, BCell Generation, Activation & Differentiation.

#### Unit –III

Immune Effector MechanismCytokinesis (Properties, receptors, antagonism & secretion) The complement system (functions, components, activation, regulation and deficiencies) Cell mediated effector responses: Cytotoxic Tcells, natural killer cells, antibody-dependent cellmediated cytotoxicity

Inflammation

Hypersensitive reactions (Type I, II, III and delayed type (DTH)

Immunology in Health & DiseaseImmune response to infectious diseases: viral, bacterial and protozoan.

Vaccines, AIDS and other Immuno deficiencies, genetically designed vaccines. BCG,

TB & Leprosy, DNA vaccines.

## Unit –IV

Transplantation and Autoimmunity Organ specific autoimmune diseases, Systemic autoimmune diseases,

Graft rejection, evidence and mechanism of graft rejection, prevention of graft rejection, immunosuppressive drugs, HLA and disease, mechanism of immunity to tumor antigens. Autoantibodies in human pathogenic mechanism, experimental models of autoimmune disease treatment of autoimmune disorders.

### INSTRUMENTATION & ITS BIOLOGICAL APPLICATION

#### Unit 1

- 1 Spectroscopy: interaction of radiation with matter, absorption of radiation, emission of radiation, Beer Lambert relationship components of a spectrophotometer, type of detectors; UV Vis spectrophotometry,
- 2 Fluorimetric methods, atomic absorption spectroscopy techniques, flame emission photometry, magnetic resonance spectroscopy,
- 3 Applications of different spectroscopic techniques.

#### Unit 2

- 1 Separation methods: principles of separation techniques, general methods of separation; methods based on polarity (absorption chromatography, liquid chromatography, gas liquid chromatography), methods based on ionic nature (ion-exchange chromatography), methods based on shape (affinity chromatography), HPLC, ELISA.
- 2 Applications of chromatographic techniques in biology.

#### Unit 3

- 1 Membrane filtration and dialysis, electrophoresis: zonal techniques, supporting medium, vertical, submarine and gradient electrophoresis.
- 2 Isoelectric focussing, isotachopheresis, capillary electrophoresis, elution parameters, immunoelectrophoresis,
- 3 Applications of electrophoresis in biology.

#### Unit 4

- 1 Centrifugation: Preparative and analytical centrifuges, sedimentation analysis, RCF, zonal and equilibrium density gradients, Ultracentrifuge.
- 2 Microscopy: light, phase contrast, fluorescence and electron microscopy.

#### Unit 5

- 1 Radioisotopes: nature of radioactivity, types of radioactivity, radioactive decay, units of radioactivity.
- 2 Detection and measurement of radioactivity. Geiger counters, scintillation counters, autoradiography.
- 3 Biochemical uses of isotopes (tracers, radio immunoassay).

## INDUSTRIAL MICROBIOLOGY AND FOOD MICROBIOLOGY

Unit 1 Introduction, history and scope of industrial microbiology, major types of microorganism used in fermentation, primary & secondary screening, industrial strain improvement strategies, selection and improvement of recombinant organisms.

Unit 2 Design and operation of various types of reactors, main components, peripheral parts and accessories, various control systems.

Unit 3 Media preparation, sterilization, kinetics of thermal death of Microorganisms, batch, continuous and fed batch process, aeration and agitation, foam and antifoam, microbial growth kinetics, measurement of growth, effect of pH, temp, and nutrient conc. on growth.

Unit 4 Down stream processing, filtration of fermentation broths, ultracentrifugation, recovery of biological products by distillation, superficial fluid extraction, Electrokinetic's dialysis, flotation.

Unit 5 Industrial production of alcohol, citric acid, solvents, amino acids, enzymes (amylase, proteases, celluloses) antibiotics, steroids and largescale production of recombinant molecules interferon, human proteins, vaccines.

Unit 6 Microorganisms important in food microbiology: Molds, Yeasts and Bacteria General characteristics, classification and importance. Principles of food preservatn. Asepsis Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Factors influencing microbial growth in food Extrinsic and Intrinsic factors; Chemical preservatives and Food additives. Canning, processing for Heat treatment D, Z, and F values and working out treatment parameters.

Unit 7 Contamination and spoilage; Cereals, sugar products, vegetables, fruits, meat and meat products, Milk products, fish and sea foodspoultry spoilage of canned food. Detection of spoilage and characterisation. Foodborne infections and intoxications: Bacterial and nonbacterial with example of infective and toxic types Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Staphylococcus, Vibrio, Yersinia; Nematodes, protozoa, algae, fungi and viruses. Foodborne outbreaks laboratory testing procedures; Prevention measures Food sanitation in manufacture and retail trade; Food control agencies and its regulations, Plant

sanitation Employee's Health standards waste treatment disposal quality control.

## Unit 8

Fermented foods: bread, cheese, vinegar, fermented vegetables, fermented dairy products, oriental Fermented foods, their quality standards and control; Experimental and Induction methods, microbial cells as food (single cell proteins) and mushroom cultivation. Fermented beverages: beer and wine. Genetically modified foods.

### Unit 1

Core techniques and essential enzymes used in rDNA technology. Restriction digestion, ligation and transformation

### Unit 2

Cloning vectors plasmids, phages and comids. Cloning strategies. Cloning and selection of individual genes, gene libraries: cDNA and genomic libraries

### Unit 3

Specialised cloning strategies, Expression vectors, promoter probe vectors, vectors for library construction artificial chromosomes

### Unit 4

PCR methods and application, DNA sequencing methods, dideoxy and chemical methods Sequence assembly. Automated sequencing Genome sequencing and physical mapping of genomes.

### Unit 5

Requirement of recombinant molecules: in pharmaceutical, health, in research laboratories, agricultural and industrial sectors. Criteria of purity.

### Unit 6

Rationale for the design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, purification tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems.

### Unit 7

Over expression conditions, production of inclusion bodies, solubilization of insoluble proteins Purification protocols and up scaling. Determination of purity and activity of over expressed proteins.

### Unit 1

Aero biology : Droplet nuclei, aerosol, assessment of air quality, solid liquid impingement methods, Brief account of air borne transmission of microbes viruses bacteria and fungi, their diseases and preventive measures.

Unit 2 Aquatic microbiology: Water ecosystems types fresh water (ponds, lake, streams) marine habitats (estuaries, mangroves, deep sea, hydrothermal vents, salt pans, coral reefs). Zonations of Water ecosystems - upwelling eutrophication food chain. Potability of water microbial assessment of water quality water purification brief account of major water borne diseases and their control measures.

Unit 3 Soil Microbiology : Classification of Soil Physical and chemical characteristics, microflora of various soil types (bacteria and nematodes in relevance to soil types; rhizosphere phyllosphere brief account of microbial interactions symbiosis mutualism commensalism competition amensalism synergism - parasitism predation ; biogeochemical cycles and their organisms, carbon nitrogen - phosphorus and sulphur, biofertilizers biological nitrogen fixation nitrogenase enzyme - nif genes; symbiotic nitrogen fixation (Rhizobium, Frankia) non symbiotic microbes - Azotobacter Azospirillum vesicular arbuscular mycorrhizae (VAM) ecto, endo, entomycorrhiza erumen microbiology

Unit 4 Waste treatment : Wastes types solid and liquid wastes characterizations solid liquid; treatments physical, chemical, biological - aerobic anaerobic primary secondary tertiary; solid waste treatment saccharification - gasification composting, utilization of solid wastes (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment trickling activated sludge - oxidation pond oxidation ditch. Subterranean microbes and biomediation

Unit 5 Positive and negative roles of microbes in environment: biodegradation of recalcitrant compounds lignin pesticides; bioaccumulation of metals and detoxification biopesticides; biodeterioration of paper - leather, wood textiles metal corrosion mode of deterioration organisms involved its disadvantages mode of prevention. Gmo and their impact

Unit 6 Introduction to microbial diversity, distribution, abundance, ecology. Oxygenic photosynthetic microbes and anoxygenic photosynthetic microbes. Oxidative transformation of metals: sulphur oxidation, iron oxidation, ammonia oxidation and hydrogen oxidation. Unculturable and culturable bacteria conventional and molecular methods of studying microbial diversity.

Unit 7  
Microbial diversity in anoxic ecosystem methanogens reduction of carbon monoxide - reduction of iron, sulphur, manganese, nitrate and oxygen Microbial transformation of carbon, phosphorus, sulphur, nitrogen and mercury. Extremophiles acidophilic, alkalophilic; thermophilic, and oxmophilic microbes, mechanisms and adaptation. Halophiles membrane variation electron transport; application of halophiles and extremophiles.

Chemical foundation of (i)  $p^H$ ,  $p^k$  acids, bases, buffers, weak bonds, free energy resonance, isomerisation. Carbohydrates: Monosaccharides and their relationship structure of sugars,

stereo isomerism and optical isomers of sugars. Reactions of aldehyde and ketone group, ring structure and tautomeric forms, mutarotation, reaction of sugars to OH groups. Important derivatives of monosaccharides, disaccharides and trisaccharides. Structure, occurrence and biological importance of structural polysaccharides e.g. cellulose, chitin, agar, alginic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, bacterial cell wall polysaccharides Storage food polysaccharides: glycogen, starch.

## Unit II

Lipids : Building block of lipids, fatty acids, glycerol, sphingosine. Definition and classification of lipids, Classification of fatty acids, physicochemical properties of fatty acids. Systematic nomenclature and classes of glycerides. Properties and function of phospholipids, prostaglandins. Classes, structure and synthesis. Lipoproteins-classification, composition and their importance. Role of lipids in cellular architecture and functions.

## Unit III

Nucleic acids Importance of nucleic acids in living systems, general composition of nucleic acids, purine and pyrimidine bases, tautomeric forms of bases, reactions of purines and pyrimidines, structure of nucleosides and nucleotides, deoxynucleotides, cyclic nucleotides and polynucleotides. Interaction of nucleic acids with protein molecules.

Proteins: Covalent properties of proteins Structure & chemistry of amino acids; Proteins Sequencing, covalent modification, splicing Primary, Secondary, tertiary and quaternary (folding patterns). Globular and fibrous proteins.

## Unit IV

Enzymes As biocatalyst, classification, specificity, active site, activity unit isozymes. Enzyme kinetics; Michaelis-Menton: Mention equation for simple enzymes, determination of kinetic parameters, multistep reactions and rate limiting steps, enzymes, inhibition, allosterism, kinetic analysis of allosteric enzymes, principles of allosteric regulation.

## Unit – V

Respiratory metabolism Embden Meyer Hof pathway Entner Doudroff pathway - glyoxalate pathway Krebs cycle oxidative and substrate level phosphorylation reverse TCA cycle gluconeogenesis Pasteur effect; fermentation of carbohydrates homo and heterolactic fermentations.

Assimilation of nitrogen dinitrogen nitrate nitrogen ammoniasynthesis of major amino acids polyamines; Synthesis of polysaccharides peptidoglycan biopolymers as cell components.

Semester – III

# MOLECULAR BIOLOGY AND MICROBIAL GENETICS

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Nucleic acids as genetic information carriers : experimental evidence. DNA structure : historical aspects and current concepts, melting of DNA replication: general principles, various modes of replication, isolation and properties of DNA polymerases, proof reading continuous and discontinuous synthesis, Asymmetric & dimeric nature of DNA polymerases and simultaneous, synthesis of leading and lagging strands, DNA polymerases, exonuclease activity in eukaryotic DNA polymerases, superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases.

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Initiation of replication of single standard DNA. Construction of replication fork in test tube. Retroviruses and their unique mode of DNA synthesis. Relation between replication and cell cycle. Inhibitors of DNA replication. repair pathways methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination, repair SOS system. Structural features of RNA and relation to function . Initiator and elongator class of tRNA, ribosome binding site on mRNA and corresponding site on rRNA. peptidyl transferase activity of 23S tRNA. Transcription: general principles, basic apparatus, types of RNA polymerases, steps : initiation, elongation and termination, inhibitors of RNA syntheses. Polycistronic and monocistronic RNAs. Control of transcription by interaction between RNA polymerases and promoter regions, use of alternate sigma factors, controlled termination : attenuation

and antitermination

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III

Regulation of gene expression: operon concept, catabolite repression instability of

bacterial RNA, positive and negative regulation, inducers and corepressors.

Negative

regulation E. coli lac operon; positive regulation E. coli ara operon; regulation by attenuation his and trp operons; antitermination N protein and nut sites in I.

DNA

binding sites on DNA, Global regulatory responses: heat shock response, stringent

response and regulation by small molecules such as ppGpp and cAMP, regulation of

rRNA and tRNA syntheses.

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IV

Maturation and processing of RNA: methylation, cutting and trimming of rRNA;

capping, polyadenylation and splicing of m RNA; cutting and modification of tRNA

degradation system. Catalytic RNA group I and group II intron splicing RNase P

Basic features of the genetic code. Protein synthesis: steps, details of initiation, elongation and termination, role of various factors in the above steps, inhibitors of

protein synthesis. Synthesis of exported proteins on membrane-bound ribosomes, signal

hypothesis. In vitro transcription and translation systems.

Gene transfer mechanisms transformation, transduction, conjugation and transfection.

Mechanisms and applications.

Genetic analysis of microbes, Bacteria and yeast

Importance and scope in biological experiments; Elements of Probability Mathematical,

Statistical and Axiomatic Definitions; Addition and multiplication. Theorems;

Probability

Distribution Function Binomial, Poisson and Normal; Area under Normal Probability

Distribution Curve.

Measures of Central Tendency Arithmetic, Geometric and Harmonic Means; Measures of

Dispersion Range, Quartile Deviation, Variance, Standard Deviation, Coefficient of Variation;

Confidence Limits of population Mean; Tests of Significance Hypotheses and Errors; Student t

test Population mean equals a postulated value, Equality of 2 independent population means

(Equal and Unequal Variances), Equality of 2 dependent means of a population.

Analysis of Variance One way classification with equal and unequal sample sizes, Two way

classification with one observation per cell, Completely Randomized Design,

Randomized Block

Design; Multiple Comparison Isd and Duncan's New Multiple Range test; Introduction to 2<sup>^</sup>

Factorial Design.

Relation between two variable; Linear Regression Regression diagram and equation, significance test, prediction of dependent variable from the independent one; Linear

Correlation

Scatter diagrams, correlation coefficient standard error, significance tests: Relationship

between

Correlation and Regression coefficients; Chi-square tests for goodness of fit, tests for

association

between attributes, Yate's Correction factor; Analysis of Covariance (One way

classification)

### Unit 1

Early discovery of pathogenic microorganisms; development of bacteriology as scientific discipline; contributions made by eminent scientists. Classification of medically important microorganisms; Normal microbial flora of human body; role of the resident flora; normal flora and the human host

### Unit 2

Establishment, spreading, tissue damage and antiphagocytic factors; mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts, Role of adhesins, depolymerising enzymes, organotropisms, variation and virulence. Organs and cells involved immune system and immune response

### Unit 3

Classifications; pathogenic bacteria. Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium Bacillus, Clostridium, Nonsporing Anaerobes, Organisms belonging to Enterobacteriaceae, Vibrios, Non fermenting gram negative bacilli Yersinia; Haemophilus; Bordetella, Brucella; Mycobacteria, Spirochaetes, Actinomycetes; Rickettsiae, Chlamydiae

### Unit 4

General properties of Viruses; Virus-Host interactions; Pox viruses; Herpes virus; Picornaviruses; Orthomyxoviruses; Paramyxoviruses; Arboviruses, Rhabdoviruses, Hepatitis viruses; Oncogenic viruses; Human Immunodeficiency Virus (AIDS). Dermatophytes, dimorphic fungi, opportunistic fungal pathogens. Description and classification of pathogenic fungi and their laboratory diagnosis

## Unit 5

Laboratory control of antimicrobial therapy; various methods of drug susceptibility testing, antibiotic assay in body fluids. Brief account on available vaccines and Schedules; passive prophylactic measures; Nosocomial infection, common types of hospital infections and their diagnosis and control

## Unit 6

Prokaryotic & eukaryotic signalling mechanisms: eukaryotic cell to cell signaling, endocrine signaling, Adipokines, prokaryotic signaling, quorum sensing and bacterial pheromones, intracellular signaling, signaling pathways.

## Unit 7

Injection and cell cell interactions; bacterial adherence: basic principles, effects of adhesion on bacteria, effect of adhesion on host cells. Bacterial invasion of host cells; mechanism, consequence of invasion, and survival after invasion. Protein toxins: agents of diseases.

Introduction of Bioinformatics: The nature of chemical bonds, Introduction to Genes and Proteins, Nucleotides, Orientation, Base pairing, The central dogma, Promoter sequences, Genetic Code, ORFs, Introns and Exons, Splice variants, Protein structure, Primary, Secondary, Tertiary and Quaternary, The notation of homology. Introduction to Data Generating Techniques: Restriction Enzymes, Gel Electrophoresis, Blotting and Hybridization, Cloning, PCR. Biological databases, Search engines, Public databases: PubMed, EMBL, GenBank, PDB, SwissPort. Genomics and Proteomics: Prokaryotic genomes, Eukaryotic Genomes, Gene Structure, GC Content in Eukaryotic genomes, Gene Expression, Protein Classification, 2D- Electrophoresis, Mass spectrometry, Microarray technology, X-ray crystallography, NMR, Sequence and Phylogeny Analysis, Detecting ORFs, Outline of sequence alignment, Introduction to BLAST, Multiple sequence alignment, Phylogenetic analysis.

Introduction to computer fundamental, Organization, low level and high level languages, Permanent storage of number system, flow charts and programming techniques (Logic

and algorithm) Decimal to binary and viceversa; binary coded decimal number.

Introduction to MSOffice software covering wordprocessing, spreadsheets and presentation software. Introduction to Hardware graphics/ Corel draw.

Application of computer in Biostatistical problems. Frequently table of single discrete viable, bubble sort, computation of mean, variance and standard deviation, ttest, correlation coefficient.

Computer in biology: Sequence databases; sequence analysis of proteins and nucleic acids, structure prediction, simple molecular modeling, computer aided drug designing.