Scheme of Instruction & Syllabi

of

M.Sc Biotechnology

JIS UNIVERSITY,
81, Nilgunj Road,Agarpara
Kolkata -700109

Course structure and syllabus

For
M.Sc. Biotechnology (2-years)

SEMESTER - I:

Sl. No.	Paper Code	Title of the Paper	L	T	P	No. of Credits	No of Hrs./Week
1	MBT101	Biochemistry - I	3	1	0	4	4
2	MBT102	Microbiology	3	1	0	4	4
3	MBT103	Biophysical Techniques	3	1	0	4	4
4	MBT104	Cell Biology	3	0	0	3	3
5	MBT191	Biochemistry Lab	0	0	3	3	3
6	MBT192	Microbiology Lab	0	0	3	3	6
7	MBT193	Cell Biology Lab	0	0	3	3	3
8	MSD181	Skill Development	1	0	0	1	-
TOTAL						**25**	**27**

SEMESTER - II:

Sl. No.	Paper Code	Title of the Paper	L	T	P	No. of Credits	No of Hrs./Week
1	MBT201	Biochemistry - II	3	1	0	4	4
2	MBT202	Immunology	3	1	0	4	4
3	MBT203	Bioprocess engineering	3	0	0	3	3
4	MBT204	Molecular Biology	3	0	0	3	3
5	MBT291	Immunology Lab	0	0	3	3	3
6	MBT292	Bioprocess engineering Lab	0	0	3	3	5
7	MBT293	Molecular Biology Lab	0	0	3	3	5
8	MSD282	Project and Seminar	0	0	2	1	-
TOTAL						**25**	**27**

SEMESTER - III:

Sl. No.	Paper Code	Title of the Paper	L	T	P	No. of Credits	No of Hrs./Week
1	MBT301	Genetics	3	1	0	4	4
2	MBT302	Recombinant DNA Technology	3	1	0	4	4
3	MBT303	Bioinformatics and C Programming	3	1	0	4	4
4	MBT304	Program Elective	3	0	0	3	3
5	MBT391	Recombinant DNA Technology Lab	0	0	3	3	4
6	MBT381	Project and internal viva	0	0	7	7	8
TOTAL						**25**	**27**

SEMESTER - IV:

Sl. No.	Paper Code	Title of the Paper	L	T	P	No. of Credits	No of Hrs./Week
1	MBT401	Open Elective	3	1	0	4	4
2	MBT402	Open Elective	3	1	0	4	4
4	MBT404	Program Elective	3	0	0	3	3
5	MBT491	Project	4	0	12	12	16
6	MBT492	Seminar and Grand Viva	0	0	0	2	0
TOTAL						**25**	**27**

MBT101 Biochemistry-I **(3-1-0)**

Unit I: Enzymes: General properties, Nomenclature and classification; Co-factors definition and function with special reference to the representative substances - a) Co-enzymes (NAD+, NADP+, Co-enzyme-A, TPP, Pyridoxal phosphate); b) Prosthetic groups (FAD+ - Succinic dehydrogenase); c) Metal ions: Zn2+, Mg2+, Fe2+, Fe3+, Mn2+ - required for enzyme action

Unit II: Enzyme Kinetics: Michaelis-Menten equation; Enzyme Inhibition – Competitive, Non-competitive, Regulatory enzymes-Allosteric, Feedback inhibition, Ribozyme (catalytic RNA) and Abzyme (use of antibody as enzyme).

Unit III: Carbohydrate metabolism: Aerobic respiration-Glycolysis (EMP-pathway) with energy production: entry of galactose & fructose in EMP-path; TCA-cycle with energy production: pentose-phosphate pathway, Fermentation - Glucose metabolism in anaerobic condition.

Unit IV: Electron Transport Chain: ETC & ATP generation sites; ATP & ADP cycle (oxidationreduction potential and electromotive force). Photophosphorylation, oxidative phosphorylation (chemiosmotic theory)

Unit V: Anaerobic respiration - Utilizing NO_2, Sulfur (SO_4), CO_2 as electron acceptors; Stickland-reaction; Entner-Doudoroff pathway

Unit VI: Photosynthesis: Photosynthetic pigments, cyclic and noncyclic electron flow; Oxygen evolution system; Calvin cycle; C3 and C4 mode of photosynthesis.

Unit VII: Bacterial photosynthesis: Cyanobacteria and Green-sulphur bacteria; Difference with eukaryotic photosynthesis.

MBT102 Microbiology **(3-1-0)**

Unit I: Food microbiology: Microbes used in food fermentation, food preservatives of microbial origin, Microbes as food (SCP, organic acid, vitamins, neutraceuticals), enzymes of microbial origin and its use in food, contribution of microbes in food digestion, microbial food spoilage, microbial food borne diseases, control of microorganism in food, HACCP, biosensors in food.

Unit II: Clinical microbiology: Microbiome of human system, host pathogen interaction, medically important microbes, microbial diseases - sources, route of transmission. pathogenesis - adhesion, invasion, host cell damage, release of pathogens, signs and symptoms of microbial diseases. treatment, prevention and control of microbial infections. immunity of microbial diseases. diagnosis of microbial diseases modern methods of microbial diagnosis.
Treatment, prevention and control of diseases caused by bacteria,

Unit III: Enzyme in microbiology: Enzymes of microbial origin and its analytical, therapeutic & industrial applications, immobilization- process, property and application

Unit IV: Industrial microbiology: Production and application of microbial pigments, therapeutic compound, industrial production of organic acid, enzymes, amino acid, microbial production of biofuels, bioinsectices, biopolymer, biosurfactent, Biofertilizers.

Unit V: Microbial interaction study- quorum sensing, different types of interaction

Unit VI: Environment microbiology

Eutrophication, bioremediation, biomonitoring, bioterrorism, biogeochemical cycle, biofertiliser, waste utilization to valuable product

MBT103 Biophysical technique **(3-1-0)**

Unit I: Spectroscopic Techniques- Basic concept, UV-Visible, fluorescence, circular dichroism, nuclear magnetic resonance, FTIR, MALDI-TOF; Mass spectrometry

Unit II: Chromatographic methods- General principles, ion exchange, gel filtration, Affinity, HPLC, and gas chromatography techniques.

Unit III: Electrophoresis- General principles, horizontal & vertical gel electrophoresis, capillary electrophoresis, isoelectric focusing, 2D, pulse-field and immuno, electrophoresis. Disc gel electrophoresis; Gradient electrophoresis; SDS PAGE.

Unit IV: Centrifugation techniques- Basic principles, different types of centrifuges, analytical and preparative ultracentrifugation methods

Unit V: Microscopy- Basic concept, Light, Dark-field, phase contrast, fluorescence, confocal, scanning and transmission electron microscopy, Scanning Probe microscopy (AFM, STM)

Unit VI: Radioisotope techniques- Basic concepts, GM and scintillation counter, autoradiography, RIA, applications in biological science

Unit VII: Viscometry- Basic concepts, different types of viscometer, its working principle and application, Relation between intrinsic viscosity and molecular weight

Unit VIII: Surface tension- Definition, angle of contact, interfacial tension, capillary rise, determination of surface tension, temperature effect.

MBT104 Cell Biology **(3-1-0)**

Unit I: Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Unit II: Cytoskeleton - Types, tubulin and microtubules, Kinesin, Dynein, and intracellular transport, Cilia and flagella – Structure and movement. Action and myosin. Mechanism of muscle contraction. Intermediate filaments, motor proteins.

Unit III: Cell signalling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and quorum sensing.

Unit IV: Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Unit V: Protein traffic in cells - Protein sorting and signal sequences; protein translocation in ER and vesicular transport to Golgi, lysosmes and plasma membrane; protein import into nuclei, mitochondria, chloroplasts and peroxisomes.

Unit VI: Cell cycle - Phases of the cell cycle. Interphase, cytokinesis, Regulation of MPF activity, Cell cycle control in mammalian cells. Role of check points in cell cycle regulation. Cell cycle and cancer. Apoptosis.

MBT191 Biochemistry Lab

1. Making of Buffers
2. One dimensional TLC of amino acids and Carbohydrates
3. Two dimensional TLC of amino acids and Carbohydrates
4. Isolation and precipitation of proteins from natural sources and Wavelength scan of proteins
5. Estimation of proteins by Lowry and Brandford methods
6. Thermal unfolding of proteins and calculations of thermo-dynamic parameters from temperature scanning UV spectrophotometer, Effect of solvent conditions on thermal stability of proteins.
7. pH titrations of protein, calculation of net charge and total charge at a particular pH.
8. Reduction of disulphide bonds of proteins.
9. Estimation of DNA by chemical means and wavelength scan of DNA
10. Melting studies of calf thymus DNA
11. Effect of temperature, time and substrate concentration on salivary alpha amylase activity

MBT 192 Microbiology Lab

1. Staining technique

   i) simple staining

   ii) differential staining

   iii) endospore staining

   iv) capsule staining

2. Pure culture method – Enumerate the number of bacteria from air and soil.

3. Preparation of bacterial growth curve

4. Assay of antibiotics by agar cup method and dilution method

5. Biochemical tests

   i) Indole tests

   ii) Methyl red test

iii) Voges Proskaur tests

iv) Starch hydrolysis tests

v) Tests for catalase, lipase, protease, amylase and oxidase

vi) Gelatin hydrosis test

6. Isolation of Rhizobium from legume root nodule

7. Water microbiology – Testing for quality of water (coliform test)

MBT 193 Cell Biology Lab

1. Cell types of plants- maceration of various tissue explant and identification of xylem, trachied, stomata, root hair, etc.

2. Mitosis in onion root tip cells: All phases (Squash method).

3. Isolation of neutrophils and demonstration of phagocytosis.

4. Determination of osmotic fragility of RBC membrane.

5. Isolation of chlorophyll and xanthophyll from spinach leaves.

6. Whole cell immobilization (Yeast) by Na Alginate and the estimation of alcohol produced

7. Vital staining of mitochondria

8. Localisation of Barrbodies

9. Blood smear – differential staining and identification of different types of cell

MBT201 Biochemistry-II **(3-1-0)**

Unit I: Fatty acid metabolism: Oxidation of fatty acids - , and . Metabolism of ketone bodies - Formation, utilization, excretion and clinical significance. Biosynthesis of fatty acids. Metabolism of triglycerides, phospholipids and sphingolipids. Cholesterol-Biosynthesis, regulation, transport and excretion. Metabolism of lipoproteins. Eicosanoid metabolism.

Unit II: Amino acid metabolism: Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen - Transamination, deamination, ammonia formation and the urea cycle.Disorders of the urea cycle. Catabolism of carbon skeletons of amino acids. Conversion of amino acids to specialized products.

Unit IV: Nucleic acid metabolism: Metabolism of purines - De novo and salvage pathways for biosynthesis. Purine catabolism. Biosynthesis and catabolism of pyrimidines.

Unit III: Metabolism of other compounds: Biosynthesis and degradation of porphyrins and heme. Minerals - Sources, daily allowance, absorption, metabolism, biological role and clinical significance of calcium, phosphate and magnesium trace elements - Metabolism of iron - Absorption, storage, transport and excretion. Iron deficiency and overload. Copper, zinc, selenium, cobalt, manganese and fluoride. Integration of metabolism - Interconversion of major foodstuffs. Metabolic profile of the liver, adipose tissue and brain. Altered metabolism in starvation.

Unit IV: Industrial uses of enzymes: Sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheesed production. Clinical enzymology - Enzymes as thromblytic agents, anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase. Enzymes and isoenzymes in diagnosis - LD, CK, transaminases, phosphateases, amylase and cholinesterase. Immobilization of enzymes and their applications.

MBT202 Immunology **(3-1-0)**

Unit I: Introduction: Phylogeny of Immune system, innate and acquired immunity, Clonal nature of immune response. Organisation and structure of lymphoid organs. Nature and Biology of antigens and super antigens.

Unit II: Antibody diversity: Antibody structure and function, antigen and antibody interactions, Major histocompatibility complex, HLA. Generation of antibody diversity and complement system.

Unit III: Cells of immune system: Hematopoiesis and differentiation, lymphocyte trafficking, B-lymphocyte, T-lymphocytes, macrophages, Dentritic cells, natural killer and lymphokine activated killer cells. Eosinophils, neutrophils and mast cells. Activation of B and T- lymphocytes. Cell mediated cytotoxicity: mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity and macrophage mediated cytotoxicity.

Unit IV: Antigen processing: Antigen processing and presentation, generation of humoral and cell mediated immune responses, cytokines and their role in immune regulation, T- cell regulation, MHC- regulation, Immunological tolerance, Hypersensitivity, Autoimmunity, Immonosenesence.

Unit V: Immunological disorders: Transplantation, Immunity to infectious agents (intracellular parasites, helimenths & viruses,) Tumor Immunology, AIDS and other immunodeficiences. Hybridoma Technology and Monoclonal Antibodies.

Unit VI: Antigen - Antibody interactions: Precipitation reactions-Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions-Hemagglutination, passive agglutination, bacterial agglutination, agglutination inhibition.

Unit VII: Complement: The complement components, function, complement activation- (i) Classical, (ii) Alternate and (iii) lectin pathways.

Unit VIII: Hypersensitivity: Definition, types, examples.

MBT203 Bioprocess Engineering **(3-1-0)**

Unit I: Introduction to bioprocess engineering: bioreactors, isolation, preservation and maintenance of industrial microorganisms, kinetics of microbial growth and death, media formulation for industrial fermentation, Air and media sterilization. Designing of a fermenter/Bioreactor.

Unit II: Types of fermentation process: analysis of batch fed batch and continuous bioreactions, biotransformation, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.) Measurement and control of bioprocess parameters

Unit III: Downstream processing: introduction, removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment

Unit IV: Industrial production of chemicals: alcohols, acids (citric, acetic and gluconic), solvents (glycerols, acetone, butanol), antibiotics (penicillin, streptomycine, tetracycline) amino acids (lysine, glutamic acid), single cell proteins.

Unit V: Food Biotechnology: Food spoilage and preservation process, dairy products, wine, beer and other alcoholic Beverages and formulated plant products, petro crops, food from water, fungal protein food from yeast, hybrid seeds, conventional breeding of plant for food production. Transformation of steroids and non steroid compounds. Mushroom -types, isolation and culture.

MBT204 Molecular Biology **(3-1-0)**

Unit I: DNA Replication: Models of DNA Replication, Origin and direction of replication, Semidiscontinuous replication, DNA polymerases of prokaryotes and their mechanism of action; Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases. Replication strategies for replicating circular DNA: φ mode replication, σ mode or rolling circle replication and D-loop replication. Eucaryotic DNA polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and processivity of replication, Inhibitors of replication.

Unit II: DNA Repair and Recombination: DNA Repair mechanisms, Photoreactivation, Excision repair mechanism, Post replication repair mechanisms - recombination repair, mismatch repair system, SOS response, transcription-repair coupling. Recombination - models of general recombination; Hollyday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination. Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

Unit III: Transcription and Transcriptional control: Structure of bacterial RNA polymerase, Transcription events, and sigma factor cycle, Eukaryotic RNA polymerase, Promoter sequences, TATA box, Hogness Box, CAAT box, Enhancers, upstream activating sequences, Initiation and termination of transcription factor, RNA processing in Prokaryotes Vs Eukaryotes, Spliceosome.

Unit IV: Translation: Prokaryotic and Eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation. Post-translational modifications and intracellular proteins transport

Unit V: Control of gene expression in prokaryotes and eukaryotes: operon model- lac and trp operon, Autogenous regulation, Feedback inhibition, Lytic cascades and lysogenic repression. Molecular Biology of Cancer causes and Genetics of cancer, Tumor suppressor genes and onco genes, anticancer agent (p53 and pRB).

MBT 291 Immunology Lab

1. Simple immunodiffusion

2. Radial immuodiffusion

3. Immuno-electrophoresis

4. Spot ELISA

5. Blood group and Rh typing

6. Rocket electrophoresis

7. Ag-Ab agglutination reaction

MBT 292 Bioprocess Engineering Lab

1. Determine the growth patterns and specific growth rate of *E. coli*

2. Determine the effect of peptone concentration on *E. coli* growth

3. Determination of specific thermal death rate constant (kd) for *E. coli*

4. Determine the effects of temperature & pH on the growth of bacteria

5. Upstream and Downstream of bioprocess for the production of Citric acid by *Aspergillus niger*

6. Citric acid production from whey with glucose as supplementary carbon source by *Aspergillus niger*

7. Upstream and Downstream of bioprocess for the production of α-amylase by *Aspergillus nudulans*

8. Preparation of immobilized enzymes & cells and evaluation of kinetic parameters.

MBT 293 Molecular Biology Lab

1. DNA isolation - from Plant cell, Animal cell (goat liver), Human Blood & Microbes

2. Plasmid DNA isolation

3. Gel electrophoresis

4. Making competent cells and transformation of *E. coli* with recombinant plasmids

5. PCR amplification of DNA from unknown bacteria

MBT 301 Genetics **(3-1-0)**

Unit I: Mendelian principles: Dominance, segregation, independent assortment.

Unit II: Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests

Unit III: Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Unit IV: Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Unit V: Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Unit VI: Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Unit VII: Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Unit VIII: Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit IX: Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Unit X: Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

MBT 302 Recombinant DNA Technology Code 3-1-0

Unit I: Techniques and enzymes in genetic recombination: Core techniques and essential enzymes used in recombination: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation.

Unit II: Plasmids: Properties, incompatibility, isolation and purification techniques, plasmid vectors and their properties, PBR 322 – its construction and derivatives, single stranded plasmids, promoter probe vectors, runaway plasmid vectors.

Unit III: Bacteriophage lambda (l) as a vector: Essential features, organization of l genome, general structure, rationale for vector construction, improved l vectors, l gt series, l EMBL vectors, invitro packaging, cosmids, phasmids, filamentous phage vectors, l zap, l blue print vectors.

Unit IV: Specialized cloning strategies: Expression vectors, promoter probe vectors, vectors for library construction, genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning, phage display. Recombinant DNA technology with reference to cloning and production of interferon and insulin. Miscellaneous applications of Genetically engineered micro organisms (GEMS) / genetically modified organisms (GMO's).

Unit IV: PCR methods and Applications: PCR methods and Applications DNA sequencing methods, Dideoxy and Chemical method. Sequence assembly. Automated sequencing.

Unit V: Molecular mapping of genome: 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 microdissection and microcloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. animal trafficking and poaching: Germplasm maintenance, taxonomy and Biodiversity.

MBT303 Bioinformatics and C Programming **3-1-0**

Unit I: Introduction to Computer: Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

Unit II: Introduction to Bioinformatics: Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases. Types of data bases – Gen bank, Swiss port, EMBL, NCBL, and PDB. Database searching using BLAST and FASTA.

Unit III: Multiple sequence alignment and Dynamic programming: Gene and Genome annotation – Tools used. Physical map of genomes. Molecular phylogeny - Concept methods of tree construction.

Unit IV: Protein secondary structure prediction: Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery.

MBT 391 Recombinant DNA Technology Lab

1. UV mutagenesis and percent survival
2. Photoreactivation of UV irradiated E. coli.
3. Development of auxotrophic mutants employing EMS
4. Screening of multiple antibiotic resistant mutants of E. coli
5. Plasmid curing in bacteria
6. Replica plating technique
7. Determination of purity and estimation of DNA
8. Transfection by single burst experiment
9. Blue and white colony selection employing X-gal-IPTG

Departmental Electives

MBT105 Bioenergetics **(3-0-0)**

Unit I: Free energy concept: Molecular basis of entropy, concept of free energy, standard free energy and measurement of free energy, significance in metabolism. Application of first and second law of thermodynamics to biological systems. Energy rich bonds - ATP and interconversions of nucleotide phosphates. Phosphorylation potential

Unit II: Energy conversions - mitochondria: Architecture, chemical activity of mitochondria. Sequence of electron carriers and sites of oxidative phosphorylation, ATP generation, heme and non- heme iron proteins. Thermodynamic considerations, oxidation - reduction electrodes, standard electrode potential, redox couples, phosphate group transfer potential. Respiratory controls. Theories of oxidative phosphorylation, uncouplers and inhibitors of energy transfer. ATP synthetase complex. ATP generation in bacterial system.

Unit III: Chloroplast: Architecture, - light harvesting complexes, bacteriorhodopsin, plastocyanin, carotenoids and other pigments. Hill reaction, photosystem I and II - location and mechanism of energy transfer, photophosphorylation and reduction of carbon dioxide. Calvin cycle , quantitative efficiency, photorespiration, C4 - metabolism.

Unit IV: Chemiosmotic theory and evidence for its occurance: ion transport through membranes, proton circuit and electrochemical gradient, ionophores, Q cycle and stoichiometry of proton extrusion and uptake, P/O and H/P ratios, reverse electron transfer.

Fractionation and reconstitution of respiratory chain complexes.

Unit V: Nitrogen fixation: Biological fixation of nitrogen, symbiotic and nonsymbiotic nitrogen fixation.

Unit VI: Hormones : General classification of hormones - synthesis, structure, secretion, transport, metabolism and mechanism of action of pancreatic, thyroid, parathyroid, hypothalamus, pituitary, adrenal and prostaglandins. Hormonal control of spermatogenesis, menstrual cycle, pregnancy and lactation . Cell membrane and intracellular receptors for hormones. Secondary messengers

Plant growth hormones - auxins, gibberllins, abscessic acid, cytokinins.

Pheromones

Bacterial hormones.

MBT 205 Ecology and Environmental Science (3-0-0)

Unit I: The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Unit II: Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Unit III: **Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Unit IV: Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit V: Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Unit VI: Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

MBT 304 Virology **(3-0-0)**

Unit I: Classification and Morphology of Viruses: Cataloging the virus through virus classification schemes of ICTV / ICNV. Morphology and ultra-structure of viruses. Virus related agents, viroids and prions.

Unit II: Cultivation and assay of viruses: Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems). Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA.

Unit III: Assay of viruses: Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.) Infectivity Assays (Plaque and end-point) Genetic analysis of viruses by classical genetic methods.

Unit IV: Viral Multiplication: Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses, mechanism of RNA synthesis, mechanism of DNA synthesis, transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions, multiplication of bacteriophages.

Unit V: Pathogenesis of Viruses: Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV]. Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

Unit VI: Control of Viruses and Emerging Viruses: Control of viral infections through vaccines, interferons and chemotherapeutic agents. Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus. Emerging viruses

MBT 305 Biostatistics **(3-0-0)**

Unit I: Random Experiment, Outcome, Event, Mutually exclusive events, Equality like and exhaustive, Classical definition of probability, conditional probability and statistical independence. Sequencial definition of probability. Baye's theorem and related problems. Axiomatic approach of probability. Exercise.

Unit II: Random variable. Probability space .Expectation. Theorems on Expectation. Joint distribution of two random variables.

Unit III: Probability distribution- Continuous and Discrete. Probability Density function. Probability Mass function. Binomial , Poisson, Normal and Rectangular distributions and their properties.

Unit IV: Elements of Statistical methods. Primary data and secondary data. Population and sample. Sample survey. Chart and diagram. Frequency distribution. Measure of central Tendencies- Mean , Median and Mode. Standard Deviation, Varience. Moment , Skewness and Kurtosis.

Unit V: Sampling distribution. Fundamental distributions- Standard normal distribution, Chi- square Distribution.

Unit VI: Bivariate Frequency Distribution. Correlation and Co-efficient. Regression lines. Curve fittings.

MBT 401 IPR, Biosafety and Bioethics (3-0-0)

Unit I: Biosafety: Introduction and Development of Biosafety Practices and Principles, General lab requirements, Definitions and Biosafety levels: 1,2,3,4; Summery of Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response.

Unit II: Bioethics: History and Introduction of Ethics and genetic engineering, Genetic Privacy, Patent of genes, Human races, Trading Human Life, Human Cloning, Stem Cells, Eugenics, Biotechnology and Christian faith, Human genome and religious considerations Case Studies.

Unit III: IPR: Introduction, Types of Intellectual Property Rights, Plant and Animal growers rights, Patents, Trade secretes, Copyrights, Trademarks, IPR and plant genetic recourses, GATT and TRIPS and Dunkels Draft, Patenting of biological materials, International conventions and cooperation, Current Issues, Patents for higher animal and higher plants, Patenting of transgenic organisms and isolated genes, Patenting of genes and DNA sequences, Indian scenario.

MBT 402 Proteomics and Genomics (3-0-0)

Unit I: Introduction: Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II: Genome sequencing projects: Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III: Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV: Pharmacogenetics: High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development.

Unit V: Functional genomics and proteomics: Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Cell Culture Technology and Tissue Engineering (3-0-0)

Unit I: Plant tissue culture technology: Culture media – composition and preparation. Factors governing in vitro behaviour, Somatic embryogenesis, organogenesis and plant regeneration. Culture types. Micro propagation, Haploids, somaclonal variations, , metabolite production in cultures. Isolation of protoplasts, protoplast fusion and culture. Somatic hybridization.

Unit II: Animal cell and tissue culture: Primary culture, balanced salt solutions and simple growth medium. Serum and protein free defined media. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture in vitro. Tissue and organ culture. Production and use of artificial tissues and organs – Skin, liver and pancreas. Apoptosis - mechanism and significance.

Unit III: The biology of stem cells: Different types of stem cells – embryonic stem cells, fetal tissue stem cells, adult stem cells; stem cell differentiation, stem cell plasticity – Differentiation versus stem cell renewal. Isolation and propagation of embryonic stem cells; chimeras; generation of knockout mice and knock-in technology.

Unit IV: Hematopoietic stem cells and bone marrow transplantation: Cells for hematopoietic reconstitution – Cord blood stem cells; cells for adoptive cellular immunotherapy; bone marrow transplantation - advantages and disadvantages. Allogenic, autologous, syngenic and congenic transplantation. Clinical applications of stem cell therapy; neurodegenerative diseases – Parkinson's disease, Alzheimers, spinal cord injury and other brain syndromes.

MBT 404 Developmental and Cancer Biology (3-0-0)

Unit I: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit II: Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit III: Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Unit IV: Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Unit V: Cancer: oncogenes, tumor suppressor genes, micro RNAs in cancer, Chromosomal rearrangements and cancer, Viruses and cancer, Chemical carcinogenesis, Cell Cycle Control, G1 and "Go" Signals, Stop Signals, Cell Cycle in Stem Cells, Growth factors and Cancer Signaling, Metastasis, Angiogenesis, Tumor microenvironments and Stroma, Inflammation and Cancer, Therapeutic strategies.