UNIVERSITY OF CALCUTTA

Notification No. CSR/ 25 /13

It is notified for the information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of his powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 04.09.2013 approved the **revised syllabus** for the **M.Sc.** course of study in **Microbiology** under this University as laid down in the accompanying pamphlet.

The above will be effective from the academic session 2013-2014.

13-09-2013

SENATE HOUSE
KOLKATA-700073
The 13th September, 2013

(Prof. Basab Chaudhuri)
Registrar

The regulations for the Two-year M.Sc. course in Microbiology, University of Calcutta

1. The University of Calcutta shall provide instructions leading towards two year M.Sc. degree in Microbiology.
2. A candidate who has passed the 3-year B.Sc. Examination with **Honours in Microbiology** will be eligible for admission to this course.
3. A limited number of seats, at par with the UGC guidelines, will be available to the non-C.U. candidates. These students, however, will have to satisfy the same eligibility criteria applicable to the students of University of Calcutta.
4. The duration of the course shall be two academic years and the examination for the M.Sc. degree in Microbiology shall be held over four semesters over a total of 1000 marks. The duration of the semesters shall be as follows:

1st Semester	**July - November**
2nd Semester	**December - April**
3rd Semester	**July – November**
4th Semester	**December – April**

5. The courses shall comprise a total credit of 72 (seventy-two) evenly distributed over the four semesters. The courses shall be grouped as Core, Supportive and Optional and will carry credits according to the number of theoretical classes required, study hours and laboratory hours.

Semester-wise distribution of courses:

	Courses	**No. of courses**	**Marks**	**Credits**
1st Semester	Core courses	5	200	15
	Supportive courses	1	50	3
2nd Semester	Core Courses	5	220	16
	Supportive Courses	1	30	2
3rd Semester	Core Courses	4	170	12
	Supportive Courses	1	50	3
	Summer Project and Seminar		30	3
4th Semester	Core Courses	5	180	13
	Dissertation		40	3
	Grand Viva		30	2
		Total	1000	72

Grading of students' performance:

Marks	**Numerical grade points**	**Grades**
75-100	5.50 – 6.00	Outstanding (O)
65-74	4.50 – 5.49	Good (A+)
60-64	4.00 – 4.49	Fair (A)
55-59	3.50 – 3.99	Satisfactory (B)
50-54	3.00 – 3.49	Average (C)
0-49	Below 3.00	Fail (F)

Orientation of courses in different semesters for M.Sc. in Microbiology

1st Semester

CORE COURSES	Theo.	Prac.	15 credits
Micro C11: Biomolecular Structures & Their Interactions	30	20	3 + 1
Micro C12: Microbial Cell Biology	40	20	3 + 1
Micro C13: Molecular Biology	30	-	3 + 0
Micro C14: Biophysical Methods & Instrumentation	30	-	2 + 0
Micro C15: Microbial Metabolism	30	-	2 + 0
SUPPORTIVE COURSES			**3 credits**
Micro S11: Enzymes and Reaction Kinetics	30	20	2 + 1

2nd Semester

CORE COURSES			16 credits
Micro C21: Biostatistics	30	-	3 + 0
Micro C22: Structural Variations in Bacteria	30	-	2 + 0
Micro C23: Recombinant DNA Technology	40	30	3 + 1
Micro C24: Environmental Microbiology	30	30	2 + 1
Micro C25: Genetics (Prokaryotes & Eukaryotes)	30	-	3 + 0
SUPPORTIVE COURSES			**2 credits**
Micro S21: Regulation of Gene Expression	30	-	3 + 0

3rd Semester

CORE COURSES			12 credits
Micro C31: Evolutionary Biology and Biodiversity	30	-	3 + 0
Micro C32: Fermentation and Bioprocess Engineering	30	30	2 + 1
Micro C33: Medical Microbiology and Phycology	30	20	3 + 1
Micro C34: Proteomics and Genomics	30	-	2 + 0
SUPPORTIVE COURSES			**3 credits**
Micro S31: Computer Application and Bioinformatics	25	25	2 + 1
Summer project and Seminar	-	30	0 + 3

4th Semester

CORE COURSES			13 credits
Micro C41: Virology	30	-	2 + 0
Micro C42: Immunology	40	20	3 + 1
Micro C43: Host-microbe interactions	30	-	1 + 0
Micro C44: Antibiotics	30	-	3 + 0
Micro C45: Medical Biotechnology and Gene Therapy	30	-	3 + 0
Dissertation		40	0 + 3
Grand Viva		30	0 + 2

Duration of theoretical examinations in different semesters for M.Sc. in Microbiology

1st Semester

	Theo.	Duration
Micro C11: Bimolecular Structures & Their Interactions	30	1hr. 30min
Micro C12: Microbial Cell Biology	40	-do-
Micro C13: Molecular Biology	30	-do-
Micro C14: Biophysical Methods & Instrumentation	30	-do-
Micro C15: Microbial Metabolism	30	-do-
Micro S11: Enzymes and Reaction Kinetics	30	1hr. 30 min

2nd Semester

Micro C21: Biostatistics	30	1hr. 30min
Micro C22: Structural Variations in Bacteria	30	-do-
Micro C23: Recombinant DNA Technology	40	-do-
Micro C24: Environmental Microbiology	30	-do-
Micro C25: Genetics (Prokaryotes & Eukaryotes)	30	-do-
Micro S21: Regulation of Gene Expression	30	-do-

3rd Semester

Micro C31: Evolutionary Biology and Biodiversity	30	1hr. 30min
Micro C32: Fermentations and Bioprocess Engineering	30	-do-
Micro C33: Medical Microbiology and Phycology	30	-do-
Micro C34: Proteomics and Genomics	30	-do-
Micro S31: Computer Application and Bioinformatics	25	1hr

4th Semester

Micro C41: Virology	30	1hr. 30min
Micro C42: Immunology	40	-do-
Micro C43: Host-microbe interactions	30	-do-
Micro C44: Antibiotics	30	-do-
Micro C45: Medical Biotechnology and Gene Therapy	30	-do-

Detailed syllabus for two year M.Sc. Programme in Microbiology

Core Courses

Micro C11: Bimolecular Structures & Their Interactions

General structure of proteins in relation to biological function; chemistry of amino acids, polypeptides; four levels of protein structure, shape of protein molecules; concept of protein structure motif, idea of prosthetic groups, chemical modification of proteins, protein splicing, unfolding of protein structure, effect of heat, pH and chemicals, denaturation and refolding of proteins, in vivo protein folding: concept of chaperones. Protein primary sequence analysis and structure prediction. Watson-Crick model of DNA; sugar puckerings , base stacking; B-; A- and Z- DNA ; denaturation kinetics of DNA , Cot curves; structure of tRNA and ribosomes, Supercoiling of DNA and its influence on structure, Nucleosomal structure.

Practical:

Estimation of protein by different methods, Separation of biomolecules by electrophoresis, Estimation of number of free cysteines of a protein by absorption spectroscopy using DTNB reaction, Fluorescence spectrum of protein, Study of protein unfolding by fluorescence spectroscopy, Determination of molecular weight by gel filtration.

Micro C12: Microbial Cell Biology

Cell as a basic unit of living systems; precellular evolution of cell; the evolution of cell from prokaryotes to eukaryotes and from single cells to multicellular organisms; structure of the cell; isolation and fractionation of cells; internal organization of the cell; membrane structure; membrane constituents; phospholopids, glycolipids, cholesterol, membrane proteins, receptors and phospholipases; bilayer structure, asymmetry, fluid mosaic model of random diffusion of membrane components, domains in membrane- natural and artificial membranes; passive movements of solutes , ion distribution; mediated permeation; ionophores; membrane transport of small molecules and the ionic basis of membrane excitability; principles of membrane transport; carrier proteins and active membrane transport; ion channels and electrical properties of membranes; intracellular compartments and protein sorting; compartmentalization of cells; transport of proteins into mitochondria and chloroplasts; peroxisomes; the endoplasmic reticulum. Cell signaling; quorum sensing and cross kingdom signaling; signaling via G-protein-linked cell surface receptors; signaling via enzyme-linked cell surface receptors**.** Cell division; general strategies of the cell division in bacteria and yeast and molecular genetics of cell-cycle control**.**

Practical:

Microscopy: Bright field, Phase Contrast & Fluorescence. Cellular localization of protein by subcellular fractionation and immuno fluoresescence. Separation of organelles by differential centrifugation.

Micro C13: Molecular Biology

DNA replication in prokaryotes and eukaryotes: General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; telomerases: mechanism of replication, maintenance of integrity and role in cancer; Transcription: RNA polymerase subunits, different sigma factors- related to stress, viral infections etc., initiation, elongation and termination (rho- dependent and independent) of RNA synthesis;

antitermination, attenuation and other influences of translational apparatus on the process of transcription; eukaryotic promoters, enhancers, transcription factors, RNA polymerases; various protein motifs involved in DNA-protein interactions during transcription; translation: in prokaryotes and eukaryotes, processing of mRNA for translation and involvement of different translational factors at different stages of the process. DNA damage and repair: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways; recombination and transposition: models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination-mechanism, the double-stranded DNA breaks; site-specific recombination and transposition: lambda phage integration and excision, bacterial use of site-specific recombination, eukaryotic (yeast, maize, fruitfly) and prokaryotic transposons; molecular mechanisms of quorum-sensing in bacteria.

Micro C14: Biophysical Methods & Instrumentation

Thermodynamics: extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, isothermal process, entropy and second law of thermodynamics, reversible and irreversible process, free energy and chemical potential; Gibb's free energy; potentiometric determination of pK's of amino acids. Free energy of charged macro-ions; Debye-Huckel theory; Hydration, solvation number.

Instrumentaion: Principles of light absorption, extinction coefficient, ultraviolet, visible and infrared absorption spectrophotometer and their working principles; molecular vibrations, normal modes and group vibrations- hydrogen bonding effect on vibrational spectra; resonance Raman spectroscopy and its biological applications; Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD) and their application in the study of macromolecules; fluorescence and phosphorescence; Nuclear Magnetic Resonance (NMR); principles of chemical shift, spin-spin interactions, nuclear quadruple effects; electron spin resonance (ESR); UV-VIS spectrophotometer; Liquid Scintillation counter; pH meter; Ultracentrifuges, Optical microscopes, optical microscopy; phase, ultraviolet and interference microscope- their basic principles; optical systems and ray diagrams- their applications in cell biology; fluorescence microscope; microspectrophotometry of cells and tissues, fluorescence activated cell sorter (FACS).

Micro C15: Microbial Metabolism

Bacterial photosynthesis (different types of photosynthetic bacteria, photopigments, paths of carbon and electron in bacterial photosynthesis); metabolism of energy reserve compounds (polyglycans, poly- and β-hydroxybutyrate); metabolic energetics: basic differences in anaerobic and respiratory kinds of energy metabolism; electron transport system; basic mechanisms of ATP synthesis; energy conservation in chemolithotrophic bacteria (*Nitrobacter*, *Nitrosomonas*, *Thiobacilli* including *Thiobacillus ferrooxidans*, methanogens, hydrogen oxidizing bacteria); respiratory metabolism-Embden-Meyerhoff pathway, Entner-Doudroff pathway, phosphoketolase pathway, glyoxalate pathway, Krebs' cycle, oxidative and substrate level phosphorylation, reverse TCA cycle, gluconeogenesis- Pasteur effect; energy metabolism and microbial growth; growth yield coefficients, theoretical growth yield; fermentation of carbohydrates-homo and heterolactic ferementations- mixed acid, propionic acid, butyric acid, acetone-butanol etc. fermentations, substrate level phosphorylation in anaerobic energy metabolism; transport processes

Micro C21: Biostatistics

Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, Poisson and Gaussian distributions, additive and multiplicative laws of probability, concept and correlation; regression;

methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function; systematic and random sampling.

Micro C22: Structural Variations in Bacteria
Bacterial Cell wall: structures, diversities and biosynthesis, different cell wall hydrolyzing enzymes; bacterial endospores: structure, formation and germination; uncommon bacterial genera: Rickettsia, Chlamydia, Mycoplasma, sheathed bacteria, stalked and budding bacteria, gliding bacteria including Myxobacteria.

Micro C23: Recombinant DNA Technology
Principles and methods of recombinant DNA technology- hybridization, cloning, sequencing, polymerase chain reaction, genome projects; gene manipulations; cloning in *E.coli*, plasmids, bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in *E. coli*, products made in *E. coli* by genetic engineering; cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2μ plasmid, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector; features of yeast promoter and expression of cloned genes; yeast 2-hybrid system; plasmid shuffling to explore interactive domains of multimeric proteins; the cassette model for mating type switches and silencing of genes. Genetic engineering of plants: transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, *Agrobacterium tumefaciens*; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells- binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

Practical: Isolation of bacterial genome and plasmid DNA, transformation, restriction enzyme digestion, ligation, conjugation etc. Southern blotting. Assay of bacteriophage, induction pattern of temperature sensitive lysogens, purification of bacteriophage, isolation of nucleic acid from bacteriophage.

Micro C24: Environmental Microbiology
Microbiology of the hydrosphere: Major environmental conditions influencing microflora; distribution of microorganisms in the aquatic environments- freshwater, estuarine and marine environment; wastewater: characteristics, treatment processes (like trickling filter, activated sludge, oxidative pond, anerobic digestion and chemical disinfection. Microbiology of the lithosphere: General description of soil as culture media for microbes; soil as a habitat for microorganisms; methods of studying microorganisms and their activities in soil; biology and biochemistry of nitrogen fixation; biochemical transformation of inorganic and organic nitrogen compounds; microbial degradation of cellulose, hemicellulose, lignin, xylans, starch and pectin; biogeochemical cycles: carbon, nitrogen, sulfur and phosphorus cycle; biodegradation of petroleum hydrocarbons, pesticides, herbicides and xenobiotics; biofertilizers. Microbiology of extreme environments: General account of thermophilic, halophilic, acidophilic and alkaliphilic microorganisms; metal-microbe interactions; microbial control of heavy-metal pollution.

Practical: Detection of pathogenic contamination (*E. coli*, *Salmonella*, *Pseudomonas*) in food and water sample. Determination of BOD and COD of water. Detection of microbial biomass; Soil enzyme assay, BIOLOG; isolation and characterization of microorganisms from plant materials and soil; isolation and characterization of pathogenic microorganisms from diseased plant materials. Chemolithotrophic growth on reduced sulphur.

Micro C25: Genetics (Prokaryotes & Eukaryotes)

Prokaryotic

Genetic recombination in Bacteria: models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition: lambda phage integration and excision, bacterial use of site-specific recombination, eukaryotic (yeast, maize, fruitfly) and prokaryotic transposons; Identification and selection of mutants; transformation: natural transformation systems, mechanism, gene mapping by transformation; chemical and electrotransformation. Conjugation: discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F12 heteroduplex analysis, chromosome transfer in other bacteria, Transduction: Generalized and specialized transduction; gene mapping by specialized transduction, mechanism of generalized transduction, abortive transduction. DNA damage and repair: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways; recombination and transposition:
Techniques of studying Bacteriophages-virulent phage (T4) and Temperate phage (phage lambda). Important aspects of life cycles; phage genome and gene mapping; host parasite relationship, immunity and repression; site specific recombination (lambda and PI), Transposable phage (Phage Mu), genetic organization and transposition, Mu as a genetic tool.

Eukaryotic

Physical basis of Heredity: Cells, chromosomes, cell division, Mendel's laws, gametogenesis, life cycle of yeast; Single gene inheritance, terminology, allelic releationship, single gene crosses, pedigree analysis; Two or more genes: Independent assortment, dihybrid cross, Genetic interactions: Two factor interaction, epistatic interaction, non-epistatic interaction, interactions with three or more factors. Linkage and Chromosome mapping: Linkage, cross over, chi square test for linkage, recombination frequency and map construction, tetrad analysis in yeast and recombination mapping with tetrad, mapping with molecular markers.

Micro C31: Evolutionary Biology and Biodiversity

Origin of life (including aspects of prebiotic environment and molecular evolution); concepts of evolution, theories of organic evolution; mechanisms of speciation; Hardy-Weinberg genetic equilibrium; genetic polymorphisms and selection; origin and evolution of economically important microbes; interactions between environment and biota, types of ecosystems, population ecology and biological control; community structure and organization, concept of habitat and ecological niches, limiting factor, energy flow, food chain, food web and tropic levels, ecological pyramids and recycling, biotic community- concept, structure, dominance, fluctuation and succession; ecosystem dynamics and management, stability and complexity of ecosystems, speciation and extinctions, phylogenetic analysis. environmental impact assessment; principles of conservation; conservation strategies; sustainable development. Molecular basis of microbial phylogeny and taxonomy.

Micro C32: Fermentation and Bioprocess Engineering

Introduction to Bioprocess Engineering, Bioreactors, and Membrane Bio reactors, Isolation, preservation, and Maintenance of Industrialn Microorganisms, Kinetics of microbial growth and death, Media and medial sterilization for industrial Fermentation. Air quality Management and air sterilization. Types of Fermentation processes: Analysis of batch, Fed-batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.); Fermentation kinetic and monitoring; Measurements and control of bioprocess parameters.
Down stream processing: Introduction, removal of microbial cells and solid matter, foam preparation, precipitation, filtration, centrifugation, cell disruptions, liquid liquid extraction, chromatography,

Membrane process, Drying and Crystaliztion, Effluent treatment: D.O.C. and C.O.D. treatment and disposal of effluents. Whole cell immobilization and their industrial applications: Immobilized enzymes, enzymes in aqueous and nonaqueous media, Bioconversion and biotransformation. Industrial production of chemicals: alcohol (ethanol), Acids (citric, acetic, and gluconic), solvents (glycerol, acetone, and butanol) antibiotics (ampicillin, streptomycin and tetracyclin), microlodes, anticancer antibiotics, aminoacids (lysine, glutamic acids), single cell protein, single cell lipids. Use of microbes in mineral beneficiation and oil recovery. Introduction to food technology: Elementary idea of canning and packing– fat based edible products, sterilization and pasteurization of food products, fat-based nutraceuticals technology of typical food/food products (bread, cheese, idli, agro-products (oilseeds), food preservation, food colors, flavors, and antioxidants. Introduction to Bioprocesses technology: Hydrogenation, oxidation, esterification.

Practical:
Alcohol, butanol, antibiotic production. Solid state fermentation.

Micro C33: Medical Microbiology and Phycology
Medical Microbiology
Disinfectant, anti-sepsis, and sterilization: Different physical and chemical methods for these processes; Pathogenic bacteria, bacterial diseases, mechanism of pathogenesis, prophylaxis, therapy etc. (*Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Closridium*,) enterobactriacae (*Shigella, Salmonella, E.coli*), *Vibrio* etc., *Mycobacterium* etc. Accute diarrhoeal diseases, food poisoning , Meningitis, tuberculosis, diptheria, leprosy, urinary tract infection, cystic fibrosis, typhoid, enteritis (in *Helicobacter pylorae*), gastritis, cholera, pneumonia; Biology of obligate parasites (*Rickettsia, Chlymadia, Trypanosomes, Spirochetes*, etc.). Bioweapons-infectious agents and their epidemiology. Common mycotic infections in human: superficial, subcutaneous, cutaneous, and systemic mycoses. General description of mycotic pathogens, diagnosis and prevention.
Important human and veterinary parasites, life cycle and biology of *Plasmodium, Entamoeba, Leishmania, Wuchereria, Fasciola, Schistosoma*, host parasite interaction. Protozoa: Classification of Protozoa, general biology of protozoal cell, process of reproduction in common protozoal classes, importance of protozoa in soil and water eco-system.
Elements of mycology: General classification of fungi, fungal cell structure, structure and biology of fungal spores of different kinds, reproduction in fungi, mycotoxins.
Phycology
Basic characteristics of Algae: Cell structure, Structure of algal thallus, pigments, nutrition, reserve food matters, reproduction, position of algae in major divisions of life (5 kingdom to 8 kingdom classification- Whittakar, classification of algae- Lee), biological and economic importance of algae, major divisions of Algae: a) Cyanobacteria---Cell structure, genetics, ecology, nitrogen fixation, and affinity; b) Chlorophyta- general structure, affinity with land plants; algal ecology: eutriphication and algal diversity, nutrient removal, bloom formation, soil reclamation, algal toxin, phytoplankton ecology, algal biotechnology.

Practical: Identification of commonly occurring algae from different class- slide preparation and microscopic observation; isolation and identification of algae from soil sample; identification of phytoplankton from water sample.

Micro C34: Proteomics and Genomics
Genomics
Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis,

chromosome microdisection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genoimc libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance,Microarray

Proteomics

Mass spectroscopy, basic principle, MALDI-TOF, ESI; 2-D Gel electrophoresis, Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR**,** NOESY, COSEY.

X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

Micro C41: Virology

Classification and modes of propagation, bacterial, plant and animal viruses: morphology and ultra structure; assay of viral particle, cell culture, viral enzymes, nuclic acids, bacterio phages; lambda, T4, T7, M13, lytic cycle, lysogeny; viral replication, nuclic acid and protein synthesis, viral diseases. Virus host interaction: virus infection, viral diseases and pathogensis: Herpes, adeno, hepatitis, rhabdo, oncogenic viruses etc. DNA viruses: Herpes, hepatitis B, adenovirus; RNA viruses: polio, VSV, influenza, retroviruses: structure and life cycle, transformation; baculovirues.; molecular biology of genetic shift and drift in influenza virus, cellular trophism of HIV; Plant viruses: TMV.

Micro C42: Immunology

Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation; cytokines; cell mediated and humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique.

Practical:

Determination of blood group (ABORL), ODD (Ouchterlony double diffusion),
Immunoelectrophoresis. Enzyme Linked Immuno Sorbent Assay (ELISA), Immunohistochemistry

Micro C43: Host-microbe Interactions

Plant-microbe interactions: Rhizosphere and phyllosphere microorganisms and their interactions with plants; Symbiotic vs nonsymbiotic Nitrogen fixation, Symbionts and their cognate hosts, Regulation of Nitrogen fixation in a symbiotic vs a nonsymbiotic N fixer: Mechanism of inception of symbiosis, symbiosis vs pathogenesis. Plant pathogens (bacterial, fungal, algal and mycoplasmal): mechanisms of plant pathogenicity, beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungi).

Human-microbe mutualism and disease, manipulation of host cell pathways by bacterial and parasitic pathogens

Micro C44: Antibiotics

Definition, phenomenon of antibiotics, concept of secondary metabolites. Role of antibiotics in the

producer organism. Assay of antibiotics: chemical versus microbiological assay system, different methods of antibiotic assays (serial dilution, photometric and agar-diffusion methods) - theory and practice; Chemical and biochemical modification of antibiotic structures: development of antibiotics (different generations of antibiotics) taking penicillins and chloramphenicols as parent compounds. Phenomenon of antibiotic resistance. Different biochemical mechanisms of resistance development, multiple-drug resistance, its genetics and chemical significance. Biochemical modes of action of antibiotics acting as inhibitors of ribosomal function (as for example aminoglycosides, tetracyclines, puromycin, choloramphenicol, microlides etc.), inhibitors of nucleic acid metabolism (actinomycin D, mitomycin C etc.), inhibitors of cell wall biosynthesis (penicilline, bacitracins etc.) and inhibitors of membrane function (polyenes, tunicamycin, ionophores etc.).

Micro C45: Medical Biotechnology and Gene Therapy

Disease diagnosis-probe, PCR, LCR immunological assay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides.

Gene therapy, Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC.

Focusing on emerging infections, viral classifications, transmissions and preventions, viral pathogenesis, mechanisms of viral induced cancer and viral evolution, developmental biology of virally induced birth defects, factors in pathogenesis and transmission of prions. Cell mediated and Gene therapy as a novel form of drug delivery, vectors, cell types. Responses to viral infections; slow and persistent infections, anti viral agents, interferons, equipments and materials for animal cell culture technology. Primary and established cell line cultures. Introduction to the balanced salt solution and the simple growth medium. Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Serum and protein free defined media and their applications. Measurements of viability and cytotoxicity. Biology and characterization of the culture cells, measuring parameters of growth. Basic techniques of mammalian cell culture in vitro; desegregation of tissue and primary culture, maintenance of cell culture, cell separation. Scaling up of animal cell culture. Cell synchronization. Cell cloning and micromanipulation. Cell transformation. Application of animal cell culture. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines, somatic cell genetics, organ and histotypic cultures.

Supportive Courses

Micro S11: Enzymes and Reaction Kinetics

Definition of enzymes; active site, substrate, coenzyme, cofactor and different kinds of enzyme inhibitors; enzyme kinetics, two substrate kinetics, three substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity; allosteric model of enzyme regulation; substrate induced conformational change in enzyme; techniques for purifying and characterizing proteins and enzymes; idea of all analytical techniques like electrophoresis, liquid chromatography, crystallography, column chromatography for enzyme protein analysis.

Practical: Enzyme kinetics, effects of pH and temperature on enzyme, use of inhibitors for active site determination, Michaelis-Menten equation: determination K_M and V_{max}, chromatographic techniques for purification of enzymes.

Micro S21: Regulation of Gene Expression
Prokaryotic transcription and translation controls; various protein motifs involved in DNA-protein interactions during eukaryotic transcription; chromatin remodeling; different modes of mRNA, tRNA splicing, general discussion on various snRNPs, capping, polyadenylation and other processing events in eukaryotes, RNA editing; discussion on ribozyme; RNA interference: mechanisms and enzymology; regulation of gene expression by miRNP pathway; plant-virus interactions and silencing of RNA silencing. Role of post translational modifications in gene regulation.

Micro S31: Computer Application and Bioinformatics
General ideas on computer: Why computer, Information explosion in life sciences< need for processing; human being as information processor, as information generator, Class of problems that can be solved by a digital computer, problems which may not solved by digital computers.
Components of a digital computer: Block diagram of digital computer-detail of input units, output units, central processing unit pointing devices, fast input devices. Exotic input/output devices. Secondary storage devices. Types of digital computer, generation of digi9tal computer. Organization; low level and high-level language: binary number system Structured computer Organization: Various levels of digital computer, operating system as resource manager.
Windows-basic concepts and commands Unix as a multi user, multi tasking operating system Introduction to Linux Introduction to programming in C/MATLAB word processing, Spreadsheets, computer graphics and presentation software Algorithm and flow chart Sequential, conditional and looping problems.

Artificial vis-a-vis Natural language, Low and high level languages the basic concepts Binary number system Basic concepts of translation process (syntax, semantics etc) C as a programming language Alphabets and language elements Operators and separators strings Flow control, Relational operators Construction of compound statements Functions and structured programming- Top down approach, character processing Network and Internet Introduction and applications.
Bioinformatics: Applications and Prospects, Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package.

Summer Project and Seminar:
A project performance report based on the summer research training in a reputed laboratory of excellence will have to be submitted. A presentation of the accomplishments will be required before a panel of experts. Evaluation will be based on both the project report and presentation.

Dissertation:
A grant proposal on any relevant topic in biology will have to be prepared by students following the format of National Institute of Health, USA. The students will also be required to defend the proposal before a panel of experts. Both the written proposal and its defense will be taken into consideration for evaluation.

Grand viva:
Students will be evaluated on all the topics discussed in the two years programme by a panel of experts.