# Entrance Syllabus
# for
# 3 Year Integrated Ph.D Programme in Biotechnology 2016

**Cell Biology:**
Cellular organelles (Structure and function), Cellular energy transaction-Role of mitochondria and chloroplast. Biological membranes and transport. Cell cycle. Cancer: Types, causes molecular basis of cancer cell behavior. Molecular signaling. Cytoskeletal structure and function. Brief introduction to cellular basis and differentiation and development with special reference to drosophila and Arabidopsis.

**Biomolecules:**
Chemical foundation of biology-pH, pK, Acids bases, buffers. Biological Interactions. Water: physical properties and structure of water. Principles of thermodynamics-concept of free energy, Gibbs Helmholtz equation free and equilibrium constants, free energy and electrode (cell) potential. Amino acids: Structure, Classifications & physiochemical properties. Peptide bond. oligo and poly peptides.
Proteins: Structure and conformations of proteins. Levels of proteins secondary structures. Prediction of secondary structure of proteins. Ramachandran plots. Tertiary structure of proteins and force stabilizing the tertiary structure. Mechanism of protein folding-Chaperons.
Nucleic acids: Deoxy/Ribonucleic acid as genetic material primary, secondary and tertiary stru ture of DNA. Re-association reactions. Cot curves. Genome organization in viruses, pr9kar otes and Eukaryotes. Structure and role of RNA. Types of RNA, their primary and secondary structure of Eukaryotes chromosomes, Heterochromatin, Euchromatin, Molecular components, packing and nucleosome organization.

**Microbiology:**
Bacterial pure culture techniques, theory & practices of sterilization. Growth curve, Synchronous growth, continuous culture, maintenance of cultures.
Bacteria: Prokaryotic cells: structure-function Cell wall of eubacteria (Peptidoglcan) related molecules; outer membrane of Gram Negative bacteria; cell wall and cell membrane synthesis, endospore. Chemotaxsis
Viruses: Bacterial, Plant and animal and tumor viruses, lysogeny, DNA Viruses, Positives STrand, negative strand and double stranded RNA viruses, replication of Viruses, viroids and prions.
Viral & Bacterial Genetic systems: Transformation, Conjugation, Transduction, recombination, Plasmids and Tranposons Bacterial genetic maps with reference to E.coli
Types of Toxins (Exo, Endo) and their mode of actions, Virulence and pathogenesis Antimicrobial agents: Sulfa drugs, Penicillin & Cephalosporin's, Broad spectrum antibiotics, Antibiotics from prokaryotes, Antifungal Antibiotics, Mode of action, resistance to antibiotics.

**Metabolism:**
Carbohydrate Metabolism: glycolysis, TCA cycle, pentose phosphate pathway, glucuronate pathway, gluconeogenesis, glycogen metabolism and its regulation. Hormonal control of carbohydrate metabolism

Lipid Metabolism: oxidation of fatty acids, Even, odd & unsaturated. Formation ofketone bodies and their oxidation. Biosynthesis of saturated fatty acids and prostaglandins. Regulation of lipid metabolism. Metabolism of circulatory lipids, Chylomicrons, LDL, HDL &VLDL.
Protein & Nucleic acid metabolism: General reactions in amino acid degradation, deamination and transamination reactions, Urea cycle, regulation of amino acid metabolism. Inborn errors of metabolism glycine, phenylalanine and Tyrosine Degradation and biosynthesis of Purine and pyrimidine nucleotides, Inter conversion and regulation of their biosynthesis Biolcgical oxidation: electron transport chain, oxidative phosphorylation, uncouplers of oxidative phosphorylation.

**Bio techniques and Biostatics:**
Basic principles of centrifugation, types of centrifugation differential centrifugation density gradient centrifugation and material used for making density gradient. Materials used for making rotors of centrifuges. Ultra centrifugation and its applications for characterization of biomolecules( sedimentation equilibrium and sedimentation velocity method).
Basic principles & types of electrophoresis, Agarose gel electrophoresis, PAGE, SDS_PAGE and isoelectric focusing.
Basic principles, instrumentation and applications of visible, UV, IR & NMR Spectroscopy. Optical rotary dispersion circular dichorism (CD), X-ray diffraction and electron microscopy techniques. Determination of antigen & antibody concentration by immunodiffusion, immunoelectrophoresis, Radioimmunoassay & ELISA methods. Nature of radioactivity, types of radiations, radioactive decay, units of radioactivity. Interaction of radiations with matter. Determination & measurements of radioactivity. Labeling of molecules by radioisotopes. Blotling techniques: Southern, Western, Far-western, South western, Northern and their applications.
Brief Clescription and tabulation of dats & its graphical representation. Measures of central tendency & dispersion: mean, median, mode range, standard deviation, variance. Idea of two types of errors and level of significance, test of significance (F & t-test), Chi-square test. Simple linear regression and correlation.

**Molecular Biology**
Replication of DNA, direction and methods of replication. Replication initation in prokaryotes and later chromosomal replication. Topoisomerrases I and II. Replication forks. Eukaryotic replication. Recombination and mutation
Messenger RNA biosynthesis in prokaryotes-RNA polymerase and promoter specificity, initation, elongation and termination of transcription. Transcriptional repression and de- repression, operon concept (Lac), complexity in regulation (Arabinose) and attenuation (Trp,
His, Leu). Organization oflambda DNA and anti-termination.
Eukaryotic transcription, RNA polymerase, general and specific transcription factors, regulatory elements and mechanism of transcription regulation. RNA processing and stability, splicing, capping, polyadenylation and their effect on stability. Ribozyme technology.
Prokaryotic and eukaryotic translation. Translational machinery, mechanism of initation, elongation and termination. Regulation of translation. Co- and post translational modifications of proteins. Degeneracy of genetic code, wobble hypothesis.

**Enzymology**

Properties of enzymes as catalytic power, specificity cofactors, brief nomenclature & classification of enzymes, isoenzymes. Determination of primary secondary, tertiary & quaternary structure of proteins/enzyme, folding & unfolding of enzymesReview of uni-substrate enzyme kinetics and factors affecting the rate of enzymes catalyzed reactions. Michaelis PH functions and their significance

Classification of multi substrate reactions with examples of each class. Kinetics of multi substrate reactions. Derivation of rate expression for ping-pong \& ordered Bi -Bi reaction mechanism. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Methods of examining enzymes-complex's, trapping E-S Complex, Use of substrate analogs, chemical modifications and protease treatment, Site directed mutagenesis & effect of changing pH. Flexibility & conformational mobility of enzymes

Determination of rate constant for enzymes catalyzed reactions, Protein – Ligand binding including measurement, analysis of binding isotherm. Cooperatively phenomenon. Hill and Scatchard plots Allosteric enzymes, sigmodial kinetics and their physiological significance. Symmetric and sequential modes for action of allosteric enzymes and their significance

Multi enzyme system : Occurrence, isolation and properties. Polygenic nature of multi enzyme system. Mechanism of catalysis of serine proteases, Ribonucleases and Triose phospbate isomerase. Enzyme regulation: general mechanism of catalysis viz Acid-base, electrostatic, Covalent and enzymes Immobilized enzyll).es and their industrial application. Effects of partition on kinetics and performance with special emphasis on changes in pH and hydrophobicity

**Immunology:**

Innate and acquired Immunity. Clonal nature of immune response Organization and structure of lym:!Jhoid organs Nature and biology of antigens and superantigens Antibody structure and fu.nctiQn Antigen-antibody interaction

Major histocompatibility complex BCR & TCR generation of diversity .Complement system Cells of immune system, Macrophages , Dendritic cells, Natural killer cells and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells

Antigen processing, processing, generation of Humoral and cell mediated Immune response. Activation of B & T lymphocytes . Cytokines and their role in immune regulation. Immunological tolerance Cell mediated cytotoxicity, Mechanism ofT-cell & NK- cell mediated lysis. Antibody dependent cell mediated cytotoxicity, Macrophages mediated cytotoxicity Hypersensitivity Autoimmunity

Transplantation. Tumor Immunology AIDS and other Immunodeficiency Hybridoma Technology and Monoclonal Antibodies

**Animal Cell science:** Biology and characterizations of the cultured cells. Measuring parameters of growth. Basic techniques of mammalian cell culture in vitro: Disaggregating of tissue and primary culture. Scaling-up of animal cell culture. Cell synchronization, cell cloning and micromanipulation. Application of Animal cell culture. Role of C02, serum and supplements. Serum and serum free defined media and their applications.

Cell transformation: Properties of transformed cells. Immortalization and methods used to immortalize cells. Measurements of viability and cytotoxicity assay: Trypan blue, MTT, TUNNEL and ELISA based assays. Cell culture based vaccines: Subunit vaccines, peptide vaccines, recombinant vaccines, genetic vaccines and attenuated vaccines

Three dimensional cultures: Spheroid culturing techniques. Tissue engineering: Design criterion for tissue engineering Organ and Histotypic cultures: Advantages and limitations, factors affecting their growth. Stem Cell Culturing: Embryonic stem cells, Adult stem cells and their applications

**Genetic engineering:**

Source DNA/RNA for recombination technology: Genomic and plasmid DNA extraction, purification and analysis (agarose gel and absorbance). Total RNA isolation and m-RNA enrichment and determination of RNA purity. Gene cloning vectors: plasmids, Bacteriophages, phagemids, cosmids, YACs and BACs. Cloning of foreign DNA, klenow filling, ligation (blunt end and cohesive end), transformation and screening of recombinant vectors. Confirmation of the insert size and validation of orientation. Molecular tools and their application: restriction modification system 1, isocaudomers and isoschizomers. Restriction mapping of DNA fragments and map construction. RFLP.

Nucleic acid amplification: polymerase chain reaction, error prone and high fidelity amplification. Primer design and characteristics. Reverse transcription: specific and random amplification, C-DNA synthesis. Methods for C- DNA end amplification. Quantitative/Real Time PCR and its applications. Library construction and screening: C-DNA and genomic libraries, primary, secondary and tertiary screening methods. Isolation of desired clone. Alternative strategies of gene cloning: cloning interacting genes-Two and three hybrid systems, phage display. evaluation of differentially expressed gene products: Transcriptomics (Microarray), proteomics. Methodology and application. Site directed mutagenesis and protein engineering. Techniques for the study of gene expression: Transfection, Northern blot, primer extension, RNase protection assay, reporter assays. Expression strategies for heterologous genes. Vecw engineering and codon optimization, host engineering. In-vitro transcription and translation. Expression in bacteria and yeast. Expression in insects and in ct cells. Expression in mammalian cells and in plants

Gene silencing technologies: anti-sense RNA, RNA caging, SiRNA.

Transgenic and gene knockout technologies. Strategies for gene therapy. T-DNA and transposon tagging: role of gene tagging in gene analysis, identification of genes through T-DN.A_ and transposon tagging

**Plant Biotechnology**

Introduction to cell and tissue culture: Totipotency of Plant cells Tissue culture media (Composition & preparation) somatic embryogenesis, Synthetic seeds Micropropagation techniques.Protoplast isolation, Culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric & Asymmetric hybrids, Cybrids

Molecular mapping, Introduction to genetic and physical maps, physical mapping

Plant Transformation Technology; Basis of tumor formation, features of Ti Plasmids, Mechanism ofT-DNA transfer, Role of Virulence gene, Use of TI Vectors, Binary vectors, use of 35S and other promoters, use of reporter genes and selectable markers, Excision of markers, Methods of nuclear transformation , Viral vectors and their applications, Multiple gene transfer; Vector less or direct DNA transfer (Particle bombardment, Electroporation, Microinjection). Transformation of monocots. Transgene Stability Application of plant transformation for productivity and performance with special example of herbicide resistance, disease resistance, long shelf fruit and flowers, Stress tolerance (water deficit stress and Oxidative stress)

Chloroplast Transformation (Advantages, Vectors, success with tobacco& potato) Molecular farming: production of carbohydrates, Metabolic engineering of lipids, Therapeutic proteins, lysosomal enzymes, Plantibodies, Edible Vaccines.

**Bioprocess Engineering:**

Introduction to bioprocess engineering. Bioreactors. Media for industrial fermentation. Air and Media sterilization.

Types of fermentation process: analysis of batch, fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc). Measurement and control of bioprocess parameters. downstream processing: introduction, removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cells disruption, liquid-liquid extraction, chromatography, membrane process, drying and crystallization, effluent treatment: D.O.C and C.O.D treatment and disposal of effluents.

Whole cell immobilization and their applications. Industrial production of chemical: alcohols (ethanol), acids (citric, acetic and gluconuic), solvents (glycerol, acetone, butanol), antibiQtics (penicillin, streptomycin, tetracycline). Amino acids (Lysine, glutamic acid). Single cell pr0tein. Use of microbes in mineral benefication and oil recovery. introduction to food technology: Elementary idea of canning and packing. Sterilization and pasteurization of food products. Technology of typical food products (bread, cheese). Food preservation.