

## SYLLABUS OF BIOTECHNOLOGY COURSES OFFERED FOR B SC DEGREE PROGRAM

### Semester-I

Course title: Biomolecules and Cell Biology

### Semester-II

Course title: Enzymology & Metabolism

### Semester-III

Course title: Bio-Techniques and Bio-Statistics

### Semester-IV

Course title: Microbiology, Immunology & Animal Cell Science

### Semester-V

Course title: Molecular Biology and Genetic Engineering

### Semester-VI

Course title: Plant Biotechnology & Bioprocess Engineering

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M.A. Chaf

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Nazia Khuram

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Dr. Mond Ashraf Khan

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Dr. Firdous Khanday

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## Semester-I

**Course title: Biomolecules and Cell Biology**

### Unit-I

Water and its Physicochemical Properties; Dissociation and Association Constants, pH, Buffers, pI, pKa, Solubility and Criteria for Solubility, Hydrophobicity and Hydrophilicity; Amino acids: Structure and classification. Importance of non-protein amino acids. Essential amino acids. Dielectric Constant. Laws of Thermodynamics, open and closed systems, isolated system. Gibbs Free Energy, Enthalpy and Entropy with special reference to Biological systems. Structure, Classification, Physical and Chemical Properties of Amino Acids. Peptide bond. Primary structure, Secondary structure, & Ramachandran Plot, Tertiary Structure of Proteins. Forces stabilizing protein structure.

### Unit-II

Definition and Properties of Carbohydrates; Structure and Function of Mono, Di and polysaccharides (Glucose, Mannose, Fructose, Galactose, Lactose, Sucrose, Glycogen, Starch and Cellulose); Isomerism of Carbohydrates; Mutarotation; Glycoproteins, Peptidoglycans, Lipopolysaccharides.

Classification of Lipids and Fatty Acids; Structure and Function of Saturated and Unsaturated Fatty Acids, Triglycerides and Cholesterol; Structure & function of Phospholipids, Sphingolipids, Cerbrosides.

### Unit-III

Vitamins: Structure and function of water soluble (B1, 2, 6, 12, C) & lipid soluble (A, D, E, K). Hormones: properties and function of Peptide hormones, steroid hormones & Amino-acid derivatives.

Structure of Purines, Pyrimidines, Nucleosides and Nucleotides; Structure of Biologically important Nucleotides and their function (FADH, NADH, NADPH, Co-A).

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SYLLABUS FOR BIOTECHNOLOGY COURSES FOR B SC PROGRAM UNDER SEMESTER SCHEME  
UNIVERSITY OF KASHMIR, SRINAGAR- 2018

**Semester-I**

**Course title:           Biomolecules and Cell Biology**

**Unit-I**

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#### Unit- IV

Structure of Prokaryotic and Eukaryotic Cells. Structure and Function of: Plasma Membrane, Endoplasmic Reticulum, Mitochondria, Golgi Apparatus, Ribosomes, Lysosomes, Chloroplast. Nucleus: structure of nuclear envelop & nuclear pore. Nucleolus function & composition. Organization of genomic DNA in the Nucleus. Histones & their role in packing of DNA. Nucleosomes as basic unit of eukaryotic chromosome structure.

#### Practicals

1. Preparation of physiological buffers.
2. Estimation of carbohydrate in given solution by anthrone method.
3. Estimation of sugar in biological samples by Dubois method.
4. Protein estimation by colorimetric method.
5. Chromosome Analysis & Karyotyping

#### Books Recommended:

1. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko and Lubert Stryer
3. Cell biology: organelle structure and function by David E. Sadava

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## Semester-II

**Course title: Enzymology & Metabolism**

### Unit-I

Nature of Enzymes, Holoenzyme, Apoenzyme, Prosthetic Group, Cofactors, Coenzymes, Enzyme Activity, Units of measurement, Nomenclature and Classification of Enzymes, Nature of Active Site. Activation energy, Enzyme Substrate Complex, Enzyme Kinetics, Michealis-Menten Equation,  $K_m$ ,  $V_{max}$ ,  $K_{cat}$ ; Factors effecting enzyme reactions, Enzyme inhibition (Competitive, Non- Competitive, Un-competitive).

### Unit-II

Carbohydrate Metabolism: Glycolysis, Gluconeogenesis, TCA cycle, Electron Transport Chain, Oxidative Phosphorylation, Pentose Phosphate Pathway, Glyoxylate cycle and their regulation.

### Unit-III

Lipid Metabolism, Transport of Fatty Acids across the Mitochondrial Membrane, Beta Oxidation of Saturated, Unsaturated Fatty Acids, Biosynthesis of Fatty Acids and Triglycerides. Prostaglandins and their synthesis.

### Unit-IV

Digestion & absorption of protein in Gastrointestinal tract. Transamination and Deamination reactions involved in Amino Acid metabolism, Urea Cycle and its Regulation. Metabolic disorders of Amino Acid Metabolism.

Denovo and salvage pathway of purine and pyrimidine biosynthesis; Degradation of purines and

pyrimidines: Conversion of Ribonucleotide to Deoxyribonucleotide and its Regulation.

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### **Semester-III**

**Course title: Bio-Techniques and Bio-Statistics**

#### **Unit-I**

Centrifugation: Principle, theory and Application of Differential and Analytical Centrifugation, Derivation of Sedimentation Coefficient, Density gradient centrifugation. Types of rotors.

Electrophoresis: Principle, Theory Application of Agarose, Poly Acrylamide Gel Electrophoresis (under native and denaturing conditions).

#### **Unit-II**

Principles and methodology of: Isoelectric focussing and 2D Gel Electrophoresis, Western, Northern & Southern Blotting, Polymerase chain reaction (PCR), PCR and hybridization based markers (RFLP, RAPD and AFLP). Immunodiffusion, Immunelectrophoresis, ELISA, RIA.

#### **Unit-III**

Chromatography: Principle, Theory and Application of, Thin layer, Ion Exchange, Gel exclusion, Affinity, HPLC Chromatography; Spectrophotometers: Beer and Lamberts Law and its Applications.

#### **Unit-IV**

Sample, Population, sampling techniques. Mean, Median, Mode and their comparison; Frequency Distribution; Standard Deviation, Standard Error of Mean (SEM); p-Value; Student t-Test (Paired and Unpaired); Chi square Test; Graphical Representation of Data (Histogram, Bar Chart, Pie chart, Frequency curve, etc).

#### **Practicals**

1. Paper and Thin layer chromatography.
2. SDS-PAGE.

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1. Principles and Techniques of practical Biochemistry: Keith Wilson, John Walker
2. Principles and Techniques of Biochemistry and Molecular Biology: Keith Wilson, John Walker.
3. Basic Biostatistics: Bert Gurtsman

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## Semester-IV

**Course title: Microbiology, Immunology & Animal Cell Science**

### Unit-I

Introduction to bacterial cell: Bacterial Cell wall structure & biosynthesis, structure and functions of outer membrane flagella, cell inclusions.. Introduction to Viruses. Classification of viruses: RNA and DNA viruses, plus & negative stranded, Genome & life cycle of lambda phage. Gene transfer in bacteria: Transformation, Conjugation and Transduction.

### Unit-II

Anatomical barrier to infections (mechanical, chemical, biological). Cellular barrier to infection. Phagocytosis & intracellular killing. Respiratory burst & intracellular killing. Mechanism of inflammation, Acute phase proteins. Lymphatic System, Organization and Structure of Lymphoid Organs; Hematopoiesis and Differentiation, Basic concept of cytokines. Toll like receptors. B and T Lymphocytes (TH1 & TH2), Dendritic Cells, Eosinophils, Neutrophils, Mast Cells, Natural Killer.

### Unit-III

Mechanism of Humoral and Cell mediated Immune Response. Primary and secondary immune responses. Complement System (pathways) & its Regulation. Nature of Antigens. Structure, types and function of Antibody. Monoclonal antibodies; Antigen-Antibody interaction, Antigen Processing and Presentation; Structure and Function of MHC Molecules.

### Unit-IV

Primary and Secondary Cell Line Cultures. Media for cell lines, Suspension & Adherent monolayer cultures, Commonly used Cell Lines; Basic Techniques of Cell culture in vitro. Disaggregation of tissue and primary culture, Maintenance of cell culture. Laminar flow hood, CO2 incubator, aseptic conditions for cell culture.

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**Practicals:**

1. Sterilization techniques for glassware and Plastic ware. Operational use of autoclave and laminar airflow.
2. Media preparation and sterilization.
3. Gram staining
4. Study of microbial growth kinetics.
5. Separation of serum from blood.
6. Blood grouping.

**Books Recommended:**

1. Immunology by Janis Kuby
2. Immunology: An Introduction by Ian R Tizard
3. General Microbiology: Roger Stanier, Ingraham, Wheelis, Painter
4. Animal Cell Science: by Ian R Freshney

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## **Semester-V**

### **Discipline centric course-1**

**Course title:           Molecular Biology and Genetic Engineering**

**Credits : 6**

#### **Unit-I**

Structure of DNA and its various forms (A, B, Z); Forces stabilizing the DNA Structure. General features of Replication (mode of replication, directionality of replication, primer synthesis). Enzymes and Proteins involved in Replication; Origin of Replication & its organization with examples from prokaryotic & eukaryotic systems. Mechanism of Replication Initiation, Elongation and Termination in Prokaryotes and Eukaryotes. End Replication of Linear DNA & Role of Telomerase.

#### **Unit-II**

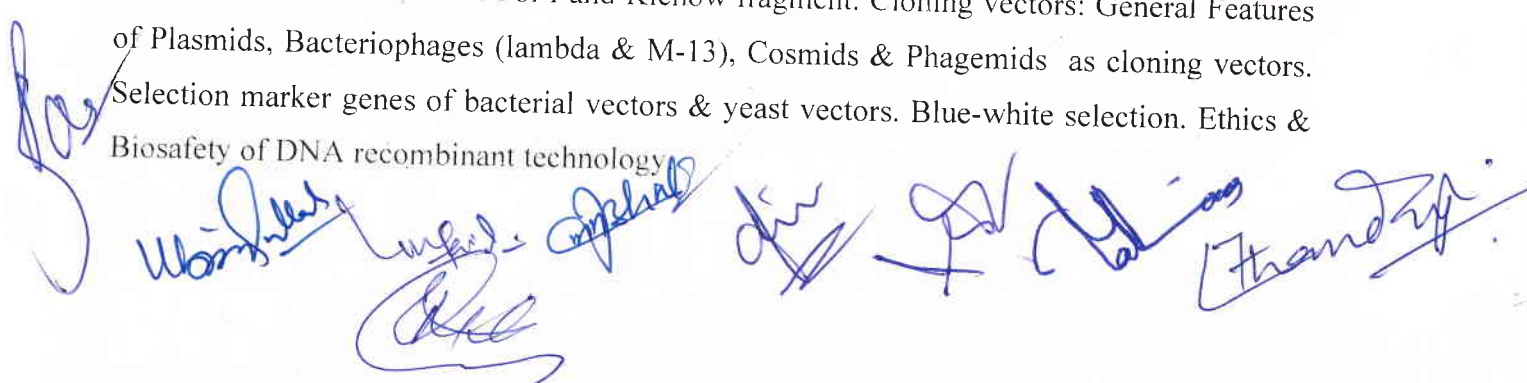
Transcription, Structure and Function of RNA Polymerase; Basal Transcription machinery, Organization of promoter in prokaryotic & eukaryotic systems. Enhancers and Silencer elements. Transcription initiation, elongation & termination. Operon Concept: Positive and Negative Regulation with reference to lac and trp operons. Post Transcriptional Modifications: Mechanism of RNA splicing, capping and polyadenylation.

#### **Unit-III**

Translation: Structural features of eukaryotic and prokaryotic mRNAs. Genetic Code: General features of genetic code. Wobble hypothesis. Basic features of translation machinery: Ribosome, t-RNA, protein factors involved in translation, amino-acyl t-RNA synthetases. Mechanism of translation initiation, elongation and termination (Prokaryotic and eukaryotic).

#### **Unit-IV**

Recombinant DNA technology tools: Restriction enzymes, Ligases, Phosphatases, T4 Polynucleotide kinase, DNA Pol I and Klenow fragment. Cloning vectors: General Features of Plasmids, Bacteriophages (lambda & M-13), Cosmids & Phagemids as cloning vectors. Selection marker genes of bacterial vectors & yeast vectors. Blue-white selection. Ethics & Biosafety of DNA recombinant technology.



### Practicals:

1. Isolation of genomic DNA and its analysis by agarose gel electrophoresis.
2. Restriction digestion of isolated DNA/plasmid DNA.
3. Quantification of DNA by spectrophotometry.
4. Formation of bacterial competent cells
5. Transformation of plasmid in competent cells

### Books Recommended:

1. Genes-XI: Benjamin Lewin
2. Molecular Biology: Robert Weaver
3. Molecular and Cell Biology: John Reece
4. Principles of gene manipulations: Old And Primrose

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**Discipline centric course-2**

**Semester-VI**

**Course title:** **Plant Biotechnology & Bioprocess Engineering**

**Credits :** 6

**Unit-I**

Concept of Plant cell Totipotency. Organization of Root apical meristem and shoot apical meristem. Plant Tissue Culture media composition (M.S media and others) Role of micro, macro nutrients, vitamins & hormones in plant tissue culture; Initiation and maintenance of Callus and Suspension cultures. Shoot Tip Culture; Production and applications of Haploids. Isolation, culture & fusion of Protoplast; Cybrids; Somatic Embryogenesis. Cryopreservation.

**Unit-II**

Gene Transfer in Plants using Agrobacterium tumefaciens, features of Ti plasmid, role of virulent proteins in T-DNA transfer. Concept of Binary vectors. Vectorless Gene Transfer (Gene Gun, whisker method, electroporation, Polyethylene glycol) General Concept of Transgenic Plants, and their utility, Golden Rice, Bt Cotton. Issues with Genetically Modified plants

**Unit-III**

Kinetics and growth of microbial cells. Methods for measuring cell growth. Concept of Fermentation; Types of fermenters. Batch type Continuous type. Substrate and Product inhibition of Product Biosynthesis, Effect of pH, Temperature and inducers on Product Synthesis; Fermentation Media composition and Sterilization;

**Unit-IV**

Bioreactors: Design and Types, Agitation and Aeration, Impeller and Sparger. Steps involved in Down Stream Processing: Separation of Cells and Broth, Sedimentation, Filtration, Centrifugation, Solvent extraction, Chromatography: Gel filtration, ion-exchange

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and Affinity (all the above methods are with special reference to product recovery in bioprocess technology) Immobilization of enzymes, Industrial Applications of Enzymes.

### Practicals:

1. Preparation of plant tissue culture media.
2. Explant culture (embryo/ovary).
3. Protoplast isolation.
4. Immobilization of sheep RBC's in alginate.

### Books Recommended:

1. Plant Biotechnology: Slater, Scott and Fowler.
2. Introduction to Plant Biotechnology: H.S. Chawla
3. Principles of Fermentation technology: Stanbury and Whitaker.

### Skill Enhancement Courses

#### Skill Enhancement Course-1

**Title of the Course:** Tissue Culture

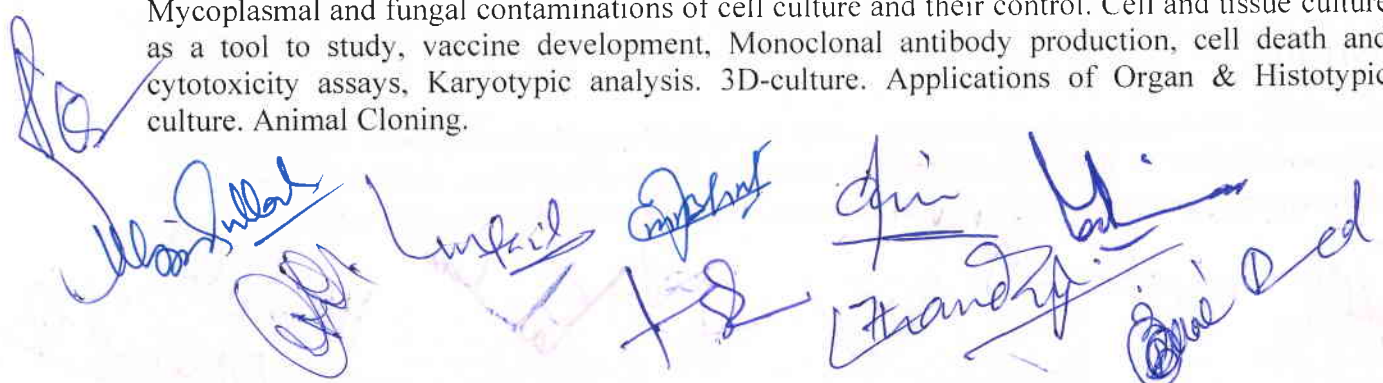
**Credits:** 4

#### Unit I:

Requirements for establishing animal cell culture facility. Importance of and progress in Animal Cell Culture Technology. Importance of Serum and Serum Free Media. Primary cell culture. Continuous Cell lines. Culturing and Sub-Culturing of Animal Cell. Cell Line Preservation. Cell Line Characterization. In Vitro Transformation of Animal Cells. Tissue and Cell Disaggregation.

#### Unit II:

Transfection of cells. Different types of transfections. Significance of transfections. Bacterial, Mycoplasmal and fungal contaminations of cell culture and their control. Cell and tissue culture as a tool to study, vaccine development, Monoclonal antibody production, cell death and cytotoxicity assays, Karyotypic analysis. 3D-culture. Applications of Organ & Histotypic culture. Animal Cloning.



SYLLABUS FOR BIOTECHNOLOGY COURSES FOR B SC PROGRAM UNDER SEMESTER SCHEME  
UNIVERSITY OF KASHMIR, SRINAGAR- 2018

**UNIT III:**

Basic Techniques in tissue culture: Preparation of Murashige and Skoog's Medium and White's media, explant selection, sterilization (steps involved) and inoculation. Initiation of callus and suspension culture. Shoot and root regeneration (organogenesis), maintenance of cultures, sub-culturing, acclimatization and hardening. Production of somatic embryos and organogenesis. Steps involved in pollen, ovary and ovule culture. Preparation of synthetic and artificial seeds by sodium alginate method and cryopreservation techniques.

**UNIT IV:**

Protoplast isolation from leaves by mechanical and enzymatic method (Cellulases and Macerozyme). Steps involved in isolation procedure (one step and sequential). Viability of protoplast (Fluorecein diacetate, phenosafranine, Evans blue, MTT assay). Protoplast culture (Hanging drop, micro culture chambers, co-culturing etc). Protoplast fusion (Spontaneous and induced) with a fusogenic agent like Polyethylene glycol (PEG), high  $\text{Ca}^{2+}$  /high pH or by electroporation.

**Skill Enhancement Course-2 (SCE)-2**

**Course Title: Industrial Fermentation**

**Credits: 4**

**UNIT-I**

Microbes as friend's - Normal flora. History of Industrial Microbiology, Microbes influencing our lives - Primary metabolites & secondary metabolites produced by the microorganisms.. Screening of Microorganisms - Primary screening - Isolation of desired and interested microorganisms - Secondary screening - yield potential of microbes - both qualitative and quantitative approach. Strain Improvement; Preservation of Microorganisms - Organizations involved in microbiological work . Fermentation media - Characteristics of an ideal production medium, Raw materials as media, Precursors and Inducers, Repressors, Antifoams

**UNIT-II**

Industrial sterilization - Principles of Sterilization - Sterilization of equipment, Sterilization of Production media and sterilization of air. Types of fermenters - Stirred tank fermenters - Packed bed fermenters - Fluidized bed fermenters - Bubble column fermenter - Air lift fermenter - Cylindrical fermenters - Flocculated cell culture fermenter - Multi phase bioreactors - Trickling bed bioreactors - Tubular fermenter- Mechanically agitated stirred tank reactors, Stirred tank fermenter (CSTF).

**UNIT-III**

Technology of Microbial cell maintenance – steps to maintain microbial culture in an aseptic & sterile environment (how to inoculate, preserve & maintain), Strain preservation, maintenance and strain improvement by mutation of gene transfer processes. Microorganisms & Agriculture – Microorganisms

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in Agricultural Waste water treatment, Vermiculture, Microbial pesticides. Products from  
**Microorganisms – Metabolites, Enzymes, Antibiotics.**

**UNIT-IV**

Downstream processing – extraction, separation, concentration, recovery & purification, operations (Insulin, Vitamins, Metabolites), Industrial production of Ethyl alcohol, Acetic Acid (Vinegar), Citric acid, lactic acid,  $\alpha$ -amylase, protease penicillin, tetracycline and vitamin B12.

**Books Recommended:**

1. Principles of Fermentation Technology. Stanbury RF and Whitaker A.
2. Bioprocess Engineering: Basic concepts Shuler ML and Kargi F.

**Skill Enhancement Course-3**

**Course Title: Biostatistics**

**Credits: 4**

**UNIT-I**

Introduction to Biostatistics: Concept of sample and population. Different sampling strategies and types. Types of data, Collection of data, Primary and secondary data, Classification and graphical representation of statistical data such as histograms, boxplots, bar charts, stem & leaf plots. Measures of Skewness and Kurtosis.

**UNIT-II**

Measures of central tendency: Mean, Mode Median, Variance, Standard deviation (SD), coefficient of variance, Statistical Estimation, Standard Error (SE) of the mean, Difference between SE and SD. Basics of Probability, Permutation and Combination; Probability Distribution: Basics of Binomial, Poisson and Normal distributions and their application in biology.

**UNIT-III**

Calculate and interpret summary statistics for data sets recognize basics of experimental design, including controls, randomization, pseudoreplication, and blocking. Methods of sampling, confidence level critical region, (Error, Variation, and Mistakes) testing of hypothesis and standard error, large sample test and small sample test.

**UNIT-IV**

Problems on test of significance, Conditions for Validity of the t-test, t-test (one tailed and paired), Chi-square test for goodness of fit and analysis of variance (ANOVA).

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**Books Recommended:**

1. An introduction to Biostatistics. PS Sunder Rao.
2. Introduction to the Practice of Statistics. Moore and McCabe
3. Principles of Biostatistics. Marcello Pagano.

**Skill Enhancement Course- 4**

**Course title:**        **Applied Enzymology**

**Credits:**        **4**

1. Introduction, History and nomenclature, Basic concepts
2. Microbial production of enzymes
3. Enzyme assays
4. Enzymes in health and disease
5. Enzymes in Food application
6. Enzymes in baking
7. Enzymes in household detergents
8. Enzymes in textile industry
9. Enzymes in paper and pulp processing
10. Enzymes in cosmetics
11. Enzymes in Waste water treatment

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