BANGALORE UNIVERSITY

Syllabus

For

M. Sc. Biochemistry
Choice based credit system (CBCS)

With effect from 2014 – 15

Department of Biochemistry,
Central College Campus
Bangalore – 560 001
FOREWORD

As per the directives from the University, the syllabus for M. Sc. Degree course in Biochemistry had to be prepared in accordance with the guidelines provided by the University.

The teaching faculty member of the Department of Biochemistry participated in the discussions for syllabus preparation. The departmental council met three times on 9, 15, and 19 July, 2014 to deliberate on the topics and subjects for the syllabus. In order to conform to the UGC Model Curriculum for development of interdisciplinary skills in students by linking general studies with professional courses and allowing horizontal and vertical mobility, as well as local needs, the Biochemistry syllabus has been redesigned. After studying the course content for the Choice Based Credit System (CBCS), the Draft syllabus was approved by the Departmental Council in its meeting held on 23rd July, 2014. The draft syllabus was placed before the Board of Studies in Biochemistry (PG) for approval on 28.07.2014.

CHAIRMAN
Department of Studies in Biochemistry
Central College Campus
Bangalore University
Bangalore -560001
Proceedings of the meeting of the Board of Studies in Biochemistry (PG) held on 28th July, 2014 in the Department of Biochemistry, Central College Campus, Bangalore University, Bangalore -560001.

The meeting of the Board of Studies in Biochemistry (PG) was held on Monday, the 28th July, 2014 at 10.30 am in the Library of Department of Chemistry to approve the M.Sc. CBCS Biochemistry syllabus.

The Chairman welcomed the members, the draft syllabus approved by the Departmental Council was placed before the board. After day-long scrutiny, the board approved the M.Sc. Biochemistry CBCS syllabus with incorporation of appropriate modifications.

The Chairman thanked all the members for their active participation and valuable inputs.

Members present:

1. Dr. Paramahansa V Salimath
   Dept. of Biochemistry & Applied Nutrition
   CFTRI, Mysore-570013
   External Member

2. Prof. N. Ramachandra Swamy
   Chairman, Dept. of Biochemistry,
   Bangalore University
   Bangalore -560001
   Chairman (BOS )

3. Dr. V. R. Devaraj,
   Dept. of Biochemistry,
   Bangalore University
   Bangalore -560001
   Member

4. Dr. K.R. Siddalinga Murthy
   Dept. of Biochemistry,
   Bangalore University
   Bangalore -560001
   Member

5. Dr. H. D. Ramachandran
   Dept. of Biochemistry,
   Bangalore University
   Bangalore -560001
   Member

6. Prof. T.B. Karegoudar,
   Dept. of Biochemistry
   Gulbarga University, Glubarga
   External Member
   ABSENT
Name of the Course: M. Sc. Biochemistry

Duration of the course: Two years

Eligibility: Candidate must have secured 40% in aggregate and studied Chemistry OR Biochemistry as one of the cognate subjects securing 50% marks at B.Sc. level, and studied Biology at PUC OR 10 + 2 level.

Intake: 14 + payment seats (05)

Admission: As per the prevailing University regulations.

SCHEME OF STUDY AND EXAMINATION

I to IV SEMESTER M. Sc. BIOCHEMISTRY COURSE

<table>
<thead>
<tr>
<th>Paper Code</th>
<th>Title of the paper</th>
<th>Contact hours</th>
<th>Exam. hours</th>
<th>Marks</th>
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<td>Biophysical and Bio – organic chemistry</td>
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<td>Analytical Biochemistry – I</td>
<td>4</td>
<td>3</td>
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<td>BCT – 104</td>
<td>General Physiology</td>
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<td>Gen. Biochemistry – I</td>
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## Third Semester

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** Non- Biochemistry Paper
### Fourth Semester

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### Scheme for Continuous Evaluation:

**Theory each Paper**

- **Attendance:** 5 Marks
- **Tests***: 25 Marks
- **Total:** 30 Marks

*Two tests will be conducted and average of marks from two tests will be computed for continuous evaluation*

**Practical (each Practical)**

- **Attendance:** 5 Marks
- **Tests***: 20 Marks
- **Records:** 5 Marks
- **Total:** 30 Marks

*Two tests will be conducted and average of marks from two tests will be computed for continuous evaluation*
FIRST SEMESTER M. Sc. BIOCHEMISTRY

BCT – 101: Biophysical and Bioorganic Chemistry

4 units (52 hrs)


6 hrs

Thermodynamics: First law of thermodynamics, basic concepts of entropy and second law of thermodynamics, free energy changes, standard free energy change and its relation to equilibrium constant. Oxidation – reduction reactions in biological systems.

5 hrs


5 hrs


12 hrs


6 hrs

Free radicals: Introduction, formation – photolysis, thermolysis, redox reactions, radical reactions with biomolecules.

4 hrs

Heterocyclic systems: Occurrence in biological systems, structure and properties of furon, pyrrole. Indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine containing biomolecules.

8 hrs

Bioinorganic chemistry: Ligand field theory of complexes, stability of complex ions in solution, kinetics and mechanism of reactions of complexes. Ligand replacement reactions and
electron transfer reactions of organometallic moieties of biological macromolecules (cytochromes, chlorophyll and hemoglobin).

References
9. Introduction to Biophysical Chemistry, Bruce Martin

BCT– 102: Biomolecules

4 units (52 hrs)

Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), glycosaminoglycans, cardioglycosides and bacterial cell wall polysaccharides. Structure elucidation of polysaccharides (starch, glycogen and cellulose). Glycoproteins – structure and functions, blood group antigens, sequence analysis of oligosaccharides. Lectins – characteristics and functions in biological system.

10 hrs

Lipids: Lipid classification, brief account of the chemical properties and structure of lipids (without structure elucidation) & biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids – prostaglandins, thromboxanes, & leukotrienes, leptin and visfatin.

7 hrs

Amino acids and Proteins: Review of classification and structure of amino acids, acid – base properties of amino acids. Non – standard, non–protein and biologically active amino acids. UV-

*Primary structure:* Elucidation of primary structure of proteins – Determination of amino acid composition, end group analysis, cleavage by enzymes and chemicals, separation of fragments. Manual and modern methods of sequencing and reconstructing the protein sequence. Assignment of disulfide bonds.


*Tertiary structure:* Forces stabilizing tertiary structure of proteins. Protein denaturation and renaturation.

*Quaternary structure and symmetry:* Structure and function of myoglobin and hemoglobin. Cooperative mechanism of oxygen binding to hemoglobin. Abnormal hemoglobin– sickle-cell hemoglobin.

20 hrs


3 hrs


12 hrs

**References**


BCT- 103: Analytical Biochemistry – I

4 Units (52 hrs)

Introduction to Biochemistry: 1 hr

Overview of Biochemical Investigations: Introduction to biochemistry, outline of strategies in biochemical investigations employing whole animal studies, isolated organs, tissues, and cell cultures. Specific investigations with isolated organelles; mitochondria and ER. Investigations with microorganisms and their mutants yeast, Caenorhabditis elegans, Arabidopsis thaliana and Drosophila melanogaster as model specimen for biochemical investigations. Basic equipments and methods, and safety considerations in animal cell culture. Types of animal cells and their characteristics in culture, culture media and common animal cell lines for laboratory investigation. Plant cell culture, media for plant cell culture, potential of plant cell culture in biochemical investigations.

Extractions: Preparation of extracts for biochemical investigations, physicochemical properties of metabolites and drugs extracts from biological materials. Physico-chemical properties of solvents, solubility and missibility, ionic bonds, and salting out. Partition, ionization, buffering and their effect on extraction. Choice of solvent for solvent extraction, mixed solvents, solid phase extraction.

9 hrs

Microscopic techniques: Review of light microscope, resolution of microscopes, Optical contrast, phase contrast, and dark field microscopy, preparation of specimen for biochemical investigations. Electron microscopy; Working principle and applications, specimens for electron microscopy, fixatives, immune-gold microscopy and its advantages. Metal shadowing, design and applications of scanning electron microscopy (SEM), Transmission electron microscopy (TEM), and cryo-electron microscopy. 3-D images, negative staining, single particle reconstruction.

5 hrs

Fluorescence Microscopy: Fluorophores, principle and applications of fluorescence microscopy, design and uses of Epifluorescence microscopy, and immuno-fluorescence microscopy. Imaging live cells and tissues; time lapse imaging, fluorescence stains of living cells, reporter molecules, multidimensional imaging. Measuring cellular dynamics; calcium imaging in live cells, fluorescence recovery after photo bleaching (FRAP), Fluorescence
resonance energy transfer (FRET). Use of ion-selective electrodes, light emitting indicators and optical tweezers in study of cellular dynamics.

5 hrs.

Centrifugation: Principle of centrifugation, the Swedberg equation, types of centrifuges and rotors. Density gradient centrifugation- Caesium chloride and sucrose density gradients; examples of separations, Sub-cellular fractionation. Design and working of analytical ultracentrifuges, sedimentation velocity and sedimentation equilibrium analyses.

Ultra-filtration: Principle, instrumentation and application. Dialysis, principle and uses of equilibrium dialysis., Precipitation; methods and applications.

Flow Cytometry; Principle and design of flow cytometer, cell sorting. Detection strategies in flow cytometry and parameters measured by flow cytometry.

7 hrs

Biocalorimetry: Arrhenius equation, determination of energy of activation from Arrhenius plots. Main thermodynamic parameters; enthalpy, and entropy. Isothermal titration calorimetry, design of experiments, determination of change in heat capacity, eg., oligomerization of valinomycin, DNA duplex. Determination of specific heat from enthalpy. Differential scanning calorimetry; design of experiment, application of DSC, microcalorimetry. Determination of thermodynamic parameters by non-calorimetric data.

5 hrs

Manometry: Instrumentation, types of manometry; Warburg constant volume manometer, Gilson’s differential respirometer, applications.

3 hrs

Radioisotopic methods of analysis: Atomic stability and radiation, types of decay, rate of radioactive decay, half life, units of radioactivity. Detection and measurement of radioactivity, Design and applications of Geiger-Muller Counter, and types of scintillation counters. Disadvantages of scintillation counters, quenching, Chemiluminescence and phospholuminescence counting efficiency, channel ratio, sample preparation, scintillation cocktails, Cerenkov counting. Autoradiography; types of emulsions and films for exposure to isotopes, suitable isotopes, times of exposure and processing films, direct autoradiography, fluorography, intensifying screens, quantification. Radio tracer techniques; Supply storage and purity of radio-labeled compounds, specific activity, radio-labeled nucleotides, metabolites. Pulse chase experiments.

8 hrs

Quantitative biochemical measurements: Analytical considerations and experimental errors, nature of experimental errors- random and systemic errors. Identification of systemic errors, SOPs. Performance of analytical methods, precision, accuracy, detection limit, analytical range, specificity, sensitivity, and robustness. Gaussian distribution (normal) of data, quantification of precision by standard deviation, coefficient of variation and variance, (data to be provided for calculation of each parameter). Assessment of accuracy; Population statistics- confidence limits and confidence intervals, student’s t-test, standard error of mean, examples for calculation. Q-tests, examples and applications, Null hypothesis, use of t-test to validate analytical methods-unpaired, paired, one-sample, two-sample tests with examples. Calibration methods; Least mean square method of fitting straight line to data with example. Correlation and regression analyses. ANOVA, one way and two-way ANOVA.
**BCT – 104: General Physiology**

**4 units (52 hrs)**

**Tissues:** Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue – extra cellular matrix, Collagens – types, composition, structure and synthesis, Elastin, fibronectins, and other proteins of the extra – cellular matrix. Basal lamina; laminins and associated proteins and their functions.

**6 hrs**

**Cytoskeleton and Cellular dynamics:** *Microfilaments*; Assembly and polymerization of G-actin, role of Thymosin-B4, Profilin and Cofilin in polymerization, structural and functional property of F-actin, Capping proteins and assembly of actin filaments, branched and unbranched
filament assemblies, Arp2/3, intracellular cellular movement and actin polymerization, use of toxins in study of actin dynamics. Role of cross-linking and adaptor proteins in actin bundling and membrane association.

Structure and organization of microtubules; dynamics of microtubules, assembly by MTOC, dynamic instability, tubulin polymerization as target of drugs. Side and end-binding proteins, capping and severing proteins. *Kinesins and dyneins*; vesicular transport along microtubule, role of kinesin-1 and dynein motors in organelle transport. Role of microfilaments and microtubules in cell migration.

*Intermediate filaments*; Assembly and tissue specific expression, dynamic nature of intermediate filaments, diseases associated with Lamins and Keratins defects.


**Respiratory System:** Mechanics and regulation of respiration, pulmonary and alveolar ventilation and its control, transport of respiratory gases, respiratory mechanism of acid-base balance.

**Endocrine system:** Hormones, feedback regulation, biosynthesis, storage, secretion, Circulation in blood. Degradation and peripheral transformation. Receptors and the mechanism of hormone action. Measurement of hormones, and receptors. Disorders of endocrine system. 

7 hrs

**References**


**BCSCT – 105: Nutrition**

4 units (39 hrs)


**Lipids:** Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions. Role of lipoproteins and cholesterol, triglycerides in health and disease.


12 hrs

**Macro-minerals:** Calcium, Phosphorus Magnesium, Sodium, Cobalt, Potassium, Chloride.

**Micro minerals:** Iron, Zinc, copper, selenium, chromium, iodine, manganese, Molybdenum and fluoride.

**Ultra trace minerals:** Arsenic, Boron, Nickel, Silicon, Vanadium & cobalt: Digestion & absorption, Functions, Toxicity, interaction with other nutrients. RDA and food sources.
6 hrs

**Vitamins and Energy metabolism:** Fat soluble vitamins: RDA. Vitamin- A, vitamin- D, E & K. Water soluble vitamins: Vitamin-C, Thiamine, Riboflavin, Niacin, Pantothenic acid, Biotin, Folic acid, Vitamin-B12, Vitamin-B6 (Digestion, absorption and transport and excretion, functions, interaction with other nutrients (if any), Deficiency and toxicity, major sources, Assessment of nutritive value and analysis in food material.

**Energy metabolism:** Basal and resting metabolism- influencing factors. Methods to determine energy requirements & expenditure. Thermo genesis, adaptation to altered energy intake, latest concepts in energy requirements and recommendations for different age groups. BMR and methods of BMR determination. Factors affecting BMR. Energy requirements for different physical activities. Specific dynamic action (SDA) of food.

**Regulation of food intake:** role of hunger and satiety centers, effect of nutrients.

**Basis for computing nutrient requirements:** latest concepts in dietary recommendations, RDA-ICMR and WHO: their uses and limitations.

10 hrs

**Nutrition in various age groups:** Physiological adjustments, Nutritional requirements, Effect of malnutrition, and special needs and nutritional problems in Pregnancy, Lactation, infancy, preschool, adolescent, young adults and elderly adults.

4 hrs


7 hrs

**References:**

BCP – 106: Gen. Biochemistry – I (4 Credits)

1. Preparation of buffers; Acetate, phosphate and tris buffer.
2. Determination of saponification number and acid value of oils and fats.
3. Determination of iodine number and peroxide value of oils and fats.
4. Determination of pKa of weak acids and amino acids by pH metric titration.
5. Isolation of potato starch / liver glycogen.
10. Determination of phytic acid.
11. Estimation of vitamin C by dichlorophenol indophenol method.

References
5. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)

BCP – 107: General Biochemistry – II (4 Credits)

1. Absorption spectra of proteins and nucleic acids and determination of molar extinction coefficient.
2. Estimation of reducing sugars (lactose in milk) by DNS method.
5. Estimation of protein by Lowry’s method.
7. Estimation of tyrosine by Millon's method.
11. Estimation of RNA by Orcinol method.

References
Second Semester M. Sc. Biochemistry

BCT – 201: Enzymology

4 units (52hrs)


*Monomeric and oligomeric enzymes:* Monomeric enzymes; serine proteases, zymogen activation, multifunctional enzymes, oligomeric enzymes and multi-enzyme complexes.  

**5 hrs**

**The investigation of active site structure:** The identification of binding sites and catalytic sites – trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains (cys, met, his, ser, asp, glu, lys, and tyr). Affinity labeling studies (chymotrypsin trisose phosphate isomerase) and super reactive amino acid chains (chymotrypsin and glutamate dehydrogenase). The 3-D structural features of active sites as revealed by X-ray crystallographic and chemical studies (chymotrypsin trypsin, elastase and triose phosphate isomerase). Site directed mutagenesis.

**7 hrs**

**Enzyme catalysis:** Chemical nature of enzyme catalysis-General acid-base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of the following enzymes-lysozyme, ribonuclease, lactate dehydrogenase, serine proteases (chymotrypsin, trypsin, elastase), sulphhydryl enzymes (papain and alcohol dehydrogenase), and multi-enzyme complexes (pyruvate dehydrogenase complex). Metal-activated and metallo-enzymes (mechanism of action of pyruvate kinase, creatine kinase, superoxide dismutase & carboxypeptidase – A).

**7 hrs**

**Coenzymes:** The mechanistic role of the following coenzymes in enzyme catalyzed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B12.

**6 hrs**

**Kinetics of enzyme-catalyzed reactions:** Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies, rapid reaction techniques and relaxation technique. Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Kinetic data evaluation-linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Integrated velocity
equation. Haldane equation. King-Altman procedure for deriving the rate equation. Effect of pH & temperature on enzymatic reactions, Arrhenius plot, determination of activation energy.  

9 hrs

**Enzyme Inhibition:** Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible inhibition.  

6 hrs

**Kinetics of bi-substrate reactions:** Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between different kinetic pathways using primary and secondary plots. Inhibition studies in the characterisation of bisubstrate reactions. Investigations of reaction mechanisms using isotopic exchange at equilibrium.  

5 hrs

**Allosteric of enzyme action:** Binding of ligands to proteins, Co-operativity, the Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. *Sigmoidal kinetics:* MWC and KNF models. Significance of sigmoidal behavior. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation.  

7 hrs

**References**

17. An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg, (1997) Jones
and Bartlett publishers.

**BCT – 202: Analytical Biochemistry – II**

4 units (52hrs)

**Chromatography:** Introduction, partition coefficient phase systems, liquid and solid phases, principle procedure and application of paper chromatography, parameters employed in column chromatography, retention, resolution, physical basis of peak broadening, capacity factors, peak symmetry, standard systems of chromatography and its components, stationary phase, elution.

**Modes of chromatography:** Ion exchange, major ion exchange matrices, elution in ion exchange chromatography. Examples of cation and anion exchangers, chromate-focusing. Gel filtration: matrix used fractionation range and matrices, determination of native mass of protein by gel filtration. Reverse phase principle and procedure.

**Hydrophobic interactions and affinity chromatography:** Affinity ligands immobilization of ligands. Activation of matrices, coupling affinity ligands (example–GSH). Metal affinity chromatography, His tag, open column chromatography, hydroxyl apatite chromatography.

**HPLC:** Instrumentation, column, pumps, plumbing, injectors, mobile phases in HPLC, two dimensional HPLC, factors affecting resolution in HPLC chromatography, flow rate and linear velocity. Separate modes: normal and reverse, gradient reverse phase, ion suppression and ion pairing. Chiral-HPLC, chiral columns. Detectors: types, UV, visible fluorescence, electrochemical detectors. Fast protein liquid chromatography (FPLC).

15 hrs

**Gas chromatography:** Principle and design of instrument. Factors affecting GC, stationary phase, mobile phase, column length, diameter, film thickness, flow rate, temperature, sample introduction. Detectors: flame ionization, thermal ionization, electron capture, mass selective detection. G.L.C; principle and application.

**Thin layer chromatography:** Introduction; phases used in TLC preparative TLC, metabolic profiling, solvent systems for TLC. Detection of compounds on TLC plates.

**Capillary electrophoresis:** Principle, instrumentation, electro-osmotic flow, free solution capillary electrophoresis. Choice of buffers and ionic strength. Organic modifiers electrochromatographic-electrically driven HPLC. Capillary sample introduction and detection in capillary electrophoresis.

**Electrophoresis:** Historical developments, principle, non-denaturing PAGE, activity staining for enzymes, zymogram, denaturing electrophoresis (PAGE), SDS-PAGE, SDS-PAGE in reducing conditions, chemical cross linking of proteins urea electrophoresis, isoelectrofocusing. Electrophoresis in DNA sequencing, Sanger- deoxynucleotide sequencing. Foot printing of DNA.

**Immuno-electrophoresis:** Dot blotting and immune-diffusion tests with antibodies, zone electrophoresis/immune-electrophoresis. Rocket electrophoresis, counter immune-electrophoresis, Agarose gel electrophoresis of nucleic acids, pulse field electrophoresis,
physical basis, equipment and applications. Electrophoretic blotting: western, southern, northern equipments and application.

9 hrs

**Spectroscopic techniques:** Wave particle duality of light, electromagnetic spectrum, transition in spectroscopy. Principle, design and application of UV-Vis spectrophotometry. Principle, design and application of fluorescence spectroscopy. Measurement of fluorescence and chemiluminescence, use of fluorescence in binding studies. Spectroscopy techniques using plane polarized light, circular dichroism (CD), equipment for CD measurement, CD of biomolecules (proteins) and LD (linear dichroism) of biomolecules.

**IR spectroscopy:** Physical basis of IR spectroscopy. Instrumentation, use of IR in structure determination, Fourier transfer, IR spectroscopy, Raman IR spectroscopy.

**NMR:** Principle, effect of atomic, identity on NMR, chemical shift, spin coupling NMR, measurement of NMR spectra, biochemical application of NMR.

**ESR:** Principle, measurement of ESR spectra uses of ESR in chemistry.

**Mass spectrometry:** Principle, overview of MS- experiment, ionization modes, equipments in MS analysis (Identification of metabolites) MS of protein/ peptides. Interfacing MS with other methods; MS/MS, LC/MS, GC/MS, electrophoresis/MS. Uses of MS in Biochemistry: MS and heterogeneity in proteins, peptide mapping, post translation modification analysis, determination of disulfide bridges, analysis of DNA compounds.

15 hrs


6 hrs

**Bioinformatics:** Definition and overview, sequence data, nucleotide and protein sequence, genome database, EST tag databases and SNP database. Tools for primary structure analysis; BLAST programme, FASTA, ClustalW, hydropathic plots, prediction of secondary structure and identification of protein families. Tertiary structure database; Cambridge database, PDB, specialist structural databases. Programs for analysis and visualization of tertiary structure databases, RasMol/RasTop, protein explorer, Swiss-prot Pdb viewer, Homology modeling, modeling proteins from known homologous structures, and application in drug discovery.

7 hrs

**References**

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

BCT – 203: Metabolism – I

4 Units (52 hrs)


Glycogen and starch metabolism: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms.
Regulation of blood glucose level, hypoglycemia and hyperglycemia. Diabetes mellitus: introduction, biochemical and clinical changes associated with IDDM and NIDDM, control of hyper glycemia, diagnosis of Diabetes mellitus and GTT. Pentosuria, Hexose interconversion, fructose and lactose intolerance, fructosuria, galactosemia. Glycosylation of proteins


12 hrs

18 hrs

13 hrs

9 hrs

**References**


**BCT – 204: Membrane Biochemistry**

4 units (52 hrs)

**Introduction:** Review of structure, nomenclature and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, Langmuir trough. **Cell and organelle membranes:** Physical properties of bi-layers, Polymorphic phases and molecular shapes exhibited by lipids, use of differential scanning calorimetry (DSC) and ³¹P NMR to study transition in phases. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolipin, engineering membrane lipid composition. Models of membranes; Metamorphic mosaic model, Singer-Nicolson fluid mosaic model, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; methods to determine membrane sidedness. Asymmetry of lipid distribution in bacterial, plant, and animal membranes, Lateral heterogeneity of membrane lipids; lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes. Physical organization of bilayers; human erythrocyte membrane as a prototype plasma membrane, role of cytoskeleton in organization of bilayers. **Liposomes:** preparation, properties and application in membrane biochemistry.

13 hrs


10 hrs


Bacterial transport systems; Lactose permease, Phospho transferase and sugar binding proteins.

7 hrs


Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Sec61 complex.

8 hrs
**Topology of membrane protein:** Protein translocation, cotranslational, post translational translocation. Start transfer and stop transfer signals for single pass transmembrane protein and multipass transmembrane proteins. ER retention signals, Glycosylation in ER. N-linked oligosaccharide, Dolichol-linked oligosaccharides. Folding of proteins in ER, role of chaperons – Calnexin and Calreticulin. N-linked oligosaccharides as timers for protein turnover, ubiquitination and protein degradation (improperly folded proteins), GPI-anchored proteins.

5 hrs


9 hrs

**References**
BCSCT – 205: Microbiology

3 units (39 hrs)

**Bacteriology:** Classification of Bacteria – Conventional and molecular methods; Identification and classification of microorganisms; *Eubacteria, Archaeabacteria, Cynobacteria*, Bergy's classification of bacteria. Brief study of important groups of bacteria: Coliform, spore formers, photosynthetic bacteria, lactic acid producing bacteria, *actinomycetes, ricketisiae, mycoplasms.*

5 hrs


4 hrs


3 hrs

**Pure culture techniques**: Principles of microbial nutrition: Nutritional requirements, different kinds of media, factors affecting growth. Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms. Modes of reproduction, Biosynthesis of cell wall components, enumeration, growth curve, generation time, synchronous growth, Chemostat. Adaptation to stationary phase, heat and cold shock, osmolarity and salinity, oxidative stress.

6 hrs

**Control of Microbial Growth:** Principles of Microbial growth, Sterilization methods and sterility testing. Physical and chemical methods of controlling bacterial growth. Antibiotic-targets and action.

3 hrs

**Food Microbiology:** Food spoilage, food preservation, fermented foods, exotoxins produced by bacteria.

3 hrs

**Dairy Microbiology:** Contamination of milk by micro-organisms. Bacterial count, reactions occurring in milk, Pasteurization and sterilization. Fermented milk products, cheese.

4 hrs

**Medical Microbiology:** Normal mouth, nose, and throat flora, Mechanisms and control of bacterial pathogens. Antiseptic and disinfectant action; Antibiotic assay; Determination of minimum inhibitory concentration (MIC), endotoxins.

4 hrs

**Virology:** Classification and General Properties and structure of plant, animal and bacterial viruses.

*Bacterio phages:* one step growth experiment, single burst and premature lysis experiments, productive cycles of λ and φx-174 viruses, lysogeny – P1, P2, P22 and Mu1 phages, RNA phages, isolation and cultivation of bacterial viruses.

*Plant viruses*– transmission, effect on plants, common diseases, TMV. Slow viruses and DI viruses- discovery and importance.

*Animal viruses*– productive cycle of DNA viruses- parvo, adeno and SV40. RNA viruses- reo, rhabdo, picorna, polio, Influenza Retrovirus (RSV and HIV)
Cultivation and enumeration of viruses; cultivation in cell culture, chick embryo and animal inoculation. Persistent chronic and acute viral infections. Inhibition and inactivation of viruses by physical and chemical agents.

Interferon - types, nomenclature and classification, induction, antiviral effect, antiviral proteins - ds RNA dependent and independent pathways.

References:

BCP – 206: Biochemical and Immunochemical Techniques (4 Credits)

1. Ascending descending and circular paper chromatography of amino acids / carbohydrates
2. Two-dimensional chromatography of amino acid / carbohydrates.
3. Thin layer chromatography of carbohydrates / amino acids.
5. Separation of proteins by non-denaturing PAGE.
6. Determination of molecular weight of Proteins by SDS–PAGE
7. Separation of isoenzymes by isoelectric focusing
8. Ion exchange chromatography of nucleic acids / proteins.
9. Demonstration of Ag-Ab interaction: Radial immuno-diffusion and ODD.
10. Demonstration of direct agglutination reaction using human blood group antigens.
11. Demonstration of indirect agglutination reaction-latex agglutination.
12. Bacterial agglutination (WIDAL)
13. Antibody titration – ELISA; Direct, Indirect, sandwich, and micro ELISA.
14. Purification of antibodies; conventional (isolation of IgY from Egg yolk).
15. Rocket electrophoresis.
16. Western blotting of proteins and Immuno-detection.
BCP – 207: Enzymology (4 Credits)

1. Determination of total activity of pea esterase.
2. Determination of $K_M$ and $V_{max}$ of pea esterase.
5. Determination of optimum temperature and activation energy of pea esterase.
7. Determination of type of inhibition (reversible or irreversible) of pea esterase.
8. Determination of $I_{50}$ of pea esterase using organophosphate inhibitor.
9. Determination of total activity of salivary $\alpha$-amylase /$\beta$-amylase (sweet potato or germinated ragi).
10. Determination of $K_m$ and $V_{max}$ of $\alpha$-amylase /$\beta$-amylase.
11. Determination of $K_m$ and $V_{max}$ of alkaline phosphatase (potato).
12. Determination of type of inhibition (reversible or irreversible) of alkaline phosphatase.
13. Determination of $I_{50}$ of alkaline phosphatase.
14. Determination of inhibitor constant, $K_i$ of alkaline phosphatase.
15. Determination of optimum temperature and activation energy of urease (horsegram).

References


**Third Semester M. Sc. Biochemistry**

**BCT – 301: Molecular Biology – I**

**4 units (52 hrs)**

**Introduction:** Historical account of DNA discovery. Relationship between genes and proteins, overview of flow of genetic information; central dogma of molecular biology. Nature of genetic material, experiments confirming DNA as genetic material. Review of physical chemistry of DNA. RNA as genetic material. Variation in size and shape of genomes; ultracentrifugation and electron microscopic methods to study the shape and size of genomes. Relationship between size of genome and genetic capacity; C-value paradox. Organelle genomes, Genome sequence and gene numbers, measurement of expressed genes.


**11 hrs**

**Prokaryotic DNA Replication:** Replicon, single and multi copy replicons, linear and circular replicons, unidirectional and bidirectional replication, experimental methods, mapping origin of replication, semi-conservative and semi-discontinuous replication; experimental demonstrations. Topological problems in DNA replication; topoisomerases, helicase and gyrase. Mechanism and classification of topoisomerases, assay of topoisomerases. Priming DNA synthesis in bacteria; experimental evidence, components of primosome., Initiation at origin (oriC) of E. Coli. Creation of replication forks. Regulation of initiation at origins, sequesteration of origins after replication, role of helicase, assay of helicase.


*Eukaryotic DNA replication:* Replicative and repair enzymes of eukaryotes. Initiation, elongation by eukaryotic DNA polymerases. Isolation of ARS of yeast, ORC, Licensing factors and control of eukaryotic DNA replication, role of MCM proteins. Replication of organelle genomes, maintenance of ends of linear DNAs; telomeric DNA and telomerase. Regulation of eukaryotic DNA replication and inhibitors of DNA replication.

**12 hrs**

**Extra chromosomal replication:** Replication of phage DNA φX174, T7, SV-40, rolling circle model of replication. Linear DNA-ends, terminal proteins, replication of plasmid DNA.

**Replication of RNA viruses:** ss +RNA viruses; Picarna (Polio) and carona virus, ss-RNA viruses; rhabdo virus (VSV), orthomixovirus (influenza virus). dsRNA- reovirus (Rota virus), Structure and mechanism of RDR pol. Retroviruses; Structure and mechanism of reverse transcriptase and integrase (HIV), replication of tumor virus (RSV). Replication of Qβ virus.

**7 hrs**

**DNA repair:** experimental demonstration of repair in prokaryotes, damaging agents and damage recognition, direct repair, Miss-match repair assay for mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER) systems; components and mechanism of repair, error prone repair, SOS and Rec-A. Eukaryotic BER and NER, controlling direction of mismatch repair, DNA damage in chromatin.

**4 hrs**


**5 hrs**

**RNA processing:** split genes, RNA splicing: R-looping experiments, splicing signals, effect of splicing on gene expression. Splicing of nuclear mRNA precursors. Branched intermediate, mechanism of RNase T1 and T2, direct evidence for a branched nucleotide. Signal at branch.


**Polyadenylation:** Function of poly A, mechanism and signals for polyadenylation. Cleavage and Polyadenylation for mRNA elongation of poly-A, poly-A binding protein (PABP), turnover of poly-A. Coordination of mRNA processing with Coupling termination and mRNA 3’ end processing.

**References**

1. Biochemistry and Molecular Biology of Plant; Buchanan, Gruissum and Jones, (2000), ASPP, USA.
BCT – 302: Molecular Physiology

4 Units (52 hrs)

**Nerve signaling:** Acetylcholine receptor (AchR) channel, origin and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins). Trafficking proteins of synaptic vesicles, vesicle cycle – exo – and endocytosis of synaptic vesicles.


**Endocrine signaling:** Signal transduction, extra – cellular signaling; hormones as signal molecules – peptide, amino acid derivatives, steroid, ecosanoids.

Signal transduction pathways of – 1) G – protein linked (epinephrine, serotonin, glucagons), 2) Ion–channel (ACh), 3) Tyrosine kinase {(RTK), [EGF, IGF, insulin]}, and 4) Intrinsic enzyme / cytokine, receptors.

Biochemistry of vision: Structure of an eye, lens and retina, perception of light, rods and cones, rhodopsin, primary events in visual excitation, cGMP and transduction in generation of nerve impulse, colour vision


**Nuclear signaling:** Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. Transcriptional activation by phosphorylation cascade; CREB.

**Cell Cycle:** Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation.

Cyclins and cyclin-dependent kinases.

**Stem Cells:** Embryonic and adult stem cells; unique properties, and potential applications.

**Apoptosis:** Discovery, morphological changes, mitochondrial regulation. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution and removal of dead cells). Distinguishing apoptotic cells from necrotic cells. Role of HeLa cells, Hyperactive apoptosis and treatments.
Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF-β pathways). Etiology of breast, colon and prostrate cancer. 19 hrs

Signaling in Plants: Outline of plant hormones and pheromones signaling. 2 hrs

References

BCOET – 303.1: Metabolism – II

4 units (52 hrs)

Bioenergetics: Basic concepts of metabolic energy capture and transfer. Biochemical energetic-group transfer reactions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Stages in extraction of energy from fuel molecules. 2 hrs

Biological oxidation: Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Mitochondrial electron transfer system- Chemical nature, topology and thermodynamic design of electron carriers. Sequence of electron carriers-isolation of mitochondrial complexes, reconstitution experiments and study of specific inhibitors of Electron Transport Chain. 4 hrs

7 hrs


4 hrs

Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides and their interconversion, regulation of biosynthesis. Other pathways of purine nucleotide formation. Biosynthesis of deoxyribonucleotides and coenzymes nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria.  

7 hrs


7 hrs

Degradation of the individual amino acids: Pathways in animal, plant and microbial systems; Amino acids forming from pyruvate (alanine, glycine, threonine, serine, cystine and cysteine), oxaloacetate (aspartic acid and asparagine), α- ketoglutarate (glutamic acid, glutamine, arginine, histidine and proline), succinyl CoA (valine, isoleucine and methionine), acetoacetate and/or acetyl CoA (leucine and lysine), pyruvate, formaldehyde, acetoacetate and/or acetyl CoA (tryptophan), and fumarate, acetoacetate and/or acetyl CoA (phenylalanine and tyrosine). Inherited disorders associated with glycine, aromatic, branched chain, basic and sulfur containing amino acid metabolism.  

9 hrs

Biosynthesis of the individual amino acids: Pathways in animal, plant and microbial systems–biosynthesis of non – essential amino acids from pyruvate (alanine), intermediates of glycolysis (serine) and TCA cycle (aspartic acid, asparagine, glutamic acid and glutamine), essential amino acid (tyrosine), non – essential amino acid (glycine, proline and arginine), and essential & non – essential amino acid (cysteine). Biosynthesis of essential amino acids from aspartate family of amino acids (threonine, lysine and methionine), pyruvate family of amino acids (valine and leucine), pyruvate and α–ketobutyrate family of amino acid (isoleucine), aromatic family of amino acids (phenylalanine, tyrosine and tryptophan) and histidine. Regulation of amino acid biosynthesis by sequential & concerted feedback inhibition.  

9 hrs
Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.  

3 hrs

References


BCOET – 303.2: PLANT PHYSIOLOGY

4 units (52hrs)


6 hrs

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps in plant cell and organellar membranes; Classification and importance of H+-ATPases. Ion channels-properties and significance; Aquaporins and water transport.  

10 hrs


12 hrs


12 hrs
**Plant responses to biotic and abiotic stresses:** Introduction; Plant pathogens and diseases; plant defense systems-hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant abiotic stress responses-Salt stress, drought and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds; An overview of oxidative stress and oxidative damage. Antioxidant enzymes and stress tolerance. Plant biotic stress response – pathogen and insects.

12 hrs

**References**


**BCP – 305: Clinical Biochemistry (4 Credits)**

Analysis of Blood and Urine for diagnostic investigations

1. Estimation of glucose by Folin Wu method.
2. Estimation of glucose by Dubosky’s method.
4. Estimation of haemoglobin by Wong’s method
5. Estimation of urea in blood by Diacetylmonoxime method.
8. Analysis of SGOT-SGPT (AST, ALT) / creatine kinase / acid or alkaline phosphatase.
9. Qualitative analysis of Urine sample for normal and abnormal constituents.
10. Determination of titrable acidity of urine.
11. Estimation of uric acid in serum and urine by Caraway’s method
12. Estimation of creatinine and creatine in serum and urine by Zaffe’s method.
15. Estimation of 17-ketosteroid by Zimmerman’s method.
References

BCP – 306: Molecular Biology (4 credits)
1. Isolation, quantification and characterization (Spectrophotometric and agarose gel electrophoresis) of genomic DNA from bacteria (E. coli).
2. Isolation, quantification and characterization (Spectrophotometric and agarose gel electrophoresis) of genomic DNA from plant.
3. Isolation, quantification and characterization (Spectrophotometric and agarose gel electrophoresis) of plasmid DNA from bacteria.
4. Isolation, quantification and characterization (Spectrophotometric and agarose gel electrophoresis) of total RNA, mRNA from plant and microbial sources.
5. Restriction digestion and ligation of DNA.
6. Spectroscopic determination of melting temperature(Tm) of calf thymus DNA.
7. Amplification of desirable gene by Polymerase chain reaction.
8. Rapid amplification of polymorphic DNA.
9. Reverse transcriptase- Polymerase chain reaction RT-PCR
10. Southern blotting
11. Phage Titration

References
Fourth Semester M. Sc. Biochemistry

BCT – 401: Molecular Biology – II

4 units (52 hrs)


Gene Expression in Eukaryotes: Stages/levels of regulation of gene expression in eukaryotes; Chromatin structure and its effect on transcription. Organization of chromatin- 30 nm fiber, higher order chromatin folding. Effect of histones on transcription activation. Nucleosome positioning; SV 40 mini chromosome, experimental location of nucleosomal positions; DNase hypersensitive sites and mapping. Locus control regions. Histone modifications; Acetylation of histone tails. Identification of histone acetyl transferases (HATs). Properties and roles of P$_{55}$ and Gcn-5 HATs. Histone deacetylases; experimental demonstration of HDACs in repressor complexes. Chromatin remodeling; Major classes of remodeling complexes; assay of remodeling; ChIP. Composition of SWI2/SNF2 and ISWI complexes. Model of SWI2/SNF2 mechanism. Remodeling in yeast HO gene and human IFN-β promoter. Histone code. Heterochromatin silencing; chromo and bromo domains, histone methylation, HMTases, SFR and RAP-proteins. Transcription elongation through nucleosomes; FACT and PARP. Mapping and quantifying transcripts; Northern blots; S1 mapping of 5’ and 3’ ends of transcripts. Primer extension, Runoff transcription and G-less cassette transcription, measuring in-vivo transcription rate- nuclear run on transcription. Quantification of gene expression by measuring protein product. 10 hrs

Transcriptional activators; classification, structure and function, domains of activators. DNA binding motifs; Zn fingers- Gal 4 activator of yeast. Nuclear receptor- structure and function of glucocorticoid, thyroid and orphan receptors. Domains of nuclear receptors; homeo, bZIP and bHLH domains. Modularity of domains of activators; chimeric transcription factors- Gal4-LexA, two hybrid assay. Dimerization of activators, modular arrangement of enhanceosomes. Recruitment of TFIID and holoenzyme; evidence, role of enhancers, interaction between enhancer and promoter-control region of human metallothionine gene. Insulators-working, insulator bodies, working of imprinting control region (ICR). Transcription factories, detection. Co-activators and mediators; discovery of mediators- mediators factors; activation of CRE-linked gene model for nuclear receptor activation. Regulation of transcription factors;
modification of activation by ubiquitination, sumoylation and acetylation. Signal transduction pathways; Ras, Raf, JAK-STAT pathway.

Regulation of gene expression via stability of mRNA; Casein mRNA and transferring-receptor mRNA, gel mobility shift assay for IRE binding protein, model for TFR mRNA destabilization by iron. RNA interference; post transcriptional gene silencing (PTGS) and quelling. Definition, mechanism of RNAi. Classical experiments with petunia and C. elegans. Simplified model, composition and function of Dicer and RISC. Role of Argonaute. siRNAs, role of RNAi machinery in heterochromatin formation and gene silencing- EF1A gene. miRNAs; control of gene expression by miRNAs example and experimental proofs, pathways of gene silencing by miRNA. Stimulation of translation by miRNAs. Translation repression; processing bodies.

12 hrs

**Molecular biology of Drosophila development:** Overview of D. Melanogaster development
Differential development by Morphogenic gradient, dorso-ventral patterning of embryo. Regulatory DNAs, role of snail and twist proteins in patterning. Localization of bicoid and nono (oskar) mRNAs in embryo, Regulation of segmentation genes expression by bicoid. Regulation of hunchback expression, and gap genes, production of segmentation stripes, Expression of eve gene, and eve stripe-2.

7 hrs

**Ribosomes:** Prokaryotic ribosomes; molecular components, in vivo assembly, dissociation of subunits, and polysomes. Eukaryotic components and their assembly, organelle ribosomes.

3 hrs


**Genetic code:** breaking the code, experimental results leading to deciphering genetic code, coding properties of mRNA, Co-linearity of genes and proteins, Coding properties of tRNA, triplet binding assay, use of synthetic oligo nucleotides (works of Khorana and Neirenberg), base pairing between codon and anti-codon, Wobble base pairing. Properties of genetic code, deviation from universal genetic code.

8 hrs

**References**
BCT – 402: Biochemical Genetics

4 units (55 hrs)

**Introduction:** Nature of genetic material. Chromosomes and genes. Mutation: types of mutation, mutagens, mechanism of mutation, induction and isolation of mutants and their role in genetic studies.  

5 hrs

**Classical Genetics:** Review of classical genetics; work on *Pisum sativum, Drosophila Melanogaster, Neurospora Crassa* etc. Inheritance (sex-linked and others). Population genetics, extranuclear inheritance. Sex determination, Morgan’s discovery of sex linked inheritance of sex linked genes, X; linked traits in humans. Identification of sex chromosomes, XX, XY, mechanism of sex determination.  

10 hrs

**Quantitative Genetics:** Human quantitative traits, discontinuous traits and continuous traits, Breeding analysis, genetics basis of quantitative variation, Multiple factor hypothesis and analysis of polygenes. Genotype-Environment Interaction and models for their measurement, estimation of Heritability Index.  

8 hrs

**Human Genetics:** Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. Chromosome banding, Chromosome mapping based on recombination frequency data. Transposons. Overview of human genome project, mapping of human genes; techniques used, assignment of important genes. Transposition in human chromosomes. Chromosomal abnormalities.  

13 hrs

8 hrs

**Viral Genetics:** Life cycles of bacteriophages, lytic cycle; replication of T-phages. Lysogeny and its regulation. Transduction; specialized, generalized and abortive. Fine structure analysis of T-phages; Benzers work, concept of cistrons.  

8 hrs

**References**


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**BCT – 403: Biotechnology**

4 credits (52 hrs)

**Introduction:** Introduction and overview of cloning procedures. Isolation of nucleic acids, characterization and purification of plasmid, bacteriophage genomic DNA for cloning purpose.

**Restriction endonucleases and DNA modifying enzymes:** Restriction enzymes Discovery, classification, properties, and applications. Reactions, application of the following modifying enzymes employed in rDNA technology; DNA- and RNA ligase, Phosphatases and kinases DNase (DNase-I) and RNases (RNase A, H), S1- and Micrococcal nuclease, double and single stranded exonucleases. DNA and RNA polymerases (Klenow fragment), template independent RNA polymerases. Topoisomerase. Linkers and adapters, TA-cloning.  

8 hrs

Genomic and cDNA libraries: Outline of methodology for genomic library construction, creation of genomic libraries using lambda and cosmid vectors. Growth, evaluation and storage of genomic libraries. cDNA libraries; methodology, random arrayed and ordered cDNA libraries, screening cDNA libraries; probe selection, hybridization. Screening with antibodies, re-screening and sub-cloning. Characterization of plasmid clones, restriction digestion, southern blot, PCR and sequence analysis.

PCR: Discovery, principle and procedure, variants of PCR- RT-PCR, long PCR, differential PCR, and inverse PCR. Application of PCR; Rapid amplification of cDNA ends (5′and 3′ RACE), Cloning PCR products, PCR in screening clones, colony PCR, Diagnostic application of PCR.

Sequencing and mutagenesis: Principle of DNA sequencing, automated sequencing, extending the sequence, shot gun sequencing. Analysis of sequence data; annotation, ORF, exon-intron boundaries, identification of genes and their products.

Gene transfer to animals cells: overview of strategies, transfection methods, phospholipids as delivery vehicles, electroporation and direct transfer, transient and stable transformation, Cotransformation and selection of stable transformants, selectable markers for animal cells. Mammalian plasmid expression vectors, reporter genes. Gene transfer by viral vectors; adeno and baculo viruses, retroviral vectors.

Gene transfer to plants: plant cell culture and protoplast, callus and their manipulations. *Agarobacterium* mediated transformation, Ti plasmid, mechanism of T-DNA transfer, Function of T-DNA genes, Ti-plasmid derivatives as plant vectors (disarmed T-DNA), cointegrate and binary vectors, high capacity binary vectors, selectable markers for plants, control of transgene expression in plants. Direct DNA transfer to plants; protoplast transformation, particle bombardment, *in planta* and chloroplast transformation. Plant expression vectors; CaMV and TMV vectors.

References

BCT – 404: Immunology and Toxicology

4 units (52 hrs)

**Infection:** Types of infection and nature of infective agents. Nonspecific host defense mechanisms. Anatomical barriers; lysozyme and other antimicrobial agents. Phagocytosis and phagocytic cells, neutrophils, monocytes and macrophages. **4 hrs**

**Compliment system:** Introduction, alternate and classical pathway, regulation **4 hrs**

**Immunity:** States of immunity; innate and acquired immunity, naturally and artificial acquired passive and active immunity. Immunization practices, use of toxoids, killed and attenuated organisms. Surface components and newer vaccines, production of vaccines. **4 hrs**

**Immunoglobulins:** Structure and functions of immunoglobulins Types; isotypes and idiotypes, isoantibodies. Methods of raising antibodies. Monoclonal antibodies, production and purification. **5 hrs**

**The Immune System:** Recognition of self and non self, the major histocompatibility antigens, H-2 and HLA antigens, Antigenecity; humoral and cell mediated immunity. T and B lymphocytes; origin, differentiation, characteristics and functions, nature of surface receptors, antigen processing and presentation. T cell and B cell interaction. Cytokines, monokines, lymphokiness and their functions. **8 hrs**

**Molecular Immunology:** Theories of antibody formation; clonal selection and network, Genetics of antibody diversity, germ line and somatic mutation theories, immunoglobulin, MHC a TCR gene organization and their recombination, class switch of Ig genes. **5 hrs**

**Clinical Immunology:** Immune disorders; hyper sensitivity, autoimmune and immunodeficiency diseases. Tissue transplantation; auto – iso -, allo-, and xenografts, tissue matching, transplantations rejection, mechanism and control, tumor immunology. **5 hrs**

**Immuno assay methods:** Antigen – antigen interaction – affinity and avidity, determination of affinity and avidity constants. Principle, procedure and applications of Immunoprecipitation,
neutralization, agglutination, compliment fixation, immunodiffusion, immunofluorescence, RIA, ELISA, micro ELISA Techniques.


**References**

4. Immunology: Roitt et al., Mosby (2001),
13. Understanding Immunology (Cell and Molecular Biology in Action); Peterwood, Pearson Education Ltd. (2006).

**BCP – 405: Genetic Engineering and Protein Chemistry (4 Credits)**

**Genetic Engineering**

1. Preparation of Competent cells.
2. Transformation of DNA by CaCl$_2$ method (recombinant vectors – plasmids / phages).
3. Isolation and characterization of gene fragments for cloning
4. Restriction digestion of isolated plasmid DNA.
5. Expression of GFP in *E. coli*.
6. DNA Amplification (PCR).
7. Synthesis of cDNA.
8. Southern Blotting and Northern Blotting; Hybridization of DNA and RNA and detection by specific probes (non-radioactive).
10. Expression, Isolation and purification of recombinant proteins.

**Protein Chemistry**

1. Extraction and isolation of enzymes (phosphatases / esterases / amylases) from Insect / Microbial / Plant sources.
2. Fractionation and purification by conventional protein purification techniques (PAGE showed be carried out at each step).
3. Ammonium sulfate, acetone and pH precipitation
4. Ion exchange chromatography.
5. Gel filtration.
6. Kinetic characterization of the enzyme

**References**

1. Nucleic Acid Blotting; D C Darling, P M Bricknell; Garland Science; (1994)

**BCP – 406: Project Work (4 Credits)**
Open elective for Non-Biochemistry PG students

BCOET – 304.1: Biochemistry of Common Disorders

4 credits (52 hrs)

**Human Physiology:** Introduction and brief description of cells, tissues and organs, their functions; Body fluids and their composition. Introduction to molecules as building blocks. Definition and differentiation of disease and disorder, types and causes. Relation between food, environment and illness. Analysis of various biochemical parameters in body fluids and specific tissues during disorders, diseases and forensics.  

**Diagnostic Techniques:** Collection and storage of biological samples for clinical use. Commonly used tests for diagnosis of various diseases and their interpretation.

**Blood analysis:** Total blood count including ESR, Total serum proteins and their fractions. Blood glucose (GTT) (Fasting and post-prandial), serum lipid fraction–cholesterol, triglyceride, LDL and HDL, blood urea, and serum calcium.  

**Urine:** Creatinine, Glucose and protein (albumin).  

**Enzymes:** SGPT, SGOT and isoenzymes as markers in various disorders and diseases.

**Diseases and Disorders (common occurrence):**  
Aetiology; classification (if any); causative factors; incidence, symptoms and biochemical aspects and markers for-identification, monitoring, prevention and interventions; and nutritional aspects, overweight and obesity.

**Cardiovascular disease:** Diabetes, diseases of Liver, Gall bladder & Pancreas-Hepatitis, (A, B, and C), Cirrhosis, alcoholic liver disease, Gall stones, pancreatitis, pancreatic surgery- Causes, Prevention and dietary management.

**Renal disease:** Nephrotic syndrome, Acute and Chronic renal failure- diagnostic procedures and dietary management. Dialysis, medical and nutrition therapy.

**Gastrointestinal diseases/disorders:** Gastro-oesophageal reflux and esophagitis, Gastritis and Peptic ulcer. Characteristics of and comparison of the stomach and duodenal ulcers. Diagnostic tests for malabsorption, sprue and tropical sprue, Crohn’s disease, diarrhoea, constipation, ulcerative colitis, diverticular disease and colon cancer.

**Cancer and HIV/AIDS:** Biochemistry of carcinogenesis, types, stages of cancer, diagnosis and existing medicines. Biochemistry of HIV infection, ART and social issues.

**References:**

**BCOET – 304.2: Biochemistry in Daily Life**

**4 units (52 hrs)**


**Food and Nutrition:** Importance of food for existence of life. Modes of nutrition in life forms – Comparable and contrasting features.  

**Human Health and Disease:** Nutrition (Health), definition, classification, food and non food sources. Nutraceuticals; use of nutraceuticals in traditional health sciences. Role of omega-3 fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinolates; organosulphur compounds in health and disease (prevention and control).  

**Prebiotics and probiotics:** Mechanics and usefulness of probiotics and prebiotics in gastrointestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.  

**Functional foods:** Definition, development of functional foods, benefits and sources of functional foods in Indian diet. Effects of processing conditions and storage.  

**Development of nutraceutical and functional foods:** Standards for health claims. Process of developing-preclinical & clinical studies.  

**Food additives:** Definitions, functions and uses in processed food products. Chemical, technological and toxicological aspects of acid, base buffer systems, salts and chelating/sequestering agents, leavening agents, antioxidants, emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents, flour bleaching agents and bread improvers.  

**Sweetening agents:** Artificial sweeteners, composition, uses. Natural and synthetic colors, food Flavors, Spices and flavoring constituents, flavors in food industries.
**Enzymes:** Introduction and essentiality to life forms. Use of enzyme in beverages- fruit juices, beer, wine, and distilleries; dairy, baking, oils and fats, plantation products, animal products. Malting and germination of grains – process, characteristics, nutritional benefits and uses. Domestic use products like detergents. Textiles-Denim processing. Leather industry. **7 hrs**

**Food processing and fortification:** Principles, objectives and rationale, selection and basis of fortificants. Technology of fortifying cereal products. Characteristics of nutrients used in cereal fortification. Fortification methods. Fortification premixes, Design and composition of premixes and quality control. Fortification of bread, pasta, noodles, biscuits, and breakfast cereals. Beverages; importance of beverage fortification, Health benefits of fortification, Selection of nutrients for fortification, Levels to be added, Characteristics of fortificants and method of fortification, Bioavailability, Organic Vs inorganic salts. *Health foods;* selection of nutrients, Technology of incorporation of fortificants, bioavailability. **12 hrs**

**References**

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