DEPARTMENT OF BIOTECHNOLOGY

UNIVERSITY OF KASHMIR

SRINAGAR

Syllabus for M.Sc Programme Session

2006 onwards

1st Semester

BTCH-01 Cell Biology

BTCH-02 Biomolecules

BTCH-03 Microbiology & Metabolism

BTCH-04 Biotechniques, Biostatistics & Computer Applications

BTCH-05 Laboratory Course I

500 Marks (100 marks for each paper: 20 internal assessments & 80 external)

2nd Semester

BTCH-06 Molecular Biology

BTCH-07 Enzymology

BTCH-08 Biology of immune system

BTCH-09 Environmental Biotechnology

BTCH-10 Elective paper

BTCH-11 Laboratory Course II

600 Marks (100 marks for each paper: 20 internal assessments & 80 external)

3rd Semester

BTCH-12 Animal cell Science & Technology

BTCH-13 Genetic Engineering

BTCH-14 Plant Biotechnology

BTCH-15 Bioprocess engineering & Technology

BTCH-16 Laboratory Course II

500 Marks (100 marks for each paper: 20 internal assessments & 80 external)

4th Semester

BTCH-17 project Work

BTCH-18 seminar

BTCH-19 Specialized paper(This paper to be set, conducted and evaluated in the department and will be based on the techniques and the back ground in the field of the respective project work done by the students)

400 Marks (250 marks for project work: 50 marks for Seminar, 100 marks for the specialized paper)

Elective paper: each student will opt for a comprehensive interactive course with on e of the faculty member. The supervisor will determine the topic of Specialization and course content

Project Work: project will be based upon research and actual bench work. Project report will be submitted at the end of 4th semester and evaluated

Specialized paper: This paper to be set, conducted and evaluated in the Department and willed on the techniques and the background in the field of the respective project work done by the students.

Student's seminar: Each student under the supervision of a faculty member will deliver seminar (Power point presentation) which will be evaluated.

Laboratory course: Practical examination for each laboratory course will be held for the four consecutive days comprising eight sessions.

CELL BIOLOGY

Course No: BTCH 01

UNIT I

Cellular diversity---An Overview

Structure of Prokaryotic and Eukaryotic cells.

Cellular organelles—Plasma membrane, Cell wall, Mitochondria, Chloroplast, Nucleus and otherOrganelles and their structural organization. Structure and function of endoplasmic reticulum, Ribosome's and Golgi complex.

UNIT II

Transport of nutrients, ions and macromolecules across membranes, endocytosis, phagocytosis and pinocytosis, Vesicular transport and secretory pathways.

Cellular energy transaction—Role of mitochondria and chloroplast.

UNIT III

Cell cycle—Molecular events and regulatory controls, cell cycle checkpoints with emphasis on animal cells and yeast cell divisions.

Control of cell numbers in multi-cellular organisms and programmed cell death.

Cancer: Types, causes molecular basis of cancer cell behaviour.

Molecular signaling: Signaling through G-protein linked cell surface receptors. Role of cAMP and Ca2+ in signaling.

UNIT IV

Cytoskeletal structures: Structure and regulation of cytoskeletal filaments. Microtubule motor protein and their significance, microtubules and actin filaments, actin-myosin complex, Mechanism of muscle contraction and motor proteins.

Brief introduction to cellular basis and differentiation and development with special reference to drosophila and Arabidopsis.

BIOMOLECULES

Course-BTCH-02

UNIT I

Chemical foundation of biology-pH, pK, Acids bases, buffers, weak bonds(hydrogen bonding, hydrophobic, hydrophilic, Wander walls bonding and ionic interactions)covalent bonds.

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.

UNIT II

Carbohydrates-Definition, Nomenclature, classifications, occurrence, characteristics and biological significance. Structure and conformation of sugars. Stereoisomerism & optical isomerism. Chemical reactions of functional groups present in carbohydrates. Amino sugars, structure and function of homo-and-hetero-polysaccharides. Mucopolysaccharides and proteoglycans-Types of glycoproteins-N and O linked glycosylations

Polysaccharides: Types, Structural features, methods for compositional analysis.

Amino acids: Structure, Classifications & physiochemical properties. Essential amino acids, non-protein amino acids. Peptide bond. oligo and poly peptides. Chemical synthesis of 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.

UNIT III

Fatty acids: Definition, Nomenclature and properties. Saturated and unsaturated fatty acids. Essential fatty acids. Classification of lipids. Chemical composition of fats. Properties of glycerides.

Phospholipids: Classification, Properties & functions of phospholipids, Glycerphospholipds, lecithins, cephalins, plasmalogens etc. Sphingo-phospholipds, glycolipds, gangliosides.

Compositions & biological role of lipoproteins. Structure and biological properties of prostaglandin, cholesterol and bile acids.

Heterocyclic compounds and secondary metabolites in living systems-Nucleotides, pigments, isoprenoids.

UNIT IV

Nucleic acids-Deoxy/Ribonucleic acid as genetic material primary, secondary and tertiary structure of DNA. Re-association reactions. Cot curves. Genome organization in viruses, prokaryotes 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 & METABOLISM

Course No: BTCH-03

UNIT I

Introduction to microbial system, Importance of microbiology in agriculture, Human and animal health industry and environment. Pure culture techniques, theory & practices of sterilization.

Growth curve, Synchronous growth, continuous culture, growth as effected by environmental factors like tempt, Acidity, Water and oxygen, culture collection and 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, Flagella and motility, cell inclusions like endospore, Gas vesicles.

Viruses: Bacterial, Plant and animal and tumor viruses, discovery classification and structure of viruses, lysogeny, DNA Viruses, Positives strand, negative strand and double stranded RNA viruses, replication of Herpes, Pox, Adenoviruses, retroviruses, viroids and prions

UNIT II

Viral & Bacterial Genetic systems:

Transformation, Conjugation, Transduction, recombination, Plasmid s and Tranposons

Bacterial genetic maps with reference to E.coli

Brief introduction to life cycle and molecular biology of some important pathogens of Hepatitis ,Tuberculosis, HIV

Host –parasite relationship: Normal microflora of Skin, Oral cavity, GIT, Entry of pathogens into

host: Colonization and factors predisposing to infection: 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

UNIT III

Metabolism I

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 of ketone bodies and their oxidation. Biosynthesis of saturated fatty acids and prostaglandins. Regulation

of lipid metabolism.

Metabolism of circulatory lipids, Chylomicrons, LDL, HDL &VLDL.

Lipid levels in pathological conditions.

UNIT IV

Metabolism II

Digestion of proteins and adsorption of amino acids. 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

Biological oxidation: electron transport chain, oxidative phosphorylation, uncouplers of oxidative phosphorylation

BIOTECHNIQUES, BIOSTATISTICS & COMPUTER APPLICATIONS

Course No: BTCH-04

UNIT I

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.

UNIT II

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.

Blotting techniques: Southern, Western, Far-western, South western,

Northern and their applications.

UNIT III

Brief description 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.

UNIT IV

Introduction to computers: organization, low and high level languages, binary number system.

Introduction to MS-Office (word processing, spread sheet & presentation software's).

Introduction to Internet and its applications.

Computer oriented statistical techniques.

Frequency table of single discrete variable, bubble sort, computation of mean, variance & standard deviation, t-test, correlation coefficient.

Protein and nucleic acid data bases and computer aided drug designing.

LAB COURSE I

Course No: BTCH-05

- Concept of solute, Solvent, Solution, Amount and Concentration, Units of measurement, preparation of solution, preparation of buffers
- Sub-cellular fractionation and marker enzymes
- Mitosis and Meiosis
- Titrimetric and potentiometric analysis: Amino acid titration
- Colorimetry: estimation of proteins and glucose
- Reactions of Amino acids, Sugars and Lipids
- Analysis of oils, iodine number, saponification value
- UV- visible spectroscopy
- Preparation of liquid and solid media for growth of microorganism
- Microscopic examination of bacteria, yeast and study of organism by gram stain, Acid fast stain, Spore staining
- Measurement of bacterial population by turbidiometery and serial dilution methods
- Demonstration of Antibiotic sensitivity and resistance

2nd Semester

MOLECULAR BIOLOGY

COURSE NO: BTCH-06

UNIT-I

DNA replication, repair and recombination:

Replication of DNA, direction and methods of replication. Replication initation in prokaryotes and later chromosomal replication. Topoisomerrases I and II. Replication forks. Eukaryotic replication. Plasmids and viruses.

Holliday junctions, gene targeting, gene disruption, FLP/FRT and Cre/lox recombination, RecA and other recombinases. Hollidat structure site, specific recombination, mutations and types:

Non-sense, missense, point mutation and frame mutation.

UNIT II

Transcription.

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 of lambda DNA and anti-termination.

UNIT III

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.

UNIT IV

Translation

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. Genetic code in mitochondria.

MOLECULAR ENZYMOLOGY & APPLICATIONS

Course No: BTCH-07

UNIT I

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

UNIT II

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

UNIT III

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

Unit IV

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

BIOLOGY OF IMMUNE SYSTEM

Course No: BTCH-08

UNIT I

Introduction

- Phylogeny of immune system
- Innate and acquired Immunity
- Clonal nature of immune response

Organization and structure of lymphoid organs

Nature and biology of antigens and superantigens

Antibody structure and function

Antigen-antibody interaction

UNIT II

Major histocompatibility complex

BCR & TCR generation of diversity

Complement system

Cells of immune system: hematopoiesis & differentiation , Lymphocyte trafficking,

B-Lymphocytes, T- Lymphocytes, Macrophages, Dendritic cells, Natural killer cells and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells

UNIT III

Regulation of Immune response

Antigen processing, processing and differentiation, 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 of T-cell & NK- cell mediated lysis.

Antibody dependent cell mediated cytotoxicity,

Macrophages mediated cytotoxicity

Hypersensitivity

Autoimmunity

UNIT IV

Transplantation

Tumor Immunology

AIDS and other Immunodeficiencies

Hybridoma Technology and Monoclonal Antibodies

ENVIRONMENTAL BIOTECHNOLOGY

Course No: BTCH-09

UNIT I

Environment: Basic concepts and issues

Environmental pollution: Types of pollution, Methods for the measurement of pollution.

Methodology of environmental management- the problem solving approach, its limitation.

Water pollution and its control: water as scare natural resource, Need for water management,

Measurement of water pollution, source of water pollution, Waste water collection, waste water

treatment, Physical, chemical and biological treatment processes

UNIT II

Microbiology of waste water treatment. Aerobic process: Activated sludge, Oxidation ditches, trickling filter & towers, rotating discs, rotating drums, oxidation ponds

Anaerobic processes: Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors

Treatment schemes for waste water of diary, distillery, tannery, sugars and antibiotic industries

UNIT III

Miccrobiology of degradation of xenobiotics in environment-ecological consideration decay behavior & degradative plasmids: hydrocarbons, substituted hydrocarbons, oil pollution, surfactants and pesticides

Bioremediation of contaminated soils and wasteland

Bio-pesticides in integrated pest management

UNIT IV

Solid wastes: source & management (Composting, Worm culture & methane Production)

Global environmental problems: Ozone depletion, UV-B, Green house effect and acid rain, their

impact & biotechnology approaches for management

Environmental implication of genetically modified organisms

LAB COURSE II

Course No: BTCH-11

- Isolation of Genomic DNA
- Isolation of RNA
- Electrophoresis of proteins , native and under denaturant conditions
- Separtion techniques (Gel filtration)
- Different absorption spectrum of BSA
- Chemical modifications of proteins
- Blood film preparation and identification of cells
- Immunodiagnostics (Demonstration using commercial kits)
- ELISA
- Double diffusion & Immuno electrophoresisi
- Western Blotting
- Detection of coliforms for determination of purity of potable water
- Determination of dissolved oxygen concentration of water sample
- Determination of Biological oxygen demand (B.O.D) & Chemical oxygen demand (C.O.D.) of a sewage sample
- Estimation of nitrate in drinking water

ANIMAL CELL SCIENCE AND TECHNOLOGY

Course No: BTCH-12

UNIT I

Structure and organization of Animal Cell.

Primary and established Cell lines.

Introduction to balanced salt solutions and simple growth medium.

Role of CO2, serum and supplements. Serum and serum free defined media and their applications.

UNIT II

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

UNIT III

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

UNIT IV

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

COURSE NO: BTCH-13

UNIT-I

Scope, Milestones and Guidelines of 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 I, isocaudomers and

isoschizomers. Restriction mapping of DNA fragments and map construction. RFLP.

UNIT-II

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.

UNIT III

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. Vector engineering and codon optimization, host enginnering. In-vitro transcription and translation. Expression in bacteria and yeast. Expression in insects and insect cells. Expression in mammalian cells and in plants

UNIT IV

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-DNA and transposon tagging

PLANT BIOTECHNOLOGY

COURSE NO: BTCH-14

UNIT I

Overview of plant cell structure and functions

Conventional Plant breeding

Introduction to cell and tissue culture: Totipotency of Plant cells

Tissue culture media (Composition & preparation)

Initiation and Maintenance of callus and suspension culture, Single cell clones

Organogenesis: somatic embryogenesis, Synthetic seeds

Micropropagation techniques and propagation of Virus free plants

Embryo culture & embryo rescue

UNIT II

Protoplast isolation, Culture and fusion; Selection of hybrid cells and regeneration of hybrid plants; Symmetric & Asymmetric hybrids, Cybrids

Anther, pollen and ovary culture for the production of haploid homozygous lines

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

UNIT III

Plant Transformation Technology; Basis of tumor formation, features of Ti Plasmids, Mechanism of T-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)

Unit IV

Chloroplast Transformation (Advantages, Vectors, success with tobacco& potato)

Molecular farming: production of carbohydrates, Metabolic engineering of lipids. Biodegradable plastic, Therapeutic proteins, lysosomal enzymes, Plantibodies, Edible Vaccines, Purification strategies-Oleosin partitioning Technology Controlled Mechanism and manipulation of Shikimate pathway

BIOPROCESS ENGINEERING AND TECHNOLOGY

COURSE NO: BTCH-15

UNIT I

Introduction to bioprocess engineering.

Bioreactors.

Media for industrial fermentation.

Air and Media sterilization.

UNIT II

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.

UNIT III

Whole cell immobilization and their applications.

Industrial production of chemical: alcohols (ethanol), acids (citric, acetic and gluconuic), solvents (glycerol, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline).

Amino acids (Lysine, glutamic acid). Single cell protein.

UNIT IV

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.

LAB COURSE III

Course No: BTCH-15

- Cell counting & cell viability
- Cryopreservation & thawing
- Preparation of tissue culture media membrane filtration
- Preparation of Single cell suspension from spleen and thymus
- Trypsination of monolayer & sub culturing
- Measurement of doubling time
- Role of Serum in cell culture
- MTT Assay for cell viability & growth
- Cell fusion with PEG
- Bacterial culture & Antibiotic selection media
- Preparation of competent cells
- Isolation of plasmid DNA
- Isolation of lambda phage DNA
- Agarose gel electrophoresis & restriction mapping of DNA
- Construction of restriction map of plasmid DNA
- Cloning in plasmid/ phagemid Vectors
- Gene expression in E.coli & analysis of gene products
- PCR
- Preparation of plant tissue culture media,
- Organ culture
- Callus propagation, organogenesis
- Protoplast Isolation & culture
- Anther culture , production of haploids
- Agrobacterium culture , Selection of transformants
- Isolation of industrially important microorganism

- Determination of Thermal death point (TDP) and Thermal death time
- Determination of growth curve of supplied microorganism
- Microbial production of citric acid using Aspergillus niger
- Microbial production of antibiotics (Penicillin)