

# UNIVERSITY DEPARTMENT

## M.Sc. BIOCHEMISTRY PART II (Sem III and IV)

Courses		Credits
	<b>Semester III Theory</b>	
<b>BCH 370</b>	Molecular Biology	5
<b>BCH 371</b>	Medical Biochemistry and Immunology	5
<b>BCH 372</b>	Neurochemistry	4
<b>BCH 373</b>	Biochemical Toxicology	5
	<b>Semester IV Theory</b>	
<b>BCH 470</b>	Biochemical Endocrinology and Plant Biochemistry	4
<b>BCH 471</b>	Fermentation Technology and Food Technology	4
<b>BCH 472</b>	Genetic Engineering	4
	<b>Optional Courses (Any One)</b>	
<b>BCH 473</b>	Nutrition and Clinical Nutrition	4
<b>BCH 474</b>	Developmental Biology and Molecular Evolution	4
	<b>Practical Courses for Part II</b>	
<b>BCH 367</b>	Molecular Biology and Clinical Biochemistry	5
<b>BCH 368</b>	Special Experiments	3
<b>BCH 467</b>	Research Project	7

### SEMESTER III

#### **BCH 370 MOLECULAR BIOLOGY**

- 1 DNA Replication: DNA polymerase I, II, III, origin locus, Okazaki fragments, replication fork (Pro and Eukaryotes).
- 2 DNA Repair: substitution, deletion and insertion mutations, pyrimidine dimer, uracil DNA glycosidase.
- 3 Gene rearrangements recombination, Holliday structures, rec A,B,C,D. SOS response, mobile genetic elements
- 4 Transcription and splicing :RNA polymerases, promoters, sigma and Rho factors, initiation, elongation and termination of transcription, post transcriptional modifications of tRNA and rRNA, inhibitors of transcription, RNA pol I,II,III, enhancers ,5' capping, 3' poly A tailing, splice site, mechanism of splicing, ribozyme.
- 5 Translation
- 6 Protein targeting: Intracellular protein targeting. Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, Peroxisomes, chloroplast, protein degradation.
- 7 Eukaryotic chromosome and gene expression
- 8 Molecular virology: Information of adenoviruses, retroviruses, HIV and H<sub>1</sub>N<sub>1</sub>

### **Reference Books**

1. Biochemistry (III/IV/V/VI edition, 2008) L. Stryer, WH Freeman and Co.
2. Molecular biology of the gene (2004) J D Watson, Benjamin/ Cummings publ. Co Inc.
3. Molecular cell biology (1990) J Darnell and D. Baltimore, W,H Freeman and Co.
4. Molecular biology of the cell (2008) B. Alberts, Garland Pub. In., NY
5. Genes X (2010), B. Lewin, John Wiley and sons, NY.

## **BCH 371 MEDICAL BIOCHEMISTRY AND IMMUNOLOGY**

### **Medical Biochemistry**

- 1 Mechanism of action at molecular level of selected antibiotics, anti metabolites, analgesics, hallucinogens and other drugs, mechanism of resistance to antibiotics and other drugs.
- 2 Lysosomes and their physiological role.
- 3 Cerebrospinal fluid, composition in health and disease.
- 4 Blood composition, molecular basis of hemoglobinopathies
- 5 Ischemic heart disease, role of enzymes and other proteins in assessment of myocardial infarction. Coronary arterial disorders
- 6 Cancer causative agents and control theories of cancer and carcinogenesis, viral etiology, control of cancer and carcinogenesis, viral etiology, control of cancer –basic approaches.
- 7 Biochemistry of diseases: Influenza (types), Malaria, Alzheimer
- 8 Ageing
- 9 Apoptosis

### **Reference Books**

1. Biochemistry of antimicrobial action (4th ed) TJ Franklin, Chapman hall (1989)
2. General Microbiology, Pelczar, Rard and Chan (1987)
3. Mechanism of microbial diseases, M Schaechter et al, Williams and Wilkino Int. Ed.(1989)
4. Biochemistry, L Stryer (3rd ed), Freeman and Co.
5. Textbook of Biochemistry with clinical correlations, Thomas Devlin,(2nd ed),John Wiley and sons
6. Biochemical aspects of human diseases (1983), RL E lkeles, Slackwell scientific publishers, Oxford
7. Analogues of nucleic acids, Ray Berman (1970), Springer Verlag.
8. Text book of Medical Physiology- Guyton (2010)
9. Medicinal chemistry- Molecular and Biochemical approach- Thomas Mogardy and Donald Weaver (3<sup>rd</sup> Ed) Oxford Press

### **Immunology**

- 1 Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non self, primary and secondary lymphoid organs, cell mediated and humoral immune responses, T and B lymphocytes, autoimmune reactions.
- 2 Antigen and antibody: antigen, antigenic determinant, immunopotency, structure of antibody,

constant and variable regions, Fab, F(ab<sub>2</sub>) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes

- 3 Measurement of antigen- antibody interaction, diffusion, immunodiffusion, immuno-electrophoresis, radioimmunoassay, immunofluorescence, ELISA, Western blotting
- 4 Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, poly reactive antibodies, catalytic antibodies, abzymes.
- 5 Complement system: classical and alternate pathway
- 6 T lymphocytes and cell mediated immunity, T cell sub populations, immune response genes, MHC gene complex, polymorphism, graft rejection, graft versus host response
- 7 Hypersensitivity and allergy, immunodeficiency diseases (AIDS)
- 8 Vaccines, interferon
- 9 Blood antigens: blood group substances and Rh factor

### Reference books

1. Molecular biology of the cell –Garland publishing Inc., NY, London
2. Immunology 3rd ed Janis Kuby
3. Essentials of immunology (5th ed) Roit, Blackwell scientific publishing, London
4. Cellular and Molecular Immunology, 3rd ed, Abbas

## BCH 372 NEUROCHEMISTRY

- 1 Brain and behavior, Nerve cells and behavior
- 2 **Anatomical organization:** Central nervous system, spinal cord, different regions of the brain, peripheral and autonomic nervous system afferent and efferent pathways.
- 3 **Cell and molecular biology of the neuron:** Cytology of neuron, synthesis and trafficking of neural proteins, ion channels, membrane potential, passive membrane properties of neuron, voltage gated ion channels and generation of action potential.
- 4 **Neurotransmission:** Membrane potentials, Resting potentials, Depolarization, Repolarization and hyperpolarization. Action potential. Mechanism of axonal neurotransmission. Membrane channels, ion gated voltage gated, chemically gated, mechanically gated and responsive to intracellular messengers.
- 5 **Neurotransmitters:** Synthesis, storage, uptake degradation and action of neurotransmitters. Acetyl choline, GABA, Serotonin, Dopamine, Glutamate Aspartate, Nitrous Oxide etc. Neuropeptides.
- 6 **Synaptic transmission:** Nerve and synapse structure, structure and function correlation at the synapse, Direct gated transmission at central synapse, direct gated transmission at nerve-muscle synapse. Transmission across the synapse membrane potential in steady state, action potential generation and propagation. Transmission of nerve impulses Transmitter release, synaptic vesicles. Chemical messengers.
- 7 **Receptors:** Types of receptors, properties of receptors, sensory modalities and sensory circuits. Sensory perception.
- 8 Cerebrospinal fluid, blood- brain barrier
- 9 Sensory systems; Touch, hearing, taste and vision.
- 10 Natural, genetic and environmental factors affecting the development of CNS.

- 11 **Learning and memory** : Mechanism of short term memory and long term potentiation. NMDA and AMPA glutamate receptors. Retrograde messengers in synaptic transmission. Role of CAM kinase II, Calcium, Protein kinase, CAMP, No, Calpain and other proteins in memory and learning process.
- 12 Synaptic plasticity.
- 13 Localization of higher functions.

#### **Reference Books:**

1. Principles of Neural Science by Eric R. Kandel, James H. Schwartz and Thomas M. Jessell.
2. Neurochemistry by Ferdinand Hucho, VCH Publications, 1986
3. Basic Neurochemistry by M.P. Spiegel
4. Molecular Cell Biology By Lodish, Baltimore et al W.H. Freeman and Co.1996.

### **BCH 373: BIOCHEMICAL TOXICOLOGY**

#### **1 Principles of toxicology**

Different areas of toxicology, spectrum of toxic dose, risk and safety.

Classification of toxic agents, characteristics of exposure, route and site of exposure. Duration of frequency of exposure.

Spectrum of undesired effects: Allergic reactions, Idiosyncratic reactions, Immediate versus delayed toxicity, Reversible versus irreversible toxicity, Local versus systemic toxicity.

Interaction of chemicals, Tolerance, Dose response. Selective toxicity.

#### **2 Evaluation of Toxicity**

Descriptive Animal toxicity tests: Acute lethality, Sub acute, sub chronic and chronic toxicity testing. Teratology and reproduction, Mutagenicity.

#### **3 Biotransformation of toxicants**

Phase I and II biotransformation reactions, Detoxication and toxication. Components of Cytochrome P-450 monooxygenase system, Mechanism of phase I and II reactions.

Bioactivation, Toxicity of insecticides i.e. organophosphorous, carbamates and chlorinated insecticides metals, animal and plant toxins, industrial solvents and vapors. Toxic responses of different tissues and organs e.g. liver, lung, kidney etc.

#### **4 Environmental pollution**

Air, soil and water pollutants. Sources and degradation. Acute and chronic effects of pollutants. Control of environmental pollution (Physical, chemical and biological)

#### **5 Occupational health and industrial toxicity**

#### **6 Applications of toxicology: forensic, clinical**

#### **7 Regulation of safety and social aspects in relation to toxicants.**

#### **Reference books**

1. Haye's principles and methods of Toxicology Ed. A Wallace Hayes, Pub. Raven press, NY
2. Casarett and Doull's Toxicology ed. John Doull, Curtio D Kleassen and Mary D Aunder, McMillan publisher Co, NY
3. Appraisal of the safety of chemicals in foods , drugs and cosmetics. Ed. The Editorial Committee of Association of Food and Drug Officials of the United States
4. Toxicology- Mechanisms and analytical methods, Vol I and II, ed Stewart CP and Stolman A,

Pub Academic press

5. Veterinary toxicology by RJ Garner ed Beilliere, tindall and Cox London
6. The chemistry and microbiology of pollution (1975) IJ Higgins and RG Burns Acad Press, NY
7. Introduction to ecological biochemistry JB Harbone Acad Press, NY (1977)

## SEMESTER IV

### **BCH 470 BIOCHEMICAL ENDOCRINOLOGY AND PLANT BIOCHEMISTRY**

#### **Biochemical Endocrinology**

- 1 General characteristics of hormones: chemistry, structure, synthesis, secretion, transport, metabolism & mechanism of action of hormones of the thyroid, hypothalamus, pituitary, pancreas, adrenals, glands, prostaglandins and gastro intestinal hormones, calcium signaling, zinc fingers
- 2 Secondary messengers and their mode of action
- 3 Cell membranes and intracellular receptors for hormones
- 4 Hormonal inter relationship
- 5 Biosynthesis of steroid hormones, cholera toxin, adenylate cyclase and TP, hormone overproduction and target cell insensitivity
- 6 EGF, NGF, PDGF, Enkephalin

#### **Reference books:**

1. Vertebrate endocrinology- Noris DO (1985) 2nd ed
2. Endocrine physiology- Martin, CR (1985)(Oxford Univ press (NY)
3. Physiological chemistry –Harper 17ed Lange medical
4. Biochemistry- Zubay (1983) Addison, Wesley publ. Co.
5. Text book of endocrinology –Williams, 6th ed Saunders Co (1981)
6. Biochemical endocrinology E. Frieden (1983)

#### **Plant Biochemistry**

- 1 Physiology and Biochemistry of plant cell and organelles
- 2 Plant primary and secondary metabolites and interfaces and their significance in chemical ecology
- 3 Photosynthetic systems in plants (C3 and C4)
- 4 Molecular biology of source sink relationship in plants
- 5 Plant hormones and their networking in plant physiology and biochemistry
- 6 Plant signaling and behavior: plant-plant, plant-insect, plant-pathogen, plant-environmental factors
- 7 Physiology and biochemistry of abiotic (Drought, Salinity, Metal) and biotic (bacteria, fungi, viruses) stresses in plants
- 8 Biochemistry and physiology of seed germination and feeling
- 9 Biochemistry and physiology of fruit development and ripening
- 10 Pharmaceutical and nutraceutical values of plants

### **Reference Books:**

1. Biochemistry and Physiology of Plant Hormones, Thomas Moore
2. Plant Biochemistry- Hans Walter Heldt
3. Introduction to Plant Biochemistry- T.W. Goodwin and E.L. Mercer
4. Plant Physiology- Devlin
5. Plant Biochemistry- Dey

## **BCH 471 FERMENTATION TECHNOLOGY AND FOOD TECHNOLOGY**

### **Fermentation Technology**

- 1 Characteristics of industrial microorganisms
- 2 Strain improvement, use of auxotrophic mutants
- 3 Methods and parameters of cultivation of microorganisms , media for industrial fermentation
- 4 Fermenters, design of fermenters, fermentation process, and maintenance of aseptic conditions, aeration and agitation.
- 5 Downstream processing, recovery and purification of fermentation products, effluent treatment
- 6 Applications of fermentation technology
- 7 Manufacturing by fermentative process: beer, Citric acid, Glutamic acid, lipase, Penicillin, L-asparaginase

### **Reference Books**

1. Principles of Fermentation technology, PF Stanbury, A Whitaker, SJ Hall (2008)
2. Molecular biology and biotechnology- edited by JM Walker and FB Gingold, Royal society of chemistry (1988)
3. Industrial Microbiology – Casida
4. General Microbiology Stainer R. Y. Ingrahm J. L., Wheelis M. L. and Painter P. R. (1987) 5<sup>th</sup> Edition, Macmillan Press Ltd. London

### **Food Technology**

- 1 Foods of animal and plant origin
- 2 Monitoring food quality
- 3 Primary feedstock
- 4 Proteins from unconventional sources- OCP, SCP etc
- 5 Starch production, manufacture of natural and synthetic sweeteners and syrups
- 6 Enzymes in food analysis, toxins, alcohol, amino acids, glucose
- 7 Enzymes in food processing, meat tenderization and fruit juice technology
- 8 Biochemistry of food spoilage, principles of food preservations
- 9 Food additives, starches, sugars, syrups and sweeteners, flavoring agents, colors
- 10 Genetically modified foods

### **Reference books**

1. Enzymes and food processing- GG Birch, N Blackbrough (1981)
2. Nutrition and food processing- MG Miller , G Tobin, AVI publishing Co, Creem Holm (1980)
3. Introduction to food sciences and technology –GF Stewart and MA Amerine (1973) Academic Press

### **BCH 472 GENETIC ENGINEERING**

- 1 Genetic engineering concepts
- 2 Enzymes in genetic engineering
- 3 Plasmids, bacteriophages, shuttle vectors
- 4 Animal, virus and derived vectors- Phages , cosmid, M13, 2 $\square$ circles
- 5 Cloning in yeast, bacillus and streptomyces
- 6 Selection of recombinant DNA clones, Southern and Northern blotting
- 7 Genomic and C-DNA library construction
- 8 Characterization of recombinant gene-S1 mapping, sequencing
- 9 Restriction mapping, chromosome walking
- 10 RFLP, PCR, DDRT PCR, DGGE
- 11 Ti plasmids and plant genetic engineering
- 12 Transgenic plant and animals
- 13 Application of genetic engineering in medicine, agriculture and industry
- 14 Protein Engineering
- 15 In vitro mutagenesis
- 16 Microarray
- 17 RNA interference
- 18 Epigenetic phenomenon

#### **Reference Books**

1. Recombinant DNA- Short courses, JD Watson, John Tooze, David T. Kurtz, Scientific American books, WH Freeman &Co.
2. Principles of gene manipulation, SB Primrose (6th ed).
3. Gene cloning- An introduction, T.A Brown, 2<sup>nd</sup> and 3<sup>rd</sup> ed, Chapman &Hall.

### **OPTIONAL COURSES**

#### **BCH 473 NUTRITION AND CLINICAL NUTRITION**

##### **Nutrition**

- 1 **Basic Concepts:** Composition of Human body. Nutritional value of foods and effect of Processing, Energy content and its measurement in foods. Thermogenic effect of foods
- 2 **Role of food proteins:** Requirements and allowances. Proteins as building material, amino acid inter relationships. Protein quality and methods of determination. Factors affecting protein metabolism, Nitrogen balance studies and factors affecting it. Protein and amino acid requirement at different stages of development.
- 3 **Carbohydrates and Energy metabolism:** Dietary requirements and source of carbohydrates,

Classification – Available and Unavailable. Physico-chemical properties and the physiological role. Energy requirement and measurement of energy requirement: Direct and Indirect calorimetry. Factors affecting requirements; BMR, SDA and activity. BMR and relation of temperature regulation to basal metabolism.

- 4 **Lipids:** Nutritional classification of dietary lipids, sources and their physiological functions.
- 5 **Minerals:** Nutritional significance. Dietary Macro elements, Calcium, Phosphorus, Magnesium. Trace Elements, Iron, Iodine, Zinc, Copper etc.
- 6 **Food utilization:** Ingestion, digestion, absorption transport, storage and disposal of food nutrients (proteins, carbohydrates, fats, vitamins and minerals).
- 7 **Primary Nutritional Diseases:** Protein energy malnutrition, starvation, obesity, vitamin deficiency disorders and biochemical basis of causation and diagnosis of nutritional anaemias.
- 8 **Conditional Nutritional Disorders:** Disorders of Gastrointestinal tract, Liver, Biliary tract and Pancreas and Heart, Diabetes
- 9 **Food toxins and Allergy**

### **Clinical Nutrition**

- 1 Diet and nutrition in India: Assessment of nutritional status
- 2 Factors affecting digestion and absorption of food
- 3 Effects of irradiation, cooking, refining, sprouting and fermentation on nutritional quality of food
- 4 Food toxins, adverse effects of alcohol, tobacco, tea
- 5 Interrelationship between dietary lipids and cholesterol metabolism
- 6 Malnutrition and infection
- 7 Malnutrition and mental development
- 8 Infant and geriatric nutrition
- 9 Nutritional basis of behavior, neutral tranquilizers
- 10 Amino acid therapy
- 11 Acidic and alkaline foods
- 12 Dietary fiber- chemical composition and importance
- 13 Physiological effects and metabolic adaptation during exercise
- 14 Nutritional management of inborn errors of metabolism

### **Reference books:**

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974), Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore
4. Amino acids in therapy – Leon Chaitwo, Thorsons publishers Inc. NY
5. Physiological chemistry- Hawk

### **BCH 474 DEVELOPMENTAL BIOLOGY AND MOLECULAR EVOLUTION**

- 1 Theories of Evolution.-the time scale and some evolutionary principles. Chemical evolution and origin of life. Prototypes of metabolic pathways.

- 2 Genesis of oxygen generating photosynthesis and aerobic respiration. Methanogens-evolution of prokaryotes
- 3 Evolution of protists
- 4 Origin of eukaryotes
- 5 Theories regarding origin of mitochondria and chloroplast, the five kingdom classification of living organisms, outline of eukaryote evolution- evolution of primates.
- 6 Construction of phylogenetic trees- molecular data set based on sequences
- 7 Evolution of proteins and nucleic acid – elastic analysis.
- 8 Evolution of introns
- 9 Evolutionary view of exon domain relationships
- 10 Developmental Biology—Cell differentiation, hierarchy of genes, measurement of time during development, nature of differentiation, DNA rearrangements& amplification, genetic control of morphogenesis, plant molecular genetics.

### **Reference Books**

1. Evolution and Diversity of life, E. Mayer Belknap Press Pub, 1976
2. Population species and evolution (1973), E Mayer Press Pub.
3. Biochemistry , Lehninger (1975) Worth pub
4. Origin of Eukaryotic cells, Margulis L.(1977)

## **PRACTICAL COURSES FOR M.Sc. PART II BIOCHEMISTRY**

### **BCH-367 MOLECULAR BIOLOGY AND CLINICAL BIOCHEMISTRY (5 Credits)**

#### **Molecular Biology**

- 1 Isolation of DNA from E. coli/ liver/ plant/ plasmid
- 2 Determination of base composition (spectrophotometry)
- 3 Agarose gel electrophoresis of DNA
- 4 Restriction digests of DNA
- 5 Isolation of plasmid
- 6 Transduction
- 7 Transformation
- 8 Expression analysis
- 9 Ligation
- 10 PCR
- 11 Plasmid mapping
- 12 Mutation
- 13 Induction of lac operon

#### **Clinical Biochemistry**

- 1 Estimation of Lipoproteins
- 2 Glucose tolerance test
- 3 Estimation of bilirubin

- 4 Estimation of blood urea
- 5 Blood sugar determination by Folin-Wu method
- 6 Estimation of creatine phosphokinase
- 7 Normal and abnormal constituents of urine
- 8 Determination of blood cholesterol
- 9 Determination of glucose by glucose oxidase method
- 10 Estimation of glycosylated hemoglobin
- 11 Estimation of LDH and its isozymes
- 12 Estimation of alkaline phosphatase from serum
- 13 Estimation of total protein and albumin from serum
- 14 Determination of SGPT and SGOT
- 15 Estimation of serum amylase

### **BCH- 368 SPECIAL EXPERIMENTS (3 Credits)**

(Any eight experiments should be conducted)

- 1 Affinity chromatography
- 2 Immobilization of enzymes
- 3 Sub cellular fractionation
- 4 Biosensors
- 5 Spectrofluorimetry
- 6 HPLC
- 7 Immunochemical techniques
- 8 Immuno-electrophoresis
- 9 Ouchterlony double diffusion
- 10 Complement fixation test.
- 11 ELISA
- 12 Production of Monoclonal antibodies
- 13 Determination of partial specific volume
- 14 2-D gel electrophoresis
- 15 Viscosity measurements by Brookfield viscometer

#### **Reference Books:**

1. Practical Biochemistry- David Plummer
2. Practical Biochemistry – J. Jayaraman
3. Biochemical methods – Sadasivam and Manickam
4. Biochemistry –Practical Approach – Kieth Wilson and J. Walker
5. Introductory Practical Biochemistry- Randhir Singh and Sawhney

### **BCH 467 PROJECT (7 Credits)**

**Student is required to carry out project work on a suitable topic and submit a dissertation based upon it.**

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