Department of Biotechnology U.G

Semester I syllabus for the years 2013-14 & 2014-15

Paper 1A Cell Biology & Genetics

Topics to be covered
Cells as basic units of living organisms, Viral, bacterial, fungal, plant and animal cells
Ultra structure of prokaryotic cell (Cell membrane, plasmids),Ultra structure of eukaryotic cell (Cell wall, cell membrane)
Ultra structure of eukaryotic cell (mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, vacuoles)
Chromosome organization in Prokaryotes and Eukaryotes,Structure of specialized chromosomes (Polytene and Lamp Brush)
Cell Division and Cell Cycle
Significance of mitosis and meiosis,
Mendel's experiments – Factors contributing to success of Mendel's experiments
Law of segregation – Monohybrid ratio, Law of Independent assortment – Dihybrids, Trihybrids
Deviation from Mendel's Laws - partial or incomplete dominance,co-dominance,Penetrance and expressivity, pleiotropism
Epistatic gene interaction – Modified dihybrid ratios (12:3:1; 9:7; !5:1; 9:3:4:, 9:6:1; 13:3)
Genes and environment – phenocopies,Linkage and recombination – Discovery of linkage, cytological proof of crossing over
Recombination frequency and map distance Interference and coincidence
Mitotic crossing over in *Drosophila*
Mechanism of sex determination-genic balance theory - *Drosophila*
Homogametic and Heterogametic theory (Human, Mamalian, Birds)
X – linked inheritance (eg. Haemophilia)

Semester I syllabus for the years 2015-16, 2016-17, 2017-18 & 2018-19
Paper 1A Microbiology & Cell Biology

Topics to be covered
History, Development and Microscopy History and development of microbiology, contributions of Louis Pasteur, Robert Koch and Edward Jenner. Compound microscopy: Numerical aperture and its importance, resolving power, oil immersion objectives and their significance, principles and applications of dark field.
Phase contrast, fluorescent microscopy. Electron microscopy: Principle, ray diagram and applications, TEM and SEM
Comparison between optical and electron microscope, limitations of electron microscopy. Stains and staining procedures: Acidic, basic and neutral stains
Gram staining, Acid fast staining, Flagella staining, and Endospore staining.
Bacterial morphology and sub cellular structures, general morphology of bacteria, shapes and sizes, generalized diagram of typical bacterial cell. Slime layer and capsule, difference between the structure, function and the position of the two structures.
Cell wall of gram +ve and Gram -ve cells, Prokaryotic classification. General account of flagella and fimbriae. Chromatin material, plasmids; definition and kind of plasmids (conjugative and non-conjugative) F, R, and Col plasmids.
Detailed study of endospore structure and its formation, germination, basis of resistance. A brief idea Bergey's manual.
Morphology of archaea, archaeal cell membrane (differences between bacterial and archaeal cell membrane), other cell structures, concept of the three distinct archaea groups.
General characteristics of viruses, difference between virus and typical microbial cell, structure, different shapes and symmetries with one example of each type, classification of viruses on the basis of nucleic acids, phage and animal cell viruses, example of each and their importance.
Selective and Differential media, Enriched media, Enrichment media. Growth rate and generation time, details of growth curve and its various phases. Concept of synchronous cultures, continuous and batch cultures (chemo stat and turbido stat)
Measurement of growth. Physical conditions required for growth: Temperature (classification of microorganisms on the basis of temperature requirements), pH etc
Pure cultures and cultural characteristics. Maintenance of pure culture. Mechanism of cell injury: Damage to cell wall, cell membrane. Denaturation of proteins, inhibition of protein synthesis, transcription, replication, other metabolic reactions and change in super coiling of DNA
Sterilization, disinfection, antiseptic, sanitization, germicide, microbistasis, preservative and antimicrobial agents. Mechanism Physical control: Temperature (moist heat, autoclave, dry heat, hot air oven and incinerators), desiccation, surface tension. Osmotic pressure, radiation, UV light, electricity, ultrasonic sound waves, filtration. Chemical control: Antiseptics and disinfectants (halogens, alcohol, gaseous sterilization. Concept of biological control
Eukaryotic Cell - Structure and function of the following: nucleus, nuclear membrane, nucleoplasm, nucleolus, Golgi complex, Mitochondria, Chloroplast, endoplasmic reticulum, lysosomes, peroxisomes, glyoxisomes and vacuoles.
Plant cell wall. Cytoskeleton (Micro and Macro filaments, microtubules) and cell locomotion. Mitosis and meiosis. Brief idea of cell cycle. Muscle and nerve cell structure, synaptic transmission and neuromuscular junctions.

Semester II syllabus for the years 2013-14 & 2014-15

Paper 1B Molecular Biology & Microbiology

Topics to be covered
DNA as the genetic material –Griffith's experiment on transformation in streptococcus pneumonia. Avery McLeod and Mc Carty's experiments.
Hershey – chase experiments with radio- labelled T2 bacteriophase
RNA as the genetic material-Tobacco mosaic virus
Structure of DNA –Watson and crick model
Formation of DNA-A,B and Z forms of DNA,super coiled and related DNA –role of topoisomerases
DNA Replication-Model of DNA replication(Semi-conservative models)
Mechanism of DNA Replication-linear and circular –rolling circular and theta mechanism of replication.
DNA Damage and Repair
Outlines of classification of microorganisms
Structure and general characters of Viruses, Bacteria, Fungi and Micro Algae (one example from each group)
Disease causing pathogens and their symptoms (examples; Typhoid, HIV only)
Isolation, identification and preservation of microorganisms (Bacteria)
Identification methods of Fungi and useful Micro Algae
Methods of sterilization
Bacterial reproduction and growth kinetics (Batch and continuous cultures) Pure cultures and cultural characteristics

Semester II syllabus for the years 2015-16, 2016-17, 2017-18 & 2018-19

Paper 1B Macromolecules, Enzymology & Bioenergetics

Topics to be covered
Nucleic Acids and Chromosomes: Chemical structure and base composition of nucleic acids,Chargaff's rules, Watson Crick Model (B-DNA), deviations from Watson-Crick model
Other forms of DNA (A- and Z-DNA), forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations, base stacking). RNA and its types.
Amino acids and Proteins: Structure of amino acids occurring in proteins, classification of amino acids
pH based, polarity based and nutrition based physico-chemical properties of amino acids.
Primary, Secondary, Tertiary &Quaternary structure of proteins
Carbohydrates:Definition, classification, nomenclature of carbohydrates, structures of monosaccharides, disaccharides
polysaccharides. Concept and examples of heteropolysaccharides.
Lipid:Types of lipids, structures of saturated and unsaturated fatty acids, triglycerides, phospholipids
Concept of acid value, saponification value and iodine value. Sphigolipids and prostaglandins.
Chemistry of Porphyrines, Heme, Cytochromes, and Chlorophylls
Enzymes: Terminology: Active site, allosteric site, Holoenzyme, apoenzyme, coenzyme, substrate, inhibitor, activator, modulator etc. Classification and nomenclature of enzymes.Substrate Specificity (bond specificity, group specificity, absolute specificity, stereospecificity),lock and key and induced fit models
Enzyme kinetics: Michaelis-Menten equation, effect of substrate concentration, effect of enzyme concentration, effect of p H and temperature, temperature. Enzyme inhibition kinetics
(reversible inhibition types – competitive, uncompetitive and non-competitive), brief idea of irreversible inhibition.
Bioenergetics: Concept of free energy, Entropy, Enthalpy & Redox Potential. Concept of high energy bonds as related to the structure of ATP, Phosphoenolpyruvate,
Creatine phosphate etc.Glycolysis (pathway, entry of other monosachharides and disaccharides, regulation, inhibitors) Gluconeogenesis: Bypass reactions.

Semester III syllabus for the years 2013-14, 2014-15 & 2015-16

Paper 2A Biomolecules & Intermediatory Metabolism

Topics to be covered
Importance ,classification & properties of carbohydrates.structure ,configuration and biochemical importances of monosaccharides(glucose & fructose)
Dissacharides – structure and biochemical importance of sucrose and trehalose.structure and function of homopolysaccharides-strach ,inulin,cellulose and glycogen.
Structure and function of heteropolysaccharides-hyaluronic acid. Classification ,structure and properties of amino acids,peptide bond
Primary,secondary ,tertiary and quarternary structures of protiens
Saturated and unsatuarated fatty acids of lipids.triacylglycerols
Sphingolipids ,sterol phospholipids (phosphatidic acid,phosphatidylcholine)
Classification and nomenclature of enzymes,kinetics of enzyme
Catalyzed reactions (Michaeli's –Menton equation only)
Factors influencing enzymatic reactions (a) PH (b)Temperature (c)Substrate concentration (d)Enzyme concentration
Enzyme Inhibition – Competitive and non competitive
Glycolysis,citric acid cycle
Mitochondrial electron transport,chemiosmotic theory of ATP Synthesis
Beta oxidation of fatty acids.deamination,decarboxylation and transamination reactions of amino acids.
Catabolism of amino acids-phenyl alanine and tyrosine(phenylketonuria and albinism)
Photosynthesis-light reaction and photophosrylation,photosystem I & II
Carbon assimilation,c4 pathway,cyclic and non cyclic photophosporelation

Semester III syllabus for the years 2016-17, 2017-18 & 2018-19

Paper 2A Biophysical Techniques

Topics to be covered
Spectrophotometry: Spectrum of light, absorption of electromagnetic radiations
B e e r ' s law - derivation and deviations, extinction coefficient. Instrumentation of UV and visible spectrophotometry
Double beam spectrometer; dual-wavelength spectrometer, Applications of UV and visible spectrophotometry.
Coloriemetry principles and its applications
Chromatography: Partition principle, partition coefficient, nature of partition forces, brief account of paper chromatography
Thin layer chromatography and column chromatography. Gel filtration: Concept of distribution coefficient, types of gels and glass beads
Applications. Ionexchange chromatography: Principle, types of resins, choice of buffers, applications including amino acid analyzer
Affinity chromatography: Principle, selection of ligand, brief idea of ligand attachment, specific and non-specific elution, applications
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility.Paper electrophoresis,
Gel electrophoresis: - Types of gels, Solubilizers, Procedure, Column & slab gels Detection, Recovery & Estimation of macromoleculesSDS-PAGE Electrophoresis and applications. Isoelectric focusing,Pulsed-field gel electrophoresis.
Isotopic tracer technique: Radioactive & stable isotopes, rate of radioactive decay. Units ofradioactivity. Measurement of radioactivity: - Ionization chambers, proportional counters, Geiger-Muller counter,
Solid and liquid scintillation counters (basic principle, instrumentation and technique), Cerenkov radiation. Measurement of Stable isotopes: Falling drop method for deuterium measurement.
Biological applications of Radioisotopes. **Centrifugation:** Basic principles, concept of RCF, types of centrifuges (clinical, high speed and ultracentrifuges).Preparative centrifugation: Differential and density gradient centrifugation, applications (Isolation of cell components).
Analytical centrifugation: Sedimentation coefficient, determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods.
Biostatistics: Basic concepts of mean, median, mode, Standard deviation and Standard error.Introduction to ANOVA

Semester IV syllabus for the years 2013-14, 2014-15 & 2015-16

Paper 2B Biostatistics, Bioinformatics & Biophysical Techniques

Topics to be covered
Concept of mean, median, mode, range, standard deviation and coefficient of variation.
Simple regression and correlation, concept of probability introduction
Probability Basic laws and its application to mendelian segregation
Concept of sampling and sampling distribution. Concept of test of hypothesis.
Applications of t-test statistics to biological problems/data: chi-square
Statistic applications in biology. ANOVA (One way Classification)
Introduction to Bioinformatics, Biological Databases introduction
Nucleotide sequence and protein databases, their utilization in Biotechnology.
Online tools and off line tools, storage and retrieval of biological data in data banks
Microscopy-Light, Inverted, Flourescent and electron microscopy.
Coloriemetry-Beer-Lamber's law ,UV-VIS Spectrophotometry
Chromatography-(a) paper(b)thin layer (c)ion exchange (d)gel-filtration
Electrophoresis-Native gels and SDS-PAGE, Agarose.
Centrifugation and filtration-basic principles
Dialysis and lyophilisation ,radio isotopes and their uses in biology

Semester IV syllabus for the years 2016-17, 2017-18 & 2018-19

Paper 2B IMMUNOLOGY

Topics to be covered
Immune system: Organs and cells of immune system Immunity, Immune response, innate immune mechanism
Acquired immune mechanism, Antigen,Humoral immunity, main pathways of complement system.
Antibody and Antigen: Antibody structure and classes, Antibody diversity,
Types of AntigensAntigenecity (factors affecting antigenecity). Complement system .
Immunity: Cell mediated immunity: TC mediated immunity, NK cell mediated immunity,
ADCC, brief description of cytokines and MHC (MHC types and diversity)
Hypersensitivity and vaccination : General features of hypersensitivity, various types of hypersensitivity
Autoimmune response,Vaccination: Discovery, principles, significance, Types of Vaccines
Immunological Techniques:Antigen-antibody reactions: Precipitation, agglutination, complement fixation
immunodiffusion, ELISA.
Hybridoma technology: Monoclonal antibodies and their applications in immunodiagnosis.

Semester V syllabus for the years 2013-14, 2014-15, 2015-16 & 2016-17

Paper 3A MOLECULAR BIOLOGY

Topics to be covered
Organization of nuclear genome-genes and gene numbers-essential and non essential genes
Denaturation and renaturation of DNA-Tm Values and Cot curves
Kinetic classes of DNA-Single copy sequences and repeated sequences
Inverted ,tandem and palindrome repeats and satellite DNA
Mitochondrial genome organization (Eg:Human)
Chloroplast genome organization in plants
Organization of eukaryotic genes-Exons,Introns,Promoters and terminators
Gene families and clusters-Eg.Globin gene ,histones and ribosomal genes
Prokaryotic and eukaryotic transcription
Post transcriptional modifications
Translation
Genetic code and its features ,wobble hypothesis
Synthesis of polypeptides
Regulation of gene expression in prokaryotes
Operon concept in bacteria-Lac Operon ,Tryptophan Operon

Semester V syllabus for the years 2013-14, 2014-15, 2015-16 & 2016-17

PAPER 4A Plant & Animal Biotechnology

Topics to be covered
Introduction to animal biotechnology,principles of animal cell culture –culture vessels
Cell culture media-types,composition,preparation and sterilization
Establishment & Preservation of cell lines
Types of cultures and sub culture-mono layer and suspension
Establishment of cell cultures using explants & cell disaggregations
Cultures of cells & tissues-stem cells cultivation and their applications
In vitro fertilization & embryo transfer technology in humans
Methods of gene transfer – micro injection & viral mediated gene transfer techniques
Production of transgenic animals and molecular pharming
Principles of ex vivo and in vivo gene therapy
Composition of media (Murashige & skoog & Gamborg's only),preparation of media & methods of sterilizations
Role of plant growth regulators on differentiation & induction of callus
Meristem culture & production of virus free plants,clonal propagation of plants on a commercial scale(somatic embryogenesis & organogenesis)
Mass cultivation of cell culture & process engineering –batch & continuous cultures
Bioreactors & methods of gene transfer techniques (Agrobacterium ,Microprojectile bombardment)
Production of commercially useful compounds from plant tissue culture
Applications of recombinant DNA Technology in Agriculture,production of theraupatic proteins from plants with two examples
Medicinal plants for common ailments(domestic remedies) & isolation & fusion of protoplast

Semester V syllabus for the years 2017-18 & 2018-19

Paper 3A Genetics & Molecular Biology

Topics to be covered
Mendel experiments & Mendel Laws and deviations.
Incomplete dominance and Co dominance, Penetration and pleiotropism.
Recessive and Dominant epistatic gene interactions. Concept of multiple alleles.
Structure of gene, gene and environment, gene copies and heterogeneity.
Meiotic non disjunction of chromosomes, chromosome abnormalities in animals and plants,
Linkage, recombination, gene maps, interference and coincidence.
Sex determination, genetic population studies and Hardy Weinberg Equations.
Enzymology of replication - Detailed treatment of DNA polymerase I,pol II and III,helicases, topoisomerases, Single strand binding proteins, DNA melting proteins
Primase and RNAprimers,distributive and processive properties of DNA polymerase I and III, importance of the-sub unit in polymerase III
proof for semi conservative replication, discontinuous replication and Okazaki fragments,
CAT I
Replication origins, initiation, primosome formation, elongation, and termination. Use of DNA replication mutants in the study of replication.Gene mutations: Induced and Spontaneous
Missense, nonsense and frame shift mutations
Physical and chemical mutagens. Repair: Mismatch repair, light induced repair SOS repair. Rec gene and its role in DNA repair, post replication repair
Enzymatic synthesis of RNA:Basic features of transcription, structure of prokaryotic RNA polymerase (core enzyme and holoenzyme significance
CAT II
Concept of promoter (Pribnowbox,-10and-35sequences and their significance). Four steps of transcription (Promoter binding and activation, RNA chain initiation and promoter escape
Chain elongation, termination and release) regulation of Transcription, Reverse transcription.

Semester V syllabus for the years 2017-18 & 2018-19

Paper 4A Gene Expression & r DNA Technology

Topics to be covered
Genetic code: Codon and its characteristics, experimental elucidation of codons, identification of start and stop codons, universality,
degeneracy and commaless nature of codons.The decoding system: aminoacyl synthetases,the adaptor hypothesis, attachment of aminoacids to tRNA.
Codon-anticodon interaction-the wobble hypothesis.Selection of initiation codon-Shine and Dalgarno sequence and the16SrRNA.
Proteinsynthesis: Initiation,elongation, termination
post translational modification. Regulation of translation:phage T4 protein p32 translational regulation. Antibiotics affecting translation.
Gene Expression and regulation Details of initiation, elongation, and termination (intrinsic and rho factor mediated termination).
Regulation of Transcription in Prokaryotes: Basic idea of lac- and trp-operons. Negative and positive control of lac operon Eukaryotic Gene Regulation: Gal operon
rDNA Technology DNA Coning: Basics of genetic engineering, restriction endonucleases, other enzymes of DNA manipulation.
Cutting and joining DNA (Cohesive end ligation, methods of blunt end ligation).Transfection and transformation. Selection of transformed cells. Screening methods.
Vectors: Plasmid vectors (pBR322 and pUC18/19) Phagevector: Lambdareplacement
insertion vectors Cosmids,phagemids, andYAC.
Genomic DNA library and cDNA library–Concept and methods of creating these libraries. Advantages and disadvantages of cDNA library over genomic DNA library.
General consideration of Polymerase chain reaction, designing of primers for PCR.
Expression of cloned genes: General features of an expression vector
Expression of a eukaryotic gene in prokaryotes –advantages and problems. Applications of recombinant DNA technology.

Semester VI syllabus for the years 2013-14, 2014-15, 2015-16 & 2016-17

Paper 3B Genetic Engineering & Immunology

Topics to be covered
Enzymes used in gene cloning :restriction endonucleases ,ligases,phosphatises,methylases,kinases
Cloning vehicles-plasmids ,cosmids,phage vectors,shuttle vectors
Baculovirus vector system,expression vectors-expression cassettes
Contruction of genomic and cDNA libraries
Identification of cloned genes
Principles involved in blotting techniques-southern ,northern and western
Principles and applications of PCR Technology
DNA Finger printing technique and its applications
Introduction to immune system-organs and cells of the immune system
Antigens,haptens-physico-chemical characteristics
Structure of different immunoglobulins and their functions
Primary and secondary antibody responses
Antigen-antibody reactions
The major histocompatibility gene complex and its role in organ transplantation
Generation of antibody diversity
Hypersensitivity-coombs classification,types of hypersensitivity & autoimmune diseases –mechanisms of auto immunity

Semester VI syllabus for the years 2013-14, 2014-15, 2015-16 & 2016-17

Paper 4B Industrial & Environmental Biotechnology

Topics to be covered
Introduction to industrial biotechnology & primary and secondary metabolic products of microorganisms
Screening and isolation and preservationof industrial microorganisms
Principles of fermentation technology
Commercial production of fuels and chemicals by microbial fermentations
Fermentative production of microbial enzymes (amylases,proteases),and antibiotics
Fermentative production of foods and dairy products
Animal cells as bioreactors;characteristics of bioreactors ,expression and over production of targeted protiens
Human growth hormones-production of alpha & beta-interferons,monoclonal antibodies
Good manufacturing practices,biosafety issues,bioethics,intellectual property rights and patenting issues
Introduction to environmental biotechnology & renewable and non-renewable energy resources
Conventional energy sources and their impact on environment (biogas,bioethanol,microbial hydrogen production)
Microbial analysis of milk ,food and water
Microbial treatment of municipal and industrial effluents
Microbial degradation of pesticides and toxic chemicals
Biopesticides and biofertilizers
Microbial ore leaching and introduction to bioremediation

Semester VI syllabus for the years 2017-18 & 2018-19

Paper 3B Ecology

Topics to be covered
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.
Population Ecology: Characteristics of a population; population growth curves;
Population regulation;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.
Species Interactions: Types of interactions, interspecific competition,
herbivory, carnivory, pollination, symbiosis.
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)

PAPER 4B PLANT PHYSIOLOGY

Photosynthesis mechanisms; CO_2 fixation -C3, C4and CAM pathways.

Unit II

Respiration and photorespiration–Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Unit III

Nitrogen metabolism- Nitrate and ammonium assimilation; amino acid biosynthesis

Unit IV

Solute transport and photoassimilate translocation–uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates

Unit V

Sensory photobiology-Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks

PAPER 5 B ANIMAL PHYSIOLOGY

Unit I

Blood and circulation- Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.

Unit II

Respiratory system- Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Unit III

Nervous system- Neurons, action potential, neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.Sense organs - Vision, hearing and tactile response.

Unit IV

Digestive system -Digestion, absorption, energy balance, BMR.

Unit V

Endocrinologyand reproduction- Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

PAPER 6B PROJECT WORK