

M.Sc. BIOCHEMISTRY

III SEMESTER

BC 3.1: PLANT BIOCHEMISTRY AND HUMAN NUTRITION

Unit-1

Photosynthesis – Light and Dark reactions. Hill reaction. Cyclic and Non-cyclic photophosphorylation, mechanisms. Light receptors – photo systems I and II – their location, mechanism of quantum capture and energy transfer between photo systems. Proton gradient and ATP synthesis. CO₂ fixation in C-3, C-4 and CAM plants. Quantum efficiency and regulation of photosynthesis. Mechanism of photorespiration and its significance.

Unit-2:

Nitrogen cycle. Symbiotic N₂ fixation, nitrate reduction and assimilation in plants. Seed germination and dormancy. Factors effecting seed germination and biochemical changes during seed germination. Secondary metabolites in plants – Nature, distribution, biosynthesis and function of plant phenolics, alkaloids, lignins, terpenoid and lectins. Structure, physiological function and mechanism of action of phytohormones – auxins, gibberellins, cytokinins, ethylene and abscisic acid.

Unit-3:

Animal and vegetative foods – chemical composition. Nutrients – Essential Nutrients and their classification. Digestibility, absorption and biochemical functions of macro nutrients, Carbohydrates – dietary requirements. Proteins – Nitrogen balance studies, Determination of Biological values of proteins, Specific Dynamic Action, improvement of protein quality by supplementation and fortification. Lipids – Dietary needs of lipids, essential fatty acids. Calorific values of foods, Basal metabolic rate and its determination, factors influencing BMR. Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis and obesity, role of leptin in regulation of body mass. Starvation – Protein sparing treatment during fasting, Protein calorie malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and aged people.

Unit-4:

Biological effects of non nutrients, dietary fibre, physiological actions. Antinutrients – Protease inhibitors, hemeagglutinins, hepatotoxin, goitrogens, cyanogenic glucosides, methyl xanthines, oxalates. Toxins from mushrooms. Biological effects of food contaminants – Hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives - saccharin and sodium nitrite. Animal foods and seafoods. Food allergy – role of allergens, diagnosis and management of food allergy. Food processing and loss of nutrients during processing and cooking.

Vitamins: sources, physiological role and deficiency disorders of vitamins A, D, E, K, Vitamin C and B complex vitamins–Thiamine, riboflavin, niacin, pantothenic acid, lipoic acid, pyridoxine, biotin, folic acid and Vitamin B₁₂. Functions and deficiency disorders of minerals.

BC 3.2: IMMUNOLOGY

Unit- I

Types of immunity – Innate and adaptive. Antigens, Super antigens, Adjuvants. Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node. T and B lymphocytes – Origin, activation, differentiation, characteristics and functions. Nature of T and B cell surface receptors. Major Histocompatibility Complex- H-2, HLA, Polymorphism of MHC molecules. Congenic and inbred strains of mice. MHC restriction and its role in immune response, Antigen presenting cells, Processing and presentation of antigens.

Unit-2

Structure of immunoglobulins, Immunoglobulin classes and biological activities. Isotypes, Allotypes, Idiotypes. Immunoglobulin genes and antibody diversity, Class switching, Humoral and cell-mediated immune responses, Cytokines, Interleukins, Interferons, The Complement components and biological consequences of complement activation.

Unit-3

Antigen-antibody interactions: Antibody affinity and avidity, Precipitation reactions – Immunodiffusion, Radial immunodiffusion, double immunodiffusion, immunoelectrophoresis, Rocket immunoelectrophoresis, Agglutination reactions- Hemeagglutination and complement fixation, Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications, humanized antibodies.

Unit-4

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayed hypersensitivity reactions, Immunodeficiencies - SCID and AIDS. Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases. Tissue transplantation - auto, allo, iso and xenograft, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents. Cancer immunology – Tumor associated antigens, Immunological surveillance of cancer.

BC 3.3: REGULATION OF GENE EXPRESSION AND GENETIC ENGINEERING

Unit-1:

Structure and function of *lac* operon, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system, Function and regulation of *trp* operon, Attenuation of *trp* operon, *ara* operon: dual functions of the repressor, Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis*, Heat-shock response in *E.coli*, Regulation of phage variation in *Salmonella*. Regulation of lytic phase and lysogenic phase of Bacteriophage λ .

Unit-2:

Structural changes in the eukaryotic active chromatin - hypersensitive sites, chromatin remodeling, Levels of eukaryote gene control - Control at the level of transcription, processing of RNA, mRNA stabilization in the cytoplasm and translation of mRNA. Eukaryote promoter and enhancer sequence organization. Interaction of eukaryote transcriptional factors with DNA - helix-turn-helix motif, zinc-finger motif, leucine zipper, helix-loop-helix motif. Regulation of galactose metabolism in yeast. Steroid hormone induced gene expression. Regulation of gene expression by anti-sense RNA.

Unit-3:

Restriction endonucleases, Restriction maps, isolation of gene fragments using restriction endonucleases and mechanical shearing. Cloning vectors - Isolation and properties of plasmids, bacteriophage cosmids, Ti plasmid (binary vector), expression vectors, viral vectors, YAC, BAC, phagemids and vectors used for cloning in mammalian cells, other enzymes related to molecular cloning. Hosts - Prokaryotic : *E.coli*, *B.subtilis*, Eukaryotic: Yeast and mammalian cell lines. Ligation of fragments - Cohesive and blunt ends, Homopolymer tailing. Gene transfer techniques. Biological and artificial delivery system, knockout mice.

Unit-4:

Cloning strategies, shot gun experiments, isolation of poly mRNA, synthesis of cDNA, cDNA cloning in bacteria. Genomic and cDNA libraries. Identification of recombinants - structural and functional analysis of recombinants. Design and preparation of DNA and RNA probes for hybridization. Southern blotting, Northern blotting, South-Western blotting, PCR, Expression of cloned genes in bacteria, yeast, animal and plant cells. Biological, Medical and Industrial applications of recombinant DNA technology. Transgenics: Making Golden rice and Dolly.

BC 3.4: INDUSTRIAL BIOTECHNOLOGY

Unit-1:

Fermentation technology – Principles of fermentation, surface, submerged and solid state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors-continuous stirred tank fermentor (CSTF), air-lift fermentor, Types of reactions in fermentations, Selection and characteristics of industrial microorganisms, Primary and secondary metabolites, Strategies for strain improvement and maintenance of the industrial strains, Raw materials, different types of fermentation media, Recovery of products, steps in downstream processing, Bioreactors.

Unit-2:

Production of ethyl alcohol and beer by yeast, Fermentative production of Antibiotics - penicillin, streptomycin, tetracycline, Organic acids - citric acid, lactic acid, acetic acid, Enzymes - amylase, proteases, streptokinase, Amino acids - glutamic acid, lysine and Vitamins - B₁₂, B₂, and vitamin C. Production of biogas from agricultural wastes.

Unit-3:

Immobilization of enzymes and cells – methods of immobilization, effect of partition on kinetic properties of enzymes, immobilization of multienzyme systems, enzyme reactors, packed bed reactors, fluidized bed reactors, problems in using immobilized biocatalysts, Industrial and medical applications of immobilized enzymes and cells. Principle and applications of Protein engineering. Principle, types and applications of Biosensors.

Unit: 4:

Single cell protein- Production and applications, Microbial transformations (bioconversions)-: Types and applications, steroidal transformations. Bioleaching, biosorption, biodegradation, bioremediation. Biofertilizers – Blue-green algal fertilizers (*Azolla*, *Aneabena*), seaweed fertilizers, *Mycorrhiza*, Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses.

PRACTICAL-I

BC 3.5: IMMUNOLOGY AND FOOD ANALYSIS

Determination of A, B, O and Rh blood groups in human beings
Dissection and Identification of thymus, spleen and lymph nodes
Techniques of Immunization and Bleeding
Ouchterlony immunodiffusion for detection of Antigens
Radial Immunodiffusion
Immunoprecipitation and precipitin curve
Immunoelectrophoresis
Rocket immunoelectrophoresis
Purification of bovine serum IgG by ammonium sulphate precipitation
Enzyme Linked Immuno Sorbent Assay (ELISA)
Western blotting
Diagnostic test for typhoid fever
VDRL Test
Pregnancy Test
Isolation of Glycogen from Sheep Liver
Preparation of Carotenes from Carrots
Preparation of Haemoglobin from Blood
Preparation of Chloroplasts from green leaves
Isolation of Glutamic acid from Gluten of Wheat
Extraction and estimation of total lipids from oil seeds (solvent extraction)
Quantitative analysis of foods for -
a) Moisture
b) Ash
c) Iron
d) Calcium
e) Copper

PRACTICAL-II

BC 3.6: BIOTECHNOLOGY AND GENETIC ENGINEERING

Fermentative production and quantification of:

Antibiotics - penicillin/ streptomycin/ tetracycline

Organic acid: citric acid/ lactic acid/ acetic acid

Enzymes: amylase/ protease/urease

Amino acid: glutamic acid/ lysine

Vitamins: B₁₂/ B₂/vitamin C

Ethyl alcohol/ fruit wine and calculation of fermentation efficiency

Methods of immobilization of protein/enzyme and microbial cells

Isolation of plasmids and estimation of plasmid DNA by UV method

Restriction digestion of λ DNA, Ligation of RE fragments

Agarose and Polyacrylamide gel electrophoresis of nucleic acids

Recovery of DNA/RNA fragments from agarose gels

Preparation of competitive *E.coli* cells and transformation

Expression of cloned gene (GFP)

DNA finger printing (RFLP or RAPD)

PCR

Southern blotting

M.Sc., BIOCHEMISTRY SEMESTER SYSTEM

CREDIT SYSTEM

SCHEME OF INSTRUCTION AND EXAMINATION

Paper No.	Title of the Paper	Periods/ Week	No of Credits	Duration of Exam (hrs)	Max Marks
<u>III Semester:</u>					
BC 3.1:	Plant Biochemistry and Human Nutrition	4	4	3	85
BC 3.2:	Immunology	4	4	3	85
BC 3.3:	Regulation of Gene Expression and Genetic Engineering	4	4	3	85
BC 3.4:	Industrial Biotechnology	4	4	3	85
<u>*Practicals:</u>					
BC 3.5:	Immunology and Food Analysis	12	2	6	85
BC 3.6:	Biotechnology and Genetic Engineering	12	2	6	85
BC 3.7:	Viva – Voce	--	1		25
Total marks for III Semester					535 + 90* = 625

*Internal assessment component carries 15 marks for each theory and practical papers.