

Following are the papers of **1st semester** for the years 2013-14, 2014-15 & 2015-16

BT 1.1: CELL BIOLOGY and EVOLUTION

UNIT-I

Structure of typical bacterial, plant and animal cells and functions of cell organelles. Mechanism of cell division. Cell cycle – Molecular events including cell cycle check points and Cdk – cyclin complexes and their role in cell cycle regulation. Ultra structure of plasmamembrane - Components and membrane asymmetry. Transport processes - active transport, ionophores and ion channels. Exo and endocytosis. Phago and pinocytosis.

UNIT-II

General morphology and functions of endoplasmic reticulum. Signal hypothesis. Ribosomes - eucaryotic and procaryotic. Ribosomal proteins. Role of Golgi in protein secretion. Lysosomes and peroxisomes. Cytoskeletal elements. Cell – cell interaction.

UNIT-III

Mitochondria - structure, biogenesis and enzymatic compartmentation. Organization of mitochondrial respiratory chain, mechanism of oxidative of phosphorylation. Ultra structure of the chloroplast. Photosynthesis - photophosphorylation. Carbon dioxide fixation in C-3, C-4 and CAM plants. Photorespiration.

UNIT-IV

Organic evolution: Origin of life. Species concept, population, clones, races, and subspecies. Mechanisms of speciation. Role of isolating mechanisms. Lamarckism, Darwinism, Neo-Darwinism, synthetic theory of evolution. Micro, macro and mega evolution, sequential and divergent evolution. Natural selection.

BT 1.2: BIOMOLECULES

UNIT-I

Chemical foundations of Biology – pH, pK, acids, bases, buffers, weak bonds and covalent bonds. Classification, structure, properties and biological significance of carbohydrates. Monosaccharides, Disaccharides, and Polysaccharides. Biological role of peptidoglycans, glycosamino glycans and Lectins. Lipids - classification, structure and properties of fatty acids, triglycerides, phospholipids, sphingolipids and cholesterol.

UNIT-II

Amino acids - Classification, structure and physico-chemical properties. Chemical synthesis of peptides – solid phase peptide synthesis. Proteins - classification, purification and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Confirmation of proteins – Ramachandran plots. Denaturation of proteins. Hetero cyclic compounds – Heme and Chlorophylls.

UNIT-III

Structure and properties of purines, pyrimidines, nucleosides, and nucleotides. Covalent structure of DNA and different forms of DNA - A,B and Z. DNA super coiling. Types of RNA and covalent structure of t-RNA. Classification, structure and physiological roles of Vitamins.

UNIT-IV

Hormones- classification and mechanism of action of steroid and protein hormones. Signal transduction cascade by cyclic AMP, Phospho inositate and calcium (Ca^+), G-proteins, growth factors and membrane receptor tyrosine kinases. Phytohormones and their physiological roles.

BT 1.3: MICROBIAL PHYSIOLOGY & GENETICS

UNIT-I

Classification and cultivation of bacteria. Bacterial reproduction and growth curve. Preparation of bacteriological media. Staining techniques. Differences between gram positive and gram negative bacteria. Methods of sterilization, pasteurization and disinfection. Microbiology of water, milk, air, soil and sewage. Clinically important bacteria. Biohazards - safety precautions.

UNIT-II

Chemical nature and classification of bacteriophages. Parasitic and temperate phages. Plant and animal viruses – multiplication of viruses. General characteristics of T Phase, ϕ x174, SV40, TMV. Clinically important viruses, retroviruses, HIV, Hepatitis B Virus and viral infections. General account of algae molds and yeasts. Economic importance of algae and fungi. Clinically significant protozoans.

UNIT – III

Microbial genetics: Recombination in prokaryotes, Transformation, conjugation, transduction and sexduction. Mapping of prokaryotic gene. Transposons, retrotransposons and mechanism of transposition. Viral genetics. Biology of plasmids. Extra chromosomal inheritance.

UNIT-IV

Genetics of Eukaryotes: Gene & Environment, Genotype and phenotype, Mendel's experiments, Dominance relationships. Multiple alleles, Gene Interaction, Gene mutations, Sex determination, Sex linkage, Linkage and recombination in diploids. Tetrad analysis. Elements of gene mapping, Pedigree analysis

BT 1.4: ANALYTICAL TOOLS AND TECHNIQUES IN BIOTECHNOLOGY

UNIT-I

Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Properties of electromagnetic radiations. Principles, instrumentation and applications of UV, visible, NMR spectroscopy. Mass spectrometry, X-ray diffraction. Flow cytometry.

UNIT-II

Principles and applications of gel-filtration, ion-exchange and affinity chromatography. TLC, GLC and HPLC. Basic principles of sedimentation. Applications of preparative and analytical ultra centrifuges. Principles and applications of lyophilization.

UNIT-III

General principles of electrophoretic techniques. Poly Acryl amide Gel Electrophoresis. Iso-electric focusing. Isotachopheresis. 2-D Electrophoresis. Capillary electrophoresis. Agarose gel electrophoresis of DNA and RNA. Blotting techniques. DNA fingerprinting.

UNIT-IV

Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences. Autoradiography. Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Operation of pH electrodes. Principles and applications of Ion-selective and gas sensing electrodes. Oxygen electrodes.

Following are the papers of **1st semester** for the years 2016-17, 2017-18 & 2018-19

BT 101 Cell Biology

Unit I:

Structure of a typical cell, Differences between prokaryotic and eukaryotic cells, animal and plant cells, Nucleus - structure and function of nuclear membrane, nucleolus, chromosome and its high resolution organization, DNA-histone interactions - formation of chromatin fibers - Hetero/ Euchromatin, endoplasmic reticulum, golgi, lysosomes, vacuole, microbodies, ribosomes, cytoskeleton, extracellular matrix.

Unit II:

Biomembranes - Chemical composition of membranes of animal and plant cells, Distribution of membrane lipids, assembly of membrane components, molecular structure of membranes, micelles and liposomes, symmetry of the membrane; membrane fluidity; fluid mosaic model of biological membranes; membrane Transport - Donnan membrane equilibrium, Diffusion across cellular membranes mediated transport; Energetics of transport systems; Passive transport - anion exchange proteins; active transport; active transport of Na^+ K^+ (Sodium potassium ATPase) Ca^{2+} (Ca^{2+} -ATPase); active transport of sugars coupled to phosphorylation; group translocation (γ -Glutamyl cycle); proton motive force in bacterial transport processes; ionophores, gap junctions; endocytosis, exocytosis; nature of receptors.

Unit III:

Mitochondria - structure, biogenesis and enzymatic compartmentation; organization of mitochondrial respiratory chain; mechanism of oxidative phosphorylation; ultrastructure of the chloroplast; Photosynthesis – photophosphorylation; Carbon dioxide fixation in C3, C4 and CAM plants; Photorespiration.

Unit IV:

Cell division and chromosomal variations: Mechanism of cell division - mitotic apparatus, cytokinesis, chromosome movement; Meiotic process - stages, chromosome pairing, chiasma formation molecular mechanisms of recombination, synaptonemal complex; Nondisjunction, regulation of eukaryotic cell cycle - Molecular events including cell cycle check points and CDK – cyclin complexes; Chromosomal abnormalities - euploidy, haploidy - their fundamental and practical significance, polyploidy - induction - aneuploidy - type and genetic significance.

BT102 Biomolecules

Unit I:

Chemical foundations of biology – pH, pK, acids, bases, ionization of water, buffers - buffering in biological systems, chemical bonding – various forces and interactions in biological systems; Amino acids – classification, structure and physicochemical properties, non-protein amino acids, Peptide bond – Structure and conformation, Naturally occurring peptides; Proteins – classification, purification, isolation and criteria of homogeneity; sequence determination and characterization of proteins, physicochemical properties, structural organization of proteins, Elucidation of primary structure, secondary structure, tertiary structure, quaternary structure, Denaturation & renaturation of proteins.

Unit II:

Carbohydrates: Definition and classification of carbohydrates, nomenclature, Reaction of Mono-saccharides, Acid derivatives of Monosaccharides amino-sugars, Oligo saccharides, structure, and properties, Chemistry and biological roles of homo and heteropolysaccharides, peptidoglycan, glycosaminoglycans, glycoproteins and other glycoconjugates.

Unit III:

Classification of Lipids, Fatty acids and their physicochemical properties, physicochemical properties and characterization of fats and oil; Structure, properties and biological roles of triacylglycerol, phospholipids, sphingolipids, Gangliosides, Prostaglandins, Thromboxanes, Leukotrienes and steroids.

Unit IV:

Nucleic acids – bases, nucleosides, nucleotides, purine and pyrimidine bases physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non enzymatic transformation of nucleotides and nucleic acids, chemical synthesis of DNA; Nucleic acid sequencing – Higher orders of DNA & RNA Structure, chromatin structure; Three dimensional structure of DNA; Types of RNA, Structure of RNAs – Secondary and Tertiary structure; DNA denaturation and renaturation kinetics.

BT103 Microbiology

Unit I:

History and Scope of Microbiology; Classification of Microorganisms-Bacteria, Fungi, Virus, Alga, Protozoa, phenotype, numerical and phylogenetic tree - rRNA, DNA and Proteins, Microbial diversity, Major characteristics used in taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations- (protein, nucleic acid composition); sterilization techniques, disinfectant and antiseptic agents; Major groups of bacteria- Archaeobacteria, Actinomycetes, Chemoautotrophs, Eubacteria, Pseudomonads, cyanobacteria; Bacterial cell- structure and functions of cellular components-cell wall composition of Gram positive and Gram negative bacteria, sub-cellular organizations, flagella, capsule and spores.

Unit II:

Modes of nutrition – phototrophy, chemotrophy, methylotrophy, organotrophy, mixotrophy, saprophytic, symbiotic and parasitic modes of nutrition; Isolation of microorganisms – Direct and indirect; Methods of maintenance of culture, composition of culture media - solid and liquid media, chemically defined media, complex and differential media; Growth and kinetics of bacterial cells; batch and continuous cultures, chemostat; Effect of pH, temperature and radiation on microbial growth; Preservation of cultures (glycerol stocks, freeze drying); staining techniques, differences between Gram-positive and Gram-negative bacteria.

Unit III:

Introduction to Virology: Classification, Morphology, size, ultra structure and life cycle of some representative viruses (ØX174, t4, SV40, Phage λ , m13 and HIV); Methods of culturing of viruses, Biology of subviral agents – Viroids, Prions, Satellite viruses, Antiviral agents-chemical and biological agents; Molds – characteristics, classification and reproduction; Yeasts – morphology, characteristics and reproduction; General characteristics of Actinomycetes, Rickettsia, Spirochaetes and mycoplasma; Economical and industrial uses of algae.

Unit IV:

Role of microorganisms in domestic and industrial sewage; Microbes and Diseases - Diseases of the respiratory tract-diphtheria, tuberculosis, pneumonia, influenza, mumps; Diseases of the skin- systemic mycoses, candidiasis; herpes viral infections, chicken pox, and small pox; Genitourinary infections- Gonorrhoea, syphilis; Diseases of GIT- Cholera, Typhoid; Hepatitis; Major human protozoan diseases- Malaria, Trypanosomiasis, meningoencephalitis, Viral diseases – Dengue, Hepatitis, HIV, Polio, Rabies, SARS; Inactivation of viruses – photodynamic inactivation.

BT104 Analytical Techniques

Unit I:

Microscopy- Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy; Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, ORD, CD, NMR spectroscopy; Spectrofluorimetry and mass spectrometry, X-ray diffraction; Flow cytometer.

Unit II:

Chromatography - Principles and applications of gel-filtration, ion-exchange and affinity chromatography; TLC, GLC and HPLC; Centrifugation - Basic principles of centrifugation, types of centrifuges, Applications of preparative and analytical ultra-centrifuges, Principles and applications of sedimentation and lyophilization.

Unit III:

Electrophoresis - Principle of electrophoretic techniques, Poly Acryl amide Gel Electrophoresis, Isoelectric focusing, Isotachopheresis, 2-D Electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis of DNA and RNA, Blotting techniques.

Unit IV:

Stable and radioactive isotopes, Detection and measurement of radioactivity, Applications of radioisotopes in biological sciences, Autoradiography, Non-isotopic tracer techniques; Principles and range of electrochemical techniques, Operation of pH electrodes, Principles and applications of Ion-selective and gas sensing electrodes, Oxygen electrodes.

Following are the papers of 2nd semester for the years 2013-14, 2014-15 & 2015-16

BT 2.1: ENZYMOLOGY & METABOLISM

UNIT – I

Factors affecting the rates of enzyme catalysed reactions. Assay of enzyme activity – units of enzyme activity. Multisubstrate reactions. Enzyme – substrate (protein ligand) binding. Methods for measurement of k_m . Coenzymes, metalloenzymes, and isoenzymes with examples.

UNIT-II

Active site determination. Mechanism of enzyme action of Chymotrypsin & Trypsin, carboxy peptidase-A and ribonuclease A. Multienzyme systems. Covalent modification. Zymogen activation. Enzyme inhibition – Competitive, non-competitive and uncompetitive. Allosteric enzymes, Ribozymes and catalytic antibodies.

UNIT – III

Glycolysis, Glycogenolysis, glycogenesis, gluconeogenesis, HMP shunt path way and their regulation. Tricarboxylic acid (TCA) cycle, Glyoxylate cycle and its significance. Biosynthesis and oxidation of fatty acids. Metabolism of cholesterol. Ketone bodies. Biosynthesis of Heme and chlorophylls.

UNIT – IV

Protein turnover. General metabolic reactions of amino acids. Urea cycle. Nitrogen fixation. Essential and non-essential amino acids. Biosynthesis and degradation of aromatic and branched chain aminoacids. Inborn errors of amino acid metabolism. Biosynthesis of purine and pyrimidine nucleotides and their regulation. Catabolism of purines and pyrimidines.

BT 2.2: MOLECULAR BIOLOGY

UNIT – I

Organization of genetic material - Packing of DNA in to chromatin - protein components of chromatin, histones, nucleosome organization. Solenoids loops, domains & scaffolds. Gene amplification, polytene chromosomes. DNA replication – apparatus, enzymes involved and mechanism. Replication at telomeres. DNA damage and repair mechanism. Nuclear genome.C - value paradox. Mitochondrial & plastid genomes and genes. Fine structure of the eukaryotic gene. Split genes. Different kinds of genes: overlapping, assembled, polyprotein & nested genes.

UNIT – II

Transcription in prokaryotes and eukaryotes. Mechanism of transcription, enzymes and transcription factors, zinc finger, leucine zipper mechanism. Maturation and processing of m-RNA, splicing, 5' end capping & 3' end tailing. RNA editing and transport. RNAi and small RNAs.

UNIT – III

Translation in prokaryotes and eukaryotes: Genetic code - properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post translational modifications. Leader sequences & protein targeting.

UNIT – IV

Regulation of gene expression in prokaryotes - The operon concept, lac & tryp operons. Transcriptional control. Post translational control. Regulation in eukaryotes - Control by promoter, enhancer and silencers. Cis-trans elements. Environmental & developmental regulation. DNA methylation & gene expression. Chromatin structure & gene expression.

BT 2.3: GENETIC ENGINEERING

UNIT-I

Isolation of DNA and RNA. Restriction mapping, DNA sequencing by chemical and enzymatic methods. Nucleic acid blotting – southern and northern blotting. DNA cloning. Enzymes used in genetic engineering : Restriction endonucleases - types, nomenclature and properties. DNA polymerase-I, polynucleotide kinase, DNA ligase, terminal nucleotide transferase, Reverse transcriptase, alkaline phosphatase, S₁ nuclease.

UNIT-II

Salient features of cloning vectors, types of cloning vectors - plasmids, cosmids, phages (lambda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes - YACs and MACs. Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors. Preparation of gene libraries and c-DNA libraries .

UNIT – III

Techniques of gene transfer - transformation , transfection, micro injection, electroporation, lipofection and biolistics. Selection of r-DNA clones and their expression. Nucleic acid probes, colony and fluorescent in-situ hybridization.

UNIT – IV

Polymerase Chain Reaction and its applications. DNA micro array technology. Applications of genetic engineering in agriculture, animal husbandry, medicine and in industry. Genomics – genome sequencing by shot gun and hierarchical method. Genome annotation – identification of genes, promoters and exon – intron boundaries

BT 2.4: BIOLOGY OF IMMUNE SYSTEM

UNIT-I

Types of immunity – innate, acquired, passive and active. Organisation and structure of lymphoid organs – bone marrow, thymus, spleen and lymphnodes. Cells of the immune system – B-Lymphocytes, T-Lymphocytes. T-cell receptor – structure and function. Macrophages. Types of cell mediated immunity and lymphokine activated killer cells. Clonal nature of immune response, Immunological memory. Immuno regulation. Adjuvants and immunological tolerance.

UNIT-II

Nature of antigens and antibodies. Structure and function of antibodies. Isotypes, Allotypes and Idiotypes. Antigen – antibody interactions. The generation of antibody diversity, antigen receptors on B & T lymphocytes. Major Histocompatibility Complex (MHC). Human leukocyte antigens (HLA), MHC restriction and typing. Lymphokines, effector cell mechanisms. Complement system.

UNIT-III

Immunological techniques - ELISA, RIA, Western Blot, Immunoblot and Immuno fluorescent techniques. FACS. Hybridoma technology - production and applications of monoclonal antibodies. Antibody engineering, chimeric antibodies.

UNIT-IV

Hypersensitivity - types of hypersensitivity - immediate and delayed hypersensitivity, autoimmune diseases, transplantation and immunity, immunity to infectious agents. Vaccines and Vaccination, types of vaccines including new generation vaccines. Tumor immunology.

Following are the papers of **2nd semester** for the years 2016-17, 2017-18 & 2018-19

BT201 Molecular Biology

Unit I:

Models of DNA Replication, Origin and direction of replication, Semi discontinuous 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; Eukaryotic DNA polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and processivity of replication, Inhibitors of replication.

Unit II:

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; Holliday 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:

Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiation of transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes, Post transcriptional processing of pre-mRNA - addition of Cap to the 5' end, Polyadenylation to the 3' end, mechanism of intron removal and exon splicing, Processing of r-RNA, Self-splicing of introns, Processing of tRNA, Inhibitors of RNA synthesis.

Unit IV:

General features of genetic code, Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes - aminoacylation of tRNA, protein synthesis - initiation, elongation and chain termination, Protein synthesis inhibitors, Post translational modifications of proteins, role in targeting (isoprenylation); Signal peptide (ERLS), role of SRP in translation of secreted proteins; molecular chaperones, HSPs in protein folding; Lysosomal pathways (endocytosis, macroautophagy, microautophagy, direct translocation from cytosol), Ubiquitin-proteasome pathway.

BT202 Enzymology

Unit I:

Classification of enzymes, Remarkable properties of enzymes – catalytic power, specificity, Transformation of different forms of energy, Enzyme localization and assay, Units of enzyme activity, Active site – Fisher and Koshland models, formation of enzyme – substrate complex and experimental evidences, Nature of active site, mapping of enzyme active site through chemical procedures and site directed mutagenesis, Factors affecting enzyme activity, Modern concepts of evolution of catalysis, ribozymes, abzyme and synzymes.

Unit II:

Kinetics of single substrate enzyme catalyzed reactions, Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots, Significance of V_{max} , K_m , K_{cat} specificity constant (K_{cat}/K_m), Kinetics of multisubstrate reaction, Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms, Use of initial velocity, Inhibition and exchange studies, Flexibility and conformational mobility of enzymes, Enzyme inhibitions – reversible inhibition – competitive, non-competitive, uncompetitive inhibition, irreversible inhibition, Determination of K_I values.

Unit III:

Types of reaction catalysis – General acid – base, electrostatic, covalent, intermolecular, metal – ion catalysis, Proximity and orientation, Mechanism of reaction catalyzed by serine proteases – trypsin and chymotrypsin, carboxypeptidase, lysozyme, triose phosphate isomerase, ribonuclease, Rotational catalysis in ATPase, Mechanism of catalysis with coenzymes – pyridoxal phosphate, flavin nucleotides, thiamine pyrophosphate, biotin, tetrahydrofolate, lipoic acid.

Unit IV:

Enzyme regulation – general mechanisms of enzyme regulation, Allosteric enzymes (ATCase), Cooperativity phenomenon, Hill and Scatchard plots, Sigmoidal kinetics and their physiological significance, Symmetric and sequential models of action of allosteric enzymes and their significance, Feedback inhibition and feed forward stimulation, Control of enzymatic activity by products and substrates, Reversible and irreversible activation, Isoenzymes, Multifunctional enzymes, Multienzyme systems – properties, mechanism of action and regulation of Pyruvate dehydrogenase and Fatty acid synthase complex; Enzyme purification - Methods of isolation, purification, Recovery and yield of enzymes, Criteria for testing purity of enzyme preparations; Immobilized enzymes - Methods of immobilization, Applications of immobilized enzymes.

BT203 Immunology

Unit I:

Types of immunity – Innate and adaptive; Antigens, Super antigens, Adjuvants; Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node; T and B lymphocytes – Origin, activation, differentiation, characteristics and functions, Nature of T and B cell surface receptors; Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules, MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens.

Unit II:

Structure of immunoglobulins, Immunoglobulin classes and biological activities, Isotypes, Allotypes, Idiotypes; Antibody diversity: Mini gene theory, Mutation theory, Germ line theory, Somatic recombination, V (D) J recombination, Combinatorial diversity, Junctional diversity, Class switching; Immunological memory; Humoral and cell-mediated immune responses, Cytokines, Interleukins, Interferons; Complement components and biological consequences of complement activation.

Unit III:

Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions-Heme agglutination and complement fixation, Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications; Development of Vaccines- conventional vaccines- attenuated, killed organisms and subunit vaccines; modern vaccines- recombinant vaccines and DNA vaccines.

Unit IV:

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayed hypersensitivity reactions; Immunodeficiencies - SCID and AIDS; Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases; Tissue transplantation - auto, allo, iso and xenograft, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents; Cancer immunology – Tumor associated antigens, Immunological surveillance of cancer.

BT204 Biostatistics

Unit I:

Introduction- definition of statistics-population and universe, the sample and population, statistical inference parameter and statistics, Handling of bulky data, construction of a histogram, interpretation of histogram, the normal distribution, the mean, mode and standard deviation representing the normal curve as straight line, uncertainties in estimating a mean.

Unit II:

Measures of variation, Range, quartile deviation, mean deviation and standard deviation, Coefficient of variation; Probability - Addition and multiplication theories, conditional probability and probability distributors; Proportion data- Examples of Proportion data – testing of medicines, animal toxicity, infection and immunization studies e.g., LD₅₀, ED₅₀, PD₅₀ statistical treatment to proportion data; normal distribution; Count data- Examples of count data (bacterial cell count, radioactivity count, colony and plaque count, etc.), Statistical treatment to count data - Poisson distribution, standard error, confidence limits of counts.

Unit III:

Simple linear regression and correlation, Correlation regression and line fitting through graph points, standard curves, correlation - linear regression (fitting the best straight line through series of points)- standards curves and interpolations of unknown y-values, Regression coefficients and properties.

Unit IV:

Types of errors and levels of significance, Parametric tests of significance– F & t tests, chi-square tests, Analysis of variance (ANOVA); Non parametric tests- sign test, Wilcoxon signed rank test, Mann-Whitney test, Kruskal-Wallis test and Friedman tests; computer aided statistics- STATVIEW, SPSS, STATISTICA, STATSOFT.

Following are the papers of **3rd semester** for the years 2013-14, 2014-15 & 2015-16

BT 3.1 : CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

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.

BT 3.2: PLANT BIOTECHNOLOGY

UNIT-I

Plant Genetic engineering: Gene cloning techniques, Techniques for gene transfer into plants. Mechanism of gene transfer by T₁ and R₁ plasmids as vectors. Reporter genes, transient gene assays and identification of transgenic plants. Molecular markers and their significance. RFLP, , AFLP and QTL in plants. RAPD for molecular mapping and crop improvement.

UNIT-II

Agricultural Biotechnology: Engineering of herbicide tolerance in plants, production of disease resistant plants by gene transfer; Development of insect resistant plants. Biotechnological strategies for engineering stress tolerance.

UNIT-III

Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato, plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plantibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

UNIT-IV

Algal Biotechnology: Laboratory culture of micro algae. Large scale biomass production. Marine micro algae/sea weeds and their products. Edible sea weeds and their cultivation. Biofertilizers – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

BT 3.3: ANIMAL BIOTECHNOLOGY

UNIT-II

Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation in vitro, In vitro fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception - hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement

UNIT-II

Production of transgenic animals - mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor.

UNIT-III

The concept of aquatic biotechnology and blue revolution. Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish, lime fish, algae, corals, and holothurians. Bioactive compounds from corals. Fish bioproducts. Pearl culture technology – principles and applications.

UNIT-IV

Aquaculture - Fresh water fish culture practices and types. Freshwater prawn culture. Brackish water fish, shrimp and crab culture practices. Fresh water fish hatchery and seed production. Hypophysation and induced breeding techniques. Eyestalk ablation. Techniques involved in transgenic fish production. Post harvest technology. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods.

BT 3.4: MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

UNIT-I

Health care products. Products from recombinant DNA Technology - insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines and Hepatitis-B vaccines.

UNIT – II

Disease diagnosis: DNA probes, Enzyme probes - glucose oxidase, lactate oxidase, monoamine oxidase. PCR amplification and diagnosis - Applications in forensic medicine. Genetic diseases and gene therapy. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

UNIT – III

Environmental pollution – types, sources and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Removal of oil spills. Environmental monitoring. Bioremediation - solid and liquid waste treatment. Biomass and energy production. Bioleaching – Microbial recovery of metals. Microbiology of waste water treatment.

UNIT-IV

Environment and energy: Renewable sources of energy – Biogas, waste materials, energy crops, cellulose. Production of energy and fuel using microorganism – Biofuels and Biodiesel. Global environmental problems: Ozone depletion, UV-B, Green house effect. Biodiversity - benefits to mankind - Conservation; Ecology and sustainable development.

Following are the papers of 3rd semester for the years 2016-17, 2017-18 & 2018-19

BT301. Cell Culture Technology and Tissue Engineering

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 – 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 knock-out 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, Alzheimer's, spinal cord injury and other brain syndromes.

BT302. Plant Biotechnology

UNIT-I

Plant Genetic engineering: Gene cloning techniques, Techniques for gene transfer into plants. Mechanism of gene transfer by TI and RI plasmids as vectors. Reporter genes, transient gene assays and identification of transgenic plants. Molecular markers and their significance. RFLP, AFLP and QTL in plants. RAPD for molecular mapping and crop improvement.

UNIT-II

Agricultural Biotechnology: Engineering of herbicide tolerance in plants, production of disease resistant plants by gene transfer; Development of insect resistant plants. Biotechnological strategies for engineering stress tolerance.

UNIT-III

Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plant antibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

UNIT-IV

Algal Biotechnology: Laboratory culture of micro algae. Large scale biomass production. Marine micro algae/sea weeds and their products. Edible sea weeds and their cultivation. Biofertilizers – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

BT303. Animal And Aquaculture Biotechnology

UNIT-I

Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation *in-vitro*, *In-vitro* fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception - hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes. Live stock improvement

UNIT-II

Production of transgenic animals - mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor.

UNIT-III

The concept of aquatic biotechnology and blue revolution. Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish, algae, corals, and holothurians. Bioactive compounds from corals. Fish byproducts. Pearl culture technology – principles and applications.

UNIT-IV

Aquaculture - Fresh water fish culture practices and types. Freshwater prawn culture. Brackish water fish, shrimp and crab culture practices. Fresh water fish hatchery and seed production. Hypophysation and induced breeding techniques. Eyestalk ablation. Techniques involved in transgenic fish production. Post harvest technology. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods. Vaccines - DNA vaccines application in aquaculture..

BT304. Medical and Environmental Biotechnology

UNIT-I

Health care products. Products from recombinant DNA Technology - insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines and Hepatitis-B vaccines.

UNIT-II

Disease diagnosis: DNA probes, Enzyme probes - glucose oxidase, lactate oxidase, monoamine oxidase. PCR amplification and diagnosis - Applications in forensic medicine. Genetic diseases and gene therapy. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

UNIT-III

Environmental pollution – types, sources and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Removal of oil spills. Environmental monitoring and biomonitoring. Bioremediation - solid and liquid waste treatment. Biomass and energy production from waste. Bioleaching – Microbial recovery of metals and acid mine drainage. Water pollution and its control. Microbiological approach of waste water treatment.

UNIT-IV

Environment and energy: Renewable sources of energy – Biogas, waste materials, energy crops, cellulose. Production of energy and fuel using microorganism – Biofuels and Biodiesel. Global environmental problems: Ozone depletion, UV-B, Green house effect. Biodiversity - benefits to mankind - Conservation; Ecology and sustainable development.

Following are the papers of **4th semester** for the years 2013-14, 2014-15 & 2015-16

BT 4.1: HETEROLOGOUS EXPRESSION AND DOWN STREAM PROCESSING

UNIT-I

Heterologous Expression: Expression vectors and hosts Generally Regarded As Safe (GRAS) organisms.

Production of active recombinant proteins of mammalian/Eukaryotic origin in prokaryotes. Principles of microbial growth – Batch fermentation, feed-batch fermentation – continuous fermentation, high density cell cultures –

Bioreactors – Large scale fermentation system – tandem Airlift reactors – Single stirred tank reactors.

UNIT-II

Downstream processing: Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins.

UNIT-III

Processing technology: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins), Vitamins (Vitamin B₁₂ and Riboflavin), Amino acids (lysine, glutamic acid). Production of single cell proteins.

UNIT-IV

Enzyme technology: Sources production, isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

BT 4.2: BIOINFORMATICS AND BIostatISTICS

UNIT-I

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

UNIT-IV

Brief description and tabulation of data and its graphical representation. Measures of central tendency and dispersion - mean, median, mode, range, standard deviation, variance. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – F & t tests, chi-square tests, ANOVA.

Following are the papers of **4th** semester for the years 2016-17, 2017-18 & 2018-19

BT401. Heterologous Expression And Down Stream Processing

UNIT-I

Heterologous Expression: Expression vectors and hosts Generally Regarded As Safe (GRAS) organisms. Production of active recombinant proteins of mammalian/Eukaryotic origin in prokaryotes. Large scale production of proteins from recombinant microorganisms. Principles of microbial growth – Batch fermentation, feed-batch fermentation – continuous fermentation, high density cell cultures – Bioreactors – Large scale fermentation system – tandem Airlift reactors – Single stirred tank reactors.

UNIT-II

Downstream processing: Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins.

UNIT-III

Processing technology: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, tetracycline, semi synthetic penicillins), Vitamins (Vitamin B12 and Riboflavin), Amino acids (lysine, glutamic acid). Production of single cell proteins.

UNIT-IV

Enzyme technology: Sources, production, isolation and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Different techniques of immobilization of enzymes, applications and kinetics of immobilized enzymes. Design and operation of immobilized enzyme systems and bioreactors. Whole cell immobilization. Biosensors - principle and types.

BT 402-Bioinformatics

UNIT – I

Introduction, History, Internet, and Bioinformatics knowledge, Discovery, data mining, problems found in Bioinformatics area, opportunities in Bioinformatics and human genome project.

UNIT – II

Data bases and their management: Data base concept, introduction, history of data bases, data base management system, types of databases, codd rules, data normalization.

UNIT – III

Biological databases: Introduction, need, organization and search for data bases. An over view of types of biological data bases - NCBI, EMBL, DDBJ, SWISS – PROT, PDB, KEGG.

Microbial and cellular data bases, primary sequence databases, carbohydrate data bases, RNA data bases, Genome data bases, Organism data bases, Biodiversity. Database searching using BLAST and FASTA.

UNIT – IV

Data base querying with NCBI using words, sequences (Proteins and genes), finding similarities, identifying genes and proteins from different organisms.

Sequence alignment – Introduction,significance of sequence alignments and use of dot matrices. Pairwise and multiple sequence alignment.

BT403. Proteomics and Genomics

UNIT-I

Introduction to proteomics- Significance and applications of proteomics in biology Protein function and expression, essential proteins, protein function from structure, rational drug design, lethal mutants. Proteome analysis: high-throughput proteome analysis with 2D-IEF, current concepts of coimmunoprecipitation for protein interaction analysis, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF mass spectrometry and nanospray MS, Phage Display, Protein chips; Micro Arrays- Affimetrics and spotted array concepts.

UNIT-II

Protein sequence Data base- Swiss-prot, Tr-EMBL, PIR, Uniprot and Pfam, Structural Data bases-CATH, SCOP, MMDB. Molecular Modeling-Homology modelling and docking studies (Using Molegro Virtual Docker) – RASMOL. Molecule Import and preparation from PDB, Docking, Analysis, Constrains, Data analyser, sidechain flexibility and template docking Drug discovery – target identification, target validation, lead identification, lead optimization, Phase I, II and III clinical trials, pharmacodynamics.

UNIT-III

Origin of genomes, the human genome. Technology, Data bases- INSD-International Nucleotide Sequence Database, Gen Bank, EMBL, DDBJ, special focus on NCBI, Sequence comparison techniques (BLAST etc). Comparative Genomics - Phylogeny, Synteny (comparison of grass genomes), COGS (Cluster of orthologous genes, NCBI website).

UNIT-IV

Functional Genomics - ESTs, Digital northern, SAGE, Relational Data Base Basics, Gene finding tools. Whole genome analysis: preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing. Conventional sequencing (Sanger and Maxam & Gilbert methods), automated sequencing. Analysis of single nucleotide polymorphism (SNP) using DNA chips.

BT404. BIOETHICS, IPR AND RESEARCH METHODOLOGY

UNIT-I

Introduction – causes of unethical acts, ignorance of laws, policies and procedures, recognition, friendship, personal gains. Professional ethics – professional conduct Ethical decision making, ethical dilemmas Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory accreditation.

UNIT-II

Socio-economic and legal impacts of biotechnology, national and international guidelines, experimental protocols approval, levels of containment
Use of genetically modified organisms, their release in the environment, moral and ethical issues in biotechnology, cloning, safety issues with GMO.

UNIT-III

Fundamentals of IPR, Basic Principles, Copyright, Trademark, Design, Geographical indication, Acquisition of rights and remedies for infringement of these IPRs- Patent Law History, development of patent law, basic principles, criteria, novelty. Utility and non obviousness, subject matter in US, UK, drafting patent specifications – International Institutions and International instruments (WTO, WIPO, TRIPS, CBT, Paris Convention, Budapest treaty)

UNIT-IV

Introduction – Basic research, applied research, need based research, Identification of the problem, defining the problem, Research project planning, Literature search – Information sources, library resources – online literature search. Design of the experimental programme – variables in the experiments, materials and methods, evolution of methods, application of methods, Progress of research – evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications, impact factor of journals