**M. Sc. BIOCHEMISTRY**

**Department of Biochemistry, Institute of Science, Banaras Hindu University**

**DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS**

 SEMESTER-I

|  |  |  |
| --- | --- | --- |
| Course Code | Title | Credits |
| BCM 101 | Cell Biology & Physiology | 4 |
| BCM 102 | Bio-analytical Techniques | 4 |
| BCM 103 | Bioenergetics & Metabolism I | 4 |
| BCM 104 | Bio-molecules & Microbial Biochemistry | 3 |
| BCM 105 | Practical: Basic Biochemical Preparations & Techniques | 3 |
| BCM 106 | Practical: Analytical Biochemistry | 3 |
|  |  Total | 21 |

 SEMESTER-II

|  |  |  |
| --- | --- | --- |
| Course Code | Title | Credits |
| BCM 201 | Metabolism II | 4 |
| BCM 202 | Methods in Molecular Biology | 4 |
| BCM 203 | Immunology | 4 |
| BCM 204 M# | Nutritional Biochemistry (for students of other PG Programmes) *# Minor Elective* | 2 |
| BCM 205 | Practical: Bio-analytical Techniques | 3 |
| BCM 206 | Practical: Microbiology & Immunology | 3 |
|  |  Total | 20 |

 SEMESTER-III

|  |  |  |
| --- | --- | --- |
| Course Code | Title | Credits |
| BCM 301 | Enzymology | 4 |
| BCM 302 | Plant Biochemistry | 4 |
| BCM 303 | Molecular Biology | 4 |
| BCM 304 M# | Neuro-biochemistry (for students of other PG Programmes) *# Minor Elective* | 2 |
| BCM 305 | Practical: Enzymology | 3 |
| BCM 306 | Practical: Enzyme Technology | 3 |
| BCM 307 | Assignment Based Seminar  | 1 |
|  |  Total | 21 |

 SEMESTER-IV

|  |  |  |
| --- | --- | --- |
| Course Code | Title | Credits |
| BCM 401 | Clinical Biochemistry | 4 |
| BCM 402 | Outlines of Biotechnology | 4 |
| BCM 403 | Practical: Molecular Biology | 3 |
| BCM 404  | Practical: Clinical Biochemistry | 3 |
| BCM 405 | Project work including presentation, comprehensive viva | 4 |
|  |  Total | 18 |

**SEMESTER – I**

**BCM 101: CELL BIOLOGY AND PHYSIOLOGY Credits – 4**

1. **Cell Biology** - Cell classification, cell variability (size, shape, complexity, functions). Structural organization of prokaryotic and eukaryotic cells. The ultra structure of nucleus, mitochondria, endoplasmic reticulum (rough and smooth), Golgi apparatus, lysosomes & peroxisomes and their functions. The cytoskeleton – microtubules and microfilaments. Cell movement and chemotaxis.
2. **Blood -** Composition and functions of plasma, erythrocytes including Hb, Leucocytes and thrombocytes, plasma proteins. Blood Coagulation – mechanism and regulation. Transfer of blood gases – Oxygen and carbon dioxide, role of 2,3-diphosphoglycerate, Bohr effect and chloride shift.
3. **Digestive system –** Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins, & nucleic acids.
4. **Respiration –** Air passages and lung structure, pulmonary volumes, alveolar surface tension, work of breathing and its regulation.
5. **Endocrine system –** Secretion and functions of hormones of thyroid, pituitary and gonads. Role of hormones in reproduction. Mechanism of action of hormones.
6. **Excretory system –** Structure of nephron, glomerular filtration, tubular re-absorption of glucose, water and electrolytes. Tubular secretion. Homeostatic regulation of water and electrolytes, Acid-base balance.

**BCM 102: BIOANALYTICAL TECHNIQUES Credits – 4**

1. **Spectroscopy -** Concepts of spectroscopy, Laws of photometry. Beer-Lambert’s law, Principles and applications of colorimetry. Visible and UV spectroscopy, ORD, CD, X-ray diffraction, X-ray absorption and NMR.
2. **Chromatography –** Principles and applications of paper, thin layer, ion exchange, affinity, gel permeation, adsorption and partition chromatography. HPLC and FPLC.
3. **Centrifugation –** Principle of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, sub-cellular fractionation.
4. **Electrophoretic techniques –** Principles of electrophoretic separation. Types of electrophoresis including paper, cellulose, acetate/nitrate and gel. Electroporation, Pulse field gel electrophoresis, **2D Gel Electrophoresis, BN-PAGE**
5. **Microscopy** – Bright field, Dark field, Phase contrast and Fluorescence microscopy

Transmission and scanning, freeze fracture techniques, specific staining of biological materials.

1. **Statistical Analysis**- "Theory of error & treatment of qualitative data; Accuracy, precision and ways of their expression; Normal error curve & its equation; probability distributions (Binomial, Poisson and normal); Useful statistical tests: Test of significance, F-test, student t-test; Correlation coefficient; X2 test; Confidence Interval; Comparison of mean with true value; Comparison of two means; Comparison of standard deviation and average deviation; Test of variance."

**BCM 103: BIOENERGETICS AND METABOLISM I Credits – 4**

1. **Bioenergetics –** Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials and free energy change (derivations and numerical included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.
2. **Intermediary Metabolism –** Approaches for studying metabolism.
3. **Carbohydrates –** Glycolysis, various forms of fermentations in micro-organisms, citric acid cycle, its function in energy generation and biosynthesis of energy rich bond, pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis, glyoxylate and Gamma aminobutyrate shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway. Metabolism of disaccharides. Hormonal regulation of carbohydrate metabolism. Energetics of metabolic cycle.
4. **Amino Acids –** General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative and non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation.

**BCM 104: BIOMOLECULES AND MICROBIAL BIOCHEMISTRY Credits– 3**

**Bio-molecules:**

1. **Carbohydrates – S**tructure, reactions and functions of monosaccharides, disaccharides polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins.
2. **Lipids -** Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrosides, steroids, bile acids, prostaglandins and lipoproteins.
3. **Nucleic acids -** Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations.
4. **Introduction to Proteins and Enzymes –** Primary, Secondary, Tertiary and Quaternary structures of proteins. **Enzymes -** Historical perspective, general characteristics, nomenclature, Enzyme classification (specific examples), and Enzyme assays
5. **Introduction to Vitamins**

**Microbial Biochemistry:**

1. **Morphology** and **Structure of bacteria**, gram positive and gram negative organisms. Sterilization: physical and chemical methods. Nutritional requirements and growth characteristics of bacteria, media for growing bacteria.
2. **Bacterial toxins –** Classification, structure and mode of action of bacterial protein toxins, enterotoxins.
3. **Viruses –** General structure, properties and classification. Virions, prions, lytic cycle, lysogeny, plasmid.

**BCM 105: PRACTICAL: BASIC BIOCHEMICAL PREPARATIONS AND TECHNIQUES Credits – 3**

1. Titration of a weak acid using a pH meter, preparation of buffers
2. Verification of Beer-Lambert’s law and estimation of absorption coefficient
3. Dinitrophenyl hydrazone of ascorbic acid or any other ketone
4. Dinitrophenyl hydrazone of ascorbic acid or any other ketone
5. Dinitrophenyl derivative of an amino acid
6. Fractionation of egg proteins and its quantification
7. Isolation of casein from milk and its quantification

**BCM 106: PRACTICAL: ANALYTICAL BIOCHEMISTRY Credits – 3**

1. Carbohydrates: Qualitative analysis, quantitation of glucose and ribose.
2. Amino acids and proteins: Qualitative analysis, quantitation of proteins and amino acids.
3. Quantitation of free and bound phosphate.
4. Quantitation of vitamin C.
5. Fats: Acid number, saponification and iodine values.

**SEMESTER – II**

**BCM 201: METABOLISM II Credits – 4**

1. **Lipids –** Introduction, hydrolysis of tri-acylglycerols, α-, ß- and ω- oxidation of fatty acids. Oxidation of odd numbered fatty acids – fate of propionate, role of carnitine, degradation of complex lipids. Fatty acid biosynthesis, Acetyl CoA carboxylase, fatty acid synthase, ACP structure and function, Lipid biosynthesis, biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.
2. **Nucleotides –** Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase. Biosynthesis of deoxyribonucleotides and polynucleotides including inhibitors of nucleic acid biosynthesis.
3. **Coenzymes and Cofactors –** Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.
4. **Biosynthesis of vitamins –** Ascorbic acid, thiamine, pantothenic acid and folic acid.
5. **Porphyrins –** Biosynthesis & degradation of porphyrins. Production of bile pigments.

**BCM 202: METHODS IN MOLECULAR BIOLOGY Credits– 4**

1. **Recombinant DNA methods –** Features of commonly used vectors, strategies for cloning in various vectors and Identification of bacterial colonies containing recombinant plasmids, and bacteriophage vectors. Restriction enzymes.
2. **Construction and analysis of c-DNA and genomic libraries** - Protocols and strategies for c-DNA cloning, analysis of genomic DNA by southern hybridization, amplification of DNA by the polymerase chain reaction, Real time PCR , preparation of radio-labeled DNA and RNA probes, synthetic oligonucleotide probes, expression of cloned genes in cultured cells, screening expression with antibodies and oligonucleotides.
3. **DNA sequencing –** Rapid DNA sequencing methods; Maxam-Gilbert technique, Sanger’s Dideoxynucleotide sequencing, gene walking, foot printing, RNA sequencing.
4. **Application of recombinant technology –** production of insulin, drug, vaccines, diagnostic probe of genetic diseases. Gene therapy.
5. **Chromatin –** Heterochromatin, euchromatin, Histone and non-histone proteins, general properties of histone, packing density, nucleosomes, size, variable linkers, solenoid structure, packaging of DNA, satellite DNA.
6. **Genes –** Prokaryotic and eukaryotic genes, pseudogenes, split genes, super gene family, transposons, C-value paradox. Reassociation kinetics.
7. **Mutation –** Types of mutations, mechanism of mutation, mutagenic agents. DNA repair: UV repair system in *E. coli*., Site Directed Mutagenesis

**BCM 203: IMMUNOLOGY Credits– 4**

1. **Introduction to immune system –** Innate and acquired immunity. Structure and functions of primary and secondary lymphoid organs.
2. **Cells involved in immune responses –** Lymphoid cells (B-lymphocytes, T-lymphocytes and Null cells), mononuclear cells (phagocytic cells and their killing mechanisms), granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cell. Differentiation of CD4 T cell in to different T cell Subsets (Th1, Th2, Tfh, Th-17, Treg, Tr1 cells)
3. **Nature of antigen and antibody –** Immunogenicity vs antigenicity, factors influencing immunogenicity, epitopes, haptens, adjuvants and mitogens. Classification, fine structure and functions of immunoglobulins, antigenic determinants on immunoglobulins, isotypic, allotypic and ideotypic variants. Monoclonal Vs. Polyclonal Antibody.
4. **Generation of Diversity in Immune system –** Clonal selection theory - concept of antigen specific receptor. Organization of immunoglobulin genes: generation of antibody diversity, T-cell receptor diversity.
5. **Immune effector Mechanisms –** Kinetics of primary and secondary immune responses, complement activation and its biological consequences, cytokines and co-stimulatory molecules: role in immune responses, Antigen processing and presentation. Cell signaling – Role of MAP kinases.
6. **Major histocompatibility complex (MHC) genes and products –** Polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation.
7. **Measurement of antigen–antibody interactions –** Agglutination, precipitation and opsonization, gel diffusion (Ouchterlony double immunodiffusion and Mancini’s Radial immunodiffusion), immunoblotting, RIA, ELISA and ELISPOT
8. **Tolerance Vs activation of immune system –** Immune tolerance, hypersensitivity (Types I, II, III, IV).
9. **Disorders of immune system and syndrome –** Autoimmunity, congenital and acquired immunodeficiency.

**BCM 204M: NUTRITIONAL BIOCHEMISTRY Credits –2**

**(Minor Elective)**

1. **Basic concepts -** Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate; factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements. Specific dynamic action of proteins. Recommended dietary allowances.
2. **Elements of nutrition –** Dietary requirement of carbohydrates, lipids and proteins. Biological value of proteins. Concepts of protein quality. Protein sparing action of carbohydrates and fats. Essential amino acids, essential fatty acids and their physiological functions.
3. **Vitamins –** Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.
4. **Minerals –** Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
5. **Malnutrition –** Prevention of malnutrition, improvement of diets.

**BCM 205: PRACTICAL: BIOANALYTICAL TECHNIQUES Credits -3**

1. Lawry Method and Bradford Methods of Protein Estimation
2. Paper chromatography – Separation of amino acids and carbohydrates in a mixture
3. Extraction, separation and determination of absorption spectra of plant pigments.
4. Column chromatography – Separation of a mixture of protein and salt using Sephadex column
5. Poly-acrylamide Gel Electrophoresis (Native/SDS)

**BCM 206: PRACTICAL: MICROBIOLOGY AND IMMUNOLOGY Credits -3**

1. Preparation of stains and reagents

2. Preparation of various culture media

3. Preparation of broth and slants

4. Sterilization of culture media by autoclave method

5. Sterilization of glassware by hot air oven

6. Isolation and propagation of bacteria

7. staining of bacteria – Simple staining, differential staining, staining of spores and capsules

8. Determination of growth curve of bacteria

9. Biochemical tests and motility for the identification of bacteria

10. Precipitin reaction by double immunodiffusion and radial immunodiffusion (Ouchterlony and Mancini’s methods)

11. Detection of antibodies or antigen by ELISA (Indirect and Sandwich ELISA)

12. Detection of antigens by immunoblotting technique

13. Isolation of peripheral Blood Mononuclear Cells by Ficoll Density Gradient, Cell Viability by Trypan Blue Exclusion Principal and Visualization of different Cell Types (WBCs) in thin layer blood smear.

**SEMESTER – III**

**BCM 301: ENZYMOLOGY Credits-4**

1. **Introduction-** Methods for isolation, purification and characterization of enzymes, enzyme specificity tests for homogeneity of enzyme preparation.
2. **Kinetics of enzyme action –** Concept of ES complex, active site, derivation of Michaelis-Menten equation for uni- substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Importance of Kcat/Km. Kinetics of zero & first order reactions. Effect of pH and temperature and their significance. Classification of multi-substrate reactions with examples of each class. Derivation of the rate of expression for Ping Pong, random & ordered Bi-Bi mechanisms. Use of initial velocity, inhibition and exchange studies to differentiate between multi-substrate reaction mechanisms. Reversible and irreversible inhibition. Competitive, non-competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of Ki and numerical based on these. Suicide inhibitions.
3. **Mechanism of Enzyme Action –** Acid-base catalysis, covalent catalysis, proximity, orientation effect. Chemical modification of active site groups. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.
4. **Enzyme Regulation –** General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modification of enzymes. Mono-cyclic and multi-cyclic cascade systems with specific examples. Feedback inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes. Half site reactivity, positive and negative co-operativity with special reference to aspartate transcarbamoylase and phosphofructokinase. Protein-ligand binding measurement, Hill and Scatchard plots.
5. **Multienzyme system –** Occurrence, isolation and their properties: Mechanism of action and regulation of pyruvate dehydrogenase complex. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.

**BCM 302: PLANT BIOCHEMISTRY Credits-4**

1. **Electron transport system in plants -** Oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient, chemiosmotic theory, ATP synthase and mechanism of ATP synthesis.
2. **Nitrogen Fixation and assimilation** - Biochemistry of biological nitrogen fixation Structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation.
3. **Photosynthesis –** Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photo-phosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation, Photorespiration.
4. **Special features of secondary plant metabolism** - Terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, Phenylpropanoids, cell wall components.
5. **Toxins of plant origin –** Mycotoxins, phytohemagglutinins, lathyrogens, nitriles, Glycosides, protease inhibitors, protein toxins.
6. **Stress metabolism in plants -** Environmental stresses, salinity, water stress, heat, chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism, criteria of stress tolerance.
7. **Antioxidative defence system in plants –** Reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defense mechanism.
8. **Plant Hormones –** Growth regulating substances and their mode of action, molecular effects of auxin in regulation of cell extension, effects of gibberellic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development.

**BCM 303: MOLECULAR BIOLOGY Credits-4**

1. **DNA Replication -** Mechanism of replication, the replicons, origin, primosome and replisomes, properties of prokaryotic and eukaryotic DNA polymerases, synthesis of leading and lagging strands, difference between prokaryotic and eukaryotic replication.
2. **Mechanism of Transcription –** Prokaryotic transcription, promoters, properties of bacterial RNA polymerase; initiation, elongation and termination. Eukaryotic transcription, promoters, enhancers, factors & properties of RNA polymerase I, II, & III. Inhibitors of transcription.
3. **Post transcriptional Processing -** Maturation of rRNA, mRNA and tRNA; RNA splicing, introns and exons, consensus sequence function. Poly A tail, 5’ capping.
4. **Recombination –** General recombination, site specific recombination and replicative recombination.
5. **Genetic Code –** Deciphering of the codons, reading frame of a sequence, Start/stop codons, degeneracy of the genetic code, Wobble hypothesis, variations to the standard genetic code.
6. **Translation in Pro- and Eukaryotes –** Ribosomes, structure, functional domain and subunit assembly, cell free protein synthesis, direction of protein synthesis (Dintzis experiment), adaptor role of tRNA, formation of initiation complex, chain elongation, translocation & termination, and role of respective factors involved therein. Inhibitors of protein biosynthesis. Comparison of protein biosynthesis in prokaryotes with eukaryotes. Post Translational processing – Proteolytic cleavage, covalent modifications, glycosylation of proteins, disulfide bond formation.
7. **Protein Localization** – Co- and post-translational protein traslocation; chaperones and protein folding, signal sequences, translocons, leader sequences.
8. **Regulation of Transcription and Translation -** Positive and negative control, Repressor & Inducer, concept of operon, lac-, ara-, trp-operons, attenuation, catabolite repression, autogenous regulation, lytic cycle of bacteriophage, stringent response of rRNA synthesis. Hormonal control, transcription factors, steroid receptors. DNA binding motifs in pro- & eukaryotes, helix-turn-helix, zinc fingers, leucine zippers/b zip, helix-loop-helix motifs.

**BCM 304M: NEUROBIOCHEMISTRY Credits -2**

**(Minor Elective)**

1. **Muscle Biochemistry –** Skeletal muscle structure. Actin, myosin, tropomyosin, troponin. Molecular mechanism of contraction. Functional classification of skeletal muscle fibers. Twitch. The motor unit. Role of calmodulin.
2. **Neuromorphology –** Organisation of neuron, dendrites and axons. Glial cells – astrocytes, oligodendrocytes, ependymal cells, Schwan cells. Nerve fiber types and functions.
3. **Neurophysiology** – Generation and conduction of monophasic action potential, saltatory conduction. Synaptic transmission, Neurotransmitters and their action. Blood Brain CSF barrier – Characteristics.
4. **Transport across membranes –** Types of transport (simple diffusion, passive-facilitated diffusion), active transport – primary and secondary group translocation, transport ATPases, transport by vesicle formation.
5. **Neurological disorders –** Headache, facial pain, migraine, epilepsy, multiple sclerosis, Myasthenia Gravis.

**BCM 305: PRACTICAL: ENZYMOLOGY Credits -3**

1. Assay of enzyme activity
2. Isolation and purification of urease.

3. Time course of enzymatic reaction.

4. Influence of substrate concentration on the rate of enzymatic reaction.

5. Effect of pH and temperature on the rate of enzyme reaction.

6. Specificity of enzyme action.

7. Inhibition of enzyme activity. Determination of Ki values.

**BCM 306: PRACTICAL: ENZYME TECHNOLOGY Credits -3**

1. Molecular weight determination of enzyme by gel filtration.
2. Isozyme detection.
3. Immobilization studies:
4. Preparation of urease entrapped in alginate beads and determination of percent entrapment.
5. Study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads.
6. Study of reusability and storage stability of urease entrapped alginate beads.
7. Immobilization of urease by covalent attachment to solid support.

**BCM 307: ASSIGNMENT BASED SEMINAR Credit-1**

**SEMESTER – IV**

**BCM 401: CLINICAL BIOCHEMISTRY Credits -4**

1. **Disorders of Carbohydrate Metabolism -** Diabetes mellitus, glucose and galactose tolerance tests, sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level, glycogen storage diseases, pentosuria, galactosemia.
2. **Disorders of Lipids –** Plasma lipoproteins, cholesterol, triglycerides and phospholipids in health and disease, hyperlipidemia, hyperlipoproteinemia, Gaucher’s disease, Tay-Sach’s and Niemann-Pick disease, ketone bodies, Abetalipoproteinemia.
3. **Inborn Errors of metabolism –** Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, histidinemia.
4. **Disorders of liver and kidney –** Jaundice, fatty liver, normal and abnormal functions of liver and kidney. Inulin and urea clearance.
5. **Electrolytes and acid-base balance –** Regulation of electrolyte content of body fluids and maintenance of pH, reabsorption of electrolytes.
6. **Diagnostic Enzymes –** Enzymes in health and diseases. Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, CPK, cholinesterase, LDH.
7. **Abnormalities in Nitrogen Metabolism –** Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance.
8. **Blood Clotting –** Disturbances in blood clotting mechanism – hemorrhagic disorders – hemophilia, von Willebrand’s disease, purpura, Rendu-Osler-Werber disease, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombin complex disorders, circulating anticoagulants.
9. **Cancer –** Types of cancer, multiple steps of tumor development, Cell Death and apoptosis, carcinogens and cancer therapy.

**BCM 402: OUTLINES OF BIOTECHNOLOGY Credits -4**

1. **Plant genetic engineering** - Prospects of improving crop productivity, gene isolation, gene transfer systems, Ti plasmid, plant virus vectors, electroporation, microinjection, microprojectile technology, gene expression, regeneration. Application in relation to protein quality, photosynthetic efficacy, nitrogen fixation efficiency and resistance to environmental stresses.
2. **Tissue culture –** Plant tissue culture, anther and pollen culture, protoplast culture, protoplast fusion, embryo rescue, animal cell lines and organ culture.
3. **Transgenic plants and animals** – Advances in producing transgenics, transgenic animals.
4. **Fermentation technology –** Fermentors, general design of fermentor, fermentation processes, production of alcohols, antibiotics, steroids and enzymes; biotransformation, biomass & production of single cell protein.
5. **Hybridoma technology –** Monoclonal antibodies, selection of hybrids, hybridomas, purification and application of monoclonal antibodies.
6. **Xenobiotic metabolism –** Biodegradation, detoxification of xenobiotics by micro-organisms, biodegradation of hydrocarbons, pesticides, surfactants, polyaromatic hydrocarbons, dyes; role of cytochrome P450 in detoxification.
7. **Enzyme Technology -** Large scale production of enzymes, enzyme reactors, immobilization of enzymes by chemical and physical methods. Effect of partition on kinetics and on changes in pH and hydrophobicity. Applications: synthetic organic chemistry, industry, food technology, medicines. Synzymes, enzyme electrodes and biosensors. Enzyme Engineering.

**BCM 403: PRACTICAL: Molecular Biology Credits -3**

1. Fractionation of sub-cellular organelles from liver and plant tissues.
2. Isolation of DNA from bacteria/eukaryotic cells and check its purity.
3. Agarose Gel Electrophoresis and separation of DNA
4. Isolation and estimation of RNA from yeast.
5. Isolation of RNA and cDNA synthesis.

**BCM 404: PRACTICAL: CLINICAL BIOCHEMISTRY Credits -3**

1. Determination of α-amylase of saliva.
2. Qualitative and quantitative analysis of following in urine:

(i) Urea

(ii) Uric acid

(iii) Glucose

(iv) Proteins

(v) Bence-Jones proteins

(vi) Cl-, PO33-, Ca2

1. Estimation of hemoglobin by canomethemoglobin

4. Quantification of serum proteins

5. Determination of A/G ratio in serum

6. Estimation of serum glucose, creatinine and uric acid.

7. Assay of serum enzymes: alkaline phosphatase, SGOT, SGPT

8. Isolation and estimation of serum cholesterol.

**BCM 405: PROJECT WORK INCLUDING PRESENTATION Credits -4**