



**UNIVERSITY OF CALICUT**

**Abstract**

M.Sc programme in Biochemisty under CUCSS (PG) - for affiliated colleges- Modified Syllabus with effect from 2013 admissions - approved– implemented--Orders issued.

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**G & A - IV - J**

U.O.No. 6960/2013/CU

Dated, Calicut University.P.O, 21.12.2013

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- Read:-*1. U.O.No. GAN/J1/1373/08 dated 23.07.2010.  
2. U.O. No. GA IV/J1/4545/10 dated 05.08.2010.  
3. Minutes of the meeting of the Board of Studies in Biochemistry held on 25.10.2013.  
4. Remarks of the Dean, Faculty of Science on 16.12.13  
5. Orders of the Vice Chancellor on 20.12.2013 in the file of even number

**ORDER**

As per University Order read as first, Credit Semester System was implemented to all PG programmes in affiliated Arts and Science Colleges and Self Financing Centers of the University with effect from 2013 admission onwards.

The scheme and syllabus for the of M.Sc Programme in Biochemistry under CUSS PG was implemented vide paper read as second above.

The Board of Studies in Biochemistry as per item no. 1 of the Minutes has modified and approved the syllabus of M.Sc. Biochemistry programme under CUCSS PG with effect from 2013 admission vide paper read as third. The Dean, Faculty of Science has recommened to approve the Syllabus as per the paper cited 4th.

The Vice-Chancellor, considering the exigency, exercising the powers of the Academic Council has approved the item no. 01 of the minutes regarding the implementation of the syllabus of M Sc. Biochemistry , subject to ratification by the Academic Council.

Sanction has therefore been accorded for implementing the modified Syllabus of M.Sc programme in Biochemistry under CUCSS PG 2010 with effect from 2013 admission.

Orders are issued accordingly. Scheme and Syllabus appended.

Lalitha K.P  
Assistant Registrar

To

Forwarded / By Order

Section Officer

## **M.Sc Biochemistry for affiliated colleges under University of Calicut**

### **UNIVERSITY OF CALICUT M.Sc. BIOCHEMISTRY (CUCSS-PG-10 PATTERN) Regulations and Syllabus**

The Board of Studies in Biochemistry (PG and UG single board) at its meeting held on 25-10-2013 considered the revision of PG programmes in Biochemistry (CUCSS-PG-2010) in affiliated colleges. The revised course pattern, syllabus, distribution of credits and scheme of evaluation, etc. approved by the Board are given below:

#### **Course Pattern**

- (a) The name of the course shall be M.Sc. Biochemistry under CUCSS-PG-2010 pattern.
- (b) The course shall be offered in four semesters within a period of two academic years.
- (c) Eligibility for admission will be as per the rules laid down by the University from time to time.
- (d) Details of the courses offered for the programme are given in Table I.

The course shall be conducted in accordance with the course pattern, scheme of examination and syllabus prescribed.

**Practicals:** In the 1<sup>st</sup> and 2<sup>nd</sup> semester there will be two core practical papers (2 credits each). In the 3<sup>rd</sup> and 4<sup>th</sup> semester there will be one practical paper each, with 2 credits in the 3<sup>rd</sup> semester and 3 credits in the 4<sup>th</sup> semester. However, practical examinations will be conducted only at the end of the second semester for BC1P01, BC1P02, BC2P03 and BC2P04. At the end of fourth semester practical exams for BC3PO5 and BC4PO6 will be conducted.

**Project and Viva Voce:** Each student will have to do an independent research project work during the entire course under the guidance of a faculty member of the college/ scientist of recognized research centre.

#### **Scheme of examinations**

1. There shall be external university examination of 3 hour duration for each theory courses at the end of the each semester.
2. Practical examinations shall be conducted by the university at the end of even semester
3. Each practical examination in the second semester (BC1P01, BC1P02, BC2P03 and BC2P04) will be of 3hours duration and in the fourth semester BC3PO5 will be of 3 hours duration and BC4PO6 will be of 6 hour duration.
4. Two days for the conduct of BC1P01, BC1P02, BC2P03 and BC2P04 at the end of second semester and two days at the end of 6<sup>th</sup> semester for the conduct of BC3PO5 and BC4PO6 practical exams.
5. Project / dissertation evaluation and viva-voce shall be conducted at the end of the programme only.
6. Practical examination, project/dissertation evaluation and viva voce shall be conducted by two external examiners.

#### **EVALUATION AND GRADING**

1. The evaluation scheme for each course shall contain two parts (a) Internal evaluation and (b) external evaluation. 25% weightage shall be given to internal evaluation and the remaining 75% to external evaluation and, therefore, the ratio of weightage between internal and external is 1: 3. Both internal and external evaluation shall be carried out using direct grading system.

Internal evaluation: The internal evaluation shall be based on predetermined transparent system involving periodic written tests, assignments, seminars and attendance in respect of theory courses and based on written tests, lab skill/records/viva and attendance in respect of practical courses. The weightage assigned to various components for internal evaluation is as follows.

#### Components of Internal Evaluation

	Component	Weightage
A	Assignment	1
B	Seminar	1
C	Attendance	1
D	Test	2

7. Weightage for each core and elective theory course shall be 36 for the external examination and 5 for the internal theory examination.
8. Weightage for each practical course shall be 24 for the external examination and 5 for the internal core.
9. Question paper for theory examination shall contain 14 short answer questions with weightage 1 each, 7 short essay questions with weightage 2 each and 2 essay questions with weightage 4 each.
10. Weightage for the external practical examination can be distributed as follows-

	Weightage
Writing procedures	2
Experiment	18
Spot test	4
<b>Total weightage</b>	<b>24</b>

11. Project report should be preferably presented using power point.
12. A minimum of one test paper for each course has to be conducted and should be counted for internal evaluation in each semester.
13. One seminar and one assignment are compulsory for each course.

#### **Criteria for the evaluation of dissertations.**

	Weightage
1. Introduction, review of literature etc.	2
2. Objectives and relevance of the study	3
3. Methodology	4
4. Results	3
5 Discussion and interpretation	4
6. Conclusions	3
7. Involvement of the students	1
8. Style and neatness of the dissertation	1
9 References	3
Total	24

### Criteria for the Viva-voce

#### A. Presentation of project work- (Preferably, Power Point Presentation)

	Weightage
1. Quality and correctness of slides	2
2. Time management	2
3. Way of presentation	2
4. Clarity of presentation	3
5. Communication skill	3
6. Answers to questions	4
Subtotal	16

#### B. General Viva-voce:

7. Knowledge of the student	3
8. Communication skill	2
9. Answers to questions	3
Subtotal	8
Grand Total (A + B )	24

TABLE I

**Courses offered for M.Sc. Biochemistry Programme under CUCSS-PG-10 PATTERN in Affiliated Colleges**

	Course code	Course Title	Instruction / Week	Credits	
Semester I	BC1C01	General and Analytical Biochemistry	5	4	
	BC1C02	Cell Biology and Physiology	5	4	
	BC1C03	Metabolism and Clinical Biochemistry	5	4	
	BC1P01	Practical 1	5	2	
	BC1P02	Practical 2	5	2	
Semester II	BC2C04	Enzymology and enzyme technology	5	4	
	BC2C05	Microbiology and immunology	5	4	
	BC2C06	Structural biology, Biostatistics and bioinformatics	5	4	
	BC2P03	Practical 3	5	2	
	BC2P04	Practical 4	5	2	
Semester III	BC3C07	Plant biochemistry and environmental biochemistry	4	4	
	BC3C08	Molecular biology, genetic engineering, patenting and IPR	4	4	
	BC3C09	Biotechnology and biosafety	4	4	
	BC3P05	Practical 5	5	2	
	<b>Any two electives from the following courses</b>				
	BC3E01	Neurobiochemistry	4	4	
	BC3E02	Nutritional biochemistry	4	4	
	BC3E03	Protein chemistry	4	4	
	BC3E04	Clinical and Diagnostic Biochemistry	4	4	
Semester IV	BC4P06	Practical 6	8	3	
	BC4Pr01	Research Project and viva voce		4+3	
	<b>Any two electives from the following courses</b>				
	BC4E05	Genetics for biologists	4	4	
	BC4E06	Biochemical and environmental toxicology	4	4	
	BC4E07	Biochemical engineering	4	4	
	BC4E08	Cancer biology	4	4	

**Total core credits    56**  
**Total elective credits   16**  
**Total credits            72**

**BC1C01. GENERAL AND ANALYTICAL BIOCHEMISTRY ( 4 credits, 90h)**

**Unit I.(2h) Chemical bonds**-Types of Bonds- covalent bond, ionic bond, hydrogen bond, Van der Waals forces and London forces. Significance of hydrogen bonding in biomolecules

**Unit II. (8h) Structure and functions of carbohydrates:** Structure, classifications and functions of carbohydrates: monosaccharides, disaccharides and polysaccharides. Sugar derivatives- Sugar acids, sugar alcohols, deoxysugars, amino sugars; Glycosidic linkages, glycosides and their functions, Heteropolysaccharides, Mucopolysaccharides, Glycosaminoglycans and Glycoproteins.

**Unit III.(8h) Structure and functions of amino acids and proteins:** Chemical structures and classifications of amino acids. Chemical properties of amino acids; Amino acid derivatives; Non-protein amino acids. Biological amines and their functions; small peptides and cyclic peptides and their biological functions. Proteins: Different types; classifications, physicochemical properties of proteins; structural organization of proteins, primary secondary, tertiary and quaternary structures.

**Unit IV.(9h) Lipids and nucleic acids:** Structure, properties and classification; Classification of fatty acids – saturated, unsaturated and poly-unsaturated, short chain, medium chain and long chain fatty acids. Triglycerides, phospholipids, prostaglandins, prostacyclins and leukotrienes; Sphingolipids and glycolipids.

**Structure and properties of nucleic acids:-** Purine and Pyrimidine bases;Nucleosides, nucleotides, nucleoside analogues. DNA-structure: Watson and Crick structure

**Unit V.(9h) Hormones:-** Chemical structure, properties and functions of different types of hormones. Classification - based on chemical nature and mechanism of action. Regulation of endocrine function, Hormone receptors, Nitrous oxide and endocrine hormones; and molecular clinical evaluation.

**Unit VI.(8h) Nutrition and dietary habits-** Physiology and nutrition of carbohydrates, fats, proteins. Vitamins A, D E, K, vitamin B complex and vitamin C. Minerals and their biological function. Basic food groups, energy providing foods, body building foods and protective foods. Composition of balanced diet; required dietary allowance for an average Indian. Locally available foods, inexpensive quality foods and food stuffs rich in more than one nutrient.

**Unit VII. (8h) Energy requirements during growth, pregnancy, lactation and various physiological activities.** Specific domain action (SDA) of foods. Malnutrition- its implications and relationship with dietary habits. Prevention of malnutrition, especially protein calories malnutrition, Kwashiorkar and Marasmus by improvement of diets. Human milk and its virtues. Food preservation standards, Food adulteration and precautions. Government regulations on preservation and quality of food

**Unit VIII. (8h) Laboratory safety protocols.** Solutions-properties, Preparation of solutions.. Polar and non-polar solvents. Preparation of buffers. Nature of radioactivity, properties of  $\alpha$ ,  $\beta$ , and  $\gamma$  rays, measurement of radioactivity. Principles and applications of tracer techniques in Biology, Radioactive isotopes-applications in biological research, Effect of radiations on biological systems. Autoradiography and its applications, Geiger-Muller counter. Scintillation counter

**Unit IX. (10h)Principles and applications of centrifugation;** Different Centrifugation techniques. Electrophoretic techniques and applications. Chromatographic techniques-different types. Paper, Thin layer chromatography (TLC), High performance thin layer chromatography (HPTLC), High performance liquid chromatography (HPLC), Gas chromatography (GC). Colorimetry,

spectrophotometry, fluorimetry and flame photometry.

**Unit X. (10h)** Spectroscopy – Mass spectroscopy, NMR; Atomic absorption and Emission spectroscopy, Circular Dichroism (CD) and Optical Rotatory Dispersion (ORD), Electron–spray. Rotary evaporator. Lyophilization techniques – principles and applications. Biphasic separation, Colloids-properties Osmosis, diffusion, dialysis.

**Unit XI.(10h)** Basic understanding of clinical samples – Blood, CSF, urine, bile; biopsy specimens. Methods for collection and preservation of samples. Instruments used in an automated biochemistry laboratory. Auto-Analyzers, hematology counter, Blood gas analyzers; enzyme-linked immunosorbent assay (ELISA) reader.

### References

1. Conn E E and Stumpf P K, Outlines of Biochemistry, Wiley Eastern, N. Delhi
2. Creighton Thomas E, Proteins: Structures and molecular properties, W H Freeman & Co New York
3. Donald T Haynie, Biological thermodynamics, Cambridge university press
4. Ganong's review of Medical physiology. McGraw-Hill Medical
5. Reginald H. Garrett, Charles M. Grisham, Biochemistry, Saunders College Publishing, Philadelphia
6. Gowenlock Alan H, Varley's Practical Clinical Biochemistry, C B S publications
7. Guyton Arthur, Text Book of Medical Physiology, Elsevier N. Delhi
8. Harold Harper, Review of Physiological chemistry, Marusan Co
9. Keith Wilson & John Walker, Principles and Techniques of Biochemistry & Molecular biology Cambridge University Press
10. Plummer David T, An introduction to practical Biochemistry, Tata MacGraw Hill
11. Sawhney S K and R Singh Introductory Practical Biochemistry, Narosa publishing house
12. Stryer Lubert & Hall John E, Biochemistry, W. H. Freeman and Company
13. Voet Donald & Voet Judith, Biochemistry, John Wiley & sons
14. Nelson, D. L. & Cox, M. M. 2008. Lehninger's Principles of Biochemistry (4th Edn). W.H. Freeman and Co.

### BC1C02 . CELL BIOLOGY AND PHYSIOLOGY( 4 credits, 90h)

**Unit I. (15h)** Events in the development of Cell Biology. Cell Theory. Prokaryotic and eukaryotic cell; cell structure and integrity; structure, composition and function of organelles; cell division, mitosis, meiosis, cell cycle and its control, apoptosis. Ageing and senescence. Properties of cancer cells. Stem cells. Flow cytometry and cell sorting – sub cellular fractionation. cell-cell fusion in both normal and abnormal cells.

**Unit II.(10h)** Biomembranes- structure and composition, preceptor biology and concepts of cell signaling, transport across membrane, passive, active, symport, antiport, uniport, ion channels, Endocytosis, exocytosis, phagocytosis, pinocytosis, cell-cell, cell-matrix interaction, cell adhesion– cell differentiation, and tissue morphogenesis. Cytokines, growth factors

**Unit III.(15h)** Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems, bacterial chemotaxis and



quorum sensing. Cellular communication: Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

**Unit IV.(15h)** Vascular biology and respiration: Blood: composition, haemopoiesis, Homeostasis and coagulation of blood. Clotting factors, Disorders of clotting. Plasma proteins and their function. Hemoglobin- structure and function. Lymph- Composition and function. Reticuloendothelial system. Spleen- structure and function. Heart anatomy, nerve innervations, cardiac cycle, cardiac output, regulatory mechanisms. Respiratory mechanism, transport of gases. Surfactant nature and function, Respiratory membrane and its importance, gas exchange, regulation; Hemophilia.

**Unit V.(15h)** Composition, structure and functions of muscle cells; molecular basis of skeletal, smooth and cardiac muscles; muscle contraction; biochemical composition of nerves tissue; mechanism of transmission of nerve impulses. Autonomous nervous system- Sympathetic and parasympathetic functions, Neurotransmitters. Functions of hypothalamus. Endocrine glands, secretions and functions, pheromones. Structure and function of eye, ear, taste buds and olfactory receptors. Muscular dystrophy.

**Unit VI.(10h)** Types of salivary glands, Salivary secretion, Composition of saliva, regulation and functions. Gastric and pancreatic secretion. Gastro intestinal hormones, regulation. Disease related to digestion and absorption of food. Achlorohydrria; ulcers, gastritis; *H.pylori*-induced gastritis.

**Unit VII.(10h)** Structure and function of nephron. Renal blood flow and its importance. Composition of urine. Functions of tubules, Nerve supply to urinary bladder, Glomerular filtration, urine composition, homeostasis. Acid - base balance. Antidiuretic hormone and osmoregulation, Thermoregulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization. Stress and adaptation

## References

1. Cell and Molecular Biology by Gerald Karp Heritage publishers
2. Cell by Gerald Karp Wiley and Sons, Inc
3. Guyton and Hall, Text Book of Medical Physiology, Saunders; 12th edition
4. Harold Harper, Review of Physiological chemistry, Marusan Co
5. William Ganong, Review of medical physiology, McGraw Hill

## BC1C03 . METABOLISM & CLINICAL BIOCHEMISTRY( 4 credits, 90h)

**Unit 1.(20h)** Carbohydrate metabolism – Glycolysis – aerobic and anaerobic types; alcohol fermentation; regulation of glycolysis. HMP–shunt and its significance. Gluconeogenesis, glycogenesis and glycogenolysis. Nucleoside diphosphate sugars and glycosidic bond formation; sucrose, lactose, starch and glycogen synthesis. Pyruvate dehydrogenase complex. Krebs cycle, anaplerotic reactions; substrate-level phosphorylation. Electron transport chain- components; oxidative phosphorylation and mechanism of ATP formation; Chemi-osmotic coupling hypothesis and other hypothesis. Structural basis of free energy of hydrolysis of ATP. Glyoxylate cycle- significance, regulation; Cyanide-insensitive respiration and its significance. Uronic acid pathway. Metabolism of alcohol and alcohol toxicity. Disorders of carbohydrate metabolism-glycogen storage diseases; Diabetes mellitus; Galactosemia and lactose intolerance. Glucose tolerance tests.

**Unit II.(15h)** Amino acid metabolism: Deamination, transamination, transmethylation and decarboxylation reactions of amino acids. Synthesis and degradation of various amino acids; essential, semi-essential and non-essential amino acids; Classification of amino acids based on metabolic end product- glucogenic and ketogenic. Urea cycle and its regulation. Proteolytic enzymes. Protein turnover. Disorders of protein metabolism- Protein energy malnutrition Phenylketonurea and alkaptonurea; Tyrosinaemia; maple syrup urine disease; Cystinurea; methylmalonyl urea. Urea cycle disorders; albinism.

**Unit III.( 15h)** Lipid metabolism – VLDL, LDL, and HDL – their formation and degradation. Fatty acid mobilization; Fatty acid oxidation;  $\alpha$ ,  $\beta$ , and  $\omega$ - oxidations; Fatty acid biosynthesis in plants and animals- fatty acid synthetase complex; synthesis of unsaturated and long chain fatty acids. Cholesterol biosynthesis and degradation. Ketone body metabolism. Metabolism of prostaglandins, prostacyclins and leukotrienes. Disorders of lipid metabolism- Hyperlipidemia, Hyper cholesterolemia; Metabolic acidosis, disorders of ketone body metabolism, sphingolipidosis; diseases associated with lipoprotein metabolism- atherosclerosis and coronary artery diseases; fatty liver, and lipotropic factors

**Unit IV.(15h)** Nucleic acid metabolism: purines and pyrimidines – biosynthesis and regulation, degradation; Uric acid formation; Salvage and de novo pathways. Heme and prophyrin metabolism, Heme biosynthesis and bile pigment formation. Metabolism of xenobiotics. Detoxification mechanisms - different types. Mineral metabolism – Macro and micronutrients – their specific biochemical functions. Disorders of nucleic acid metabolism- Purine and pyrimidine metabolism; Uric acid and gout; Gouty arthritis.

**Unit V.(15h)** Disorders of hormonal imbalance – Hyper and hypothyroidism, growth hormone imbalance, disorders of sex hormone imbalance, Organ functions and function tests- Liver functions and liver function test. Hepatitis, cirrhosis; jaundice, hepatic coma. Tests for the assessment of liver functions, kidney functions, cardiac functions and gastric functions

**Unit VI(10h)** . Regulation of physiological pH- Different mechanisms. Buffer systems of the body. Quality control in biochemical analysis. Concepts of accuracy, precision, reliability reproducibility and other factors of quality control; normal values, therapeutic index.

## References

1. Donald T Haynie, Biological thermodynamics, Cambridge university press
2. Stryer Lubert & Hall John E, Biochemistry, Freeman and company
3. Lehninger Principles of Biochemistry. W.H Freeman and company
4. Harold Harper, Review of Physiological chemistry, Marusan Co
5. Conn E E and Stumpf P K, Outlines of Biochemistry, Wiley, N. Delhi
6. Voet Donald & Voet Judith, Biochemistry, John Wiley & sons, US
7. Garrett Reginald H and Grisham Charles M, Biochemistry, Saunders College Publishing, Philadelphia
8. Devlin Thomas M, Text Book of Biochemistry with clinical correlations, Wiley Liss, New York
9. Zubay Geoffrey, Biochemistry, W.M.C Brown publishers
10. Murray Robert et al, Harper's Biochemistry, Appleton & Lange
11. Vasudevan D M and Sreekumari S, Text Book of Biochemistry for medical students, Jaypee Brothers medical publishers, N. Delhi
12. Kaplan Lawrence A et al, Clinical Chemistry, Mosby, Missouri

### **BC1P01 . PRACTICAL I (2 credits, 5h/week)**

1. Qualitative analysis of carbohydrates (monosaccharide, disaccharides and polysaccharides)
2. Qualitative analysis of proteins and amino acids
3. Preparation of buffers using pH meter.
4. Detection of isoelectric pH of a protein
5. Quantitative estimation of proteins – Comparative evaluation by Lowry *et al* method, Bradford method, Biuret method and spectrophotometric method.
6. Quantitative estimation of reducing sugar
7. Quantitative estimation of cholesterol.
8. Estimation of muscle and liver glycogen.
9. Extraction and estimation of starch
10. Iodine value and saponification value of oils
11. Detection of abnormal constituents in urine sample
12. Assay of serum aspartate aminotransferase and alanine aminotransferase
13. Estimation of serum bilirubin, creatinine and calcium
14. Paper Chromatography of sugars
15. TLC of amino acids
16. Column chromatography of plant pigments and analysis of the absorption spectra of different fractions.
17. Polyacrylamide gel electrophoresis of proteins
18. Centrifugation: Organelle separation by differential centrifugation and density gradient centrifugation.

### **BC1P02 . PRACTICAL II( 2 credits, 5h/week)**

1. Examination of onion root tip cells for different stages of cell division
2. Karyotype preparation
3. Blood smear preparation, differential WBC count, total WBC count and total RBC count
4. Erythrocyte sedimentation rate (ESR)
5. Clinical examination of radial pulse
6. Blood pressure measurement
7. Recording of lung volume and lung capacities using students' respirometer

## **SEMESTER II**

### **BC2C04 ENZYMOLOGY AND ENZYME TECHNOLOGY (4 credits, 90h))**

**Unit I.( 25h)** Enzymes: Classification, naming and E.C numbering of enzymes. General properties of enzymes. Enzyme structure – apoenzyme and holoenzyme, co-enzyme and co-factors. Structure of active site of enzyme. Mechanisms of enzyme catalysis- different types. Formation of enzyme substrate complex- lock and key and induced fit hypothesis of enzyme-substrate interaction; transition state and energy of activation. Enzyme kinetics: Michaelis – Menten equation;  $K_M$  value and its significance. *In vitro* measurement of enzyme activity- unit of enzyme, specific activity. Factors affecting enzyme activity. Regulation of enzyme activity – covalent modification; allosteric regulation; feed back regulation. Enzyme inhibition – Competitive and non-competitive and

uncompetitive inhibition. Inhibitor constant ( $K_I$ ) and its determination.

**Unit II.( 20h)** Co-enzymes – chemical structures and specific functions. Multimeric enzymes; multienzyme complexes. Structure of pyruvate dehydrogenase complex and the mechanism of catalysis. Isoenzymes - properties and significance. Lactate dehydrogenase. Intracellular and extra cellular enzymes; soluble and membrane bound enzymes.

**Unit III.( 25h)** Ribozymes – structure, properties and functions. Abzymes – structure, properties and function. Gastro intestinal enzymes- properties and functions. Microbial enzymes- amylases, lipases and proteases. Enzyme immobilization techniques. Different procedures for immobilization. Applications of immobilized enzymes. Extraction and purification of enzymes from different sources – plant, animal and microbial. Composition of extraction media. Celldisruption and homogenization techniques. Steps in purification- salt fractionation, dialysis, chromatography (molecular sieving, ion exchange, adsorption, affinity). Test of purity. Specificactivity determination and enrichment. Enzyme localization.

**Unit IV.( 20h)** Measurement of enzyme activity: direct and indirect methods. Applications of enzymes in genetic engineering and biotechnology. Taq Polymerase and reverse transcriptases – their applications. Restriction endonucleases and ligases – their applications. Applications of enzyme in food, beverages and pharmaceutical industries. Enzyme-based diagnostic techniques – ELISA. Enzymes in quantitative biochemical procedures and diagnostic kits. Enzymes used as diagnostic tools. Therapeutic enzymes and their future prospects.

### References

1. Nicholas C Price, Fundamentals of Enzymology, Oxford University press, New York
2. Voet Donald & Voet Judith, Biochemistry, John Wiley & sons, US
3. Dixon & Webb, Enzymes, Academic press
4. Palmer Trevor, Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Publishing, Chichester
5. Conn E E , Stumpf P K, Bruening G and Doi R H Outlines of Biochemistry, 5 th Ed, John Wiley & Sons, New York
6. Creighton Thomas E, Proteins: Structures and molecular properties, W H Freeman &Co New York

### BC2C05 MICROBIOLOGY AND IMMUNOLOGY( 4 credits)

**Unit I.(9h)** History of microbiology –mile stones. Five kingdom classification of living systems. Prokaryotes and Eukaryotes. Various approaches used in microbial classification. Molecular level approaches used in microbial taxonomy. Microscopy: Bright field, dark field, phase contrast and electron microscopy. Specimen preparation and staining.

**Unit II. (15h)** Ultra structure of bacterial cell. Movement of substances across membranes and membrane transport systems. Cytosol and cell organelles. Storage granules, chromosome and extra cellular genetic materials. Spores, sporulation and associated production of usefult. Structure of virus, bacteriophage, fungi and protozoa. Cultivation of bacteria; Nutritional types of bacteria; phototrophs, chemotrophs, auxotrophs, and heterotrophs. Bacterial media, types of media, preparation of media, physical condition required for growth- temperature, pH, gaseous requirement etc. Culture methods- anaerobic culture method, method of isolating pure cultures. Brief account of viral and fungal cultivation. Virus attack on cells; phage attack on bacteria.

**Unit III.(8h)** Sterilization and disinfection; physical agents – dry heat, moist heat, pasteurization, autoclaving, boiling, filtration, radiation. Chemical agents – alcohol, aldehyde, dyes, halogen, phenol, surface acting agents, metallic salts. Testing of disinfectants. Rideal Walker coefficient. Microbial genetics; Spontaneous and induced mutation, UV damage and repair, replica plating, genetic transfer, bacterial transformation, transduction and conjugation.

**Unit IV.(8h)** Environmental microbiology, biochemical role of soil microorganism, nitrogen cycle, proteolysis, ammonification, nitrification, denitrification, nitrogen fixation – symbiotic and non symbiotic. Air microbiology; Source of microbes in air, factors effecting the extent and type of microorganisms in air. Air sanitation; microbiology of water and waste water. Bacteriological techniques for detecting water quality, presumptive test, confirmed and complete test.

**Unit V.(17h)** Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants . Types of immunity- innate, acquired, passive and active. Physiology of immune response, influencing factors, phagocytosis, fever, complement system. Antigens and antibody interaction- its biochemistry. Types of antigens, Structural aspects of biological antigens-determinants/epitopes, linear, conformational. Haptens; structure of immunoglobulin; synthesis and secretion of immunoglobulin molecules. Regulation. Plantibodies, Classes of Immunoglobulins, distribution and function. Organs of the immune system. Ontogeny and physiology of immune system-origin, development, activation and differentiation of B & T cell receptors.

**Unit VI.(8h)** Structure and functions of class I and class II molecules. MHC restriction. Antigen processing and presentation. Effector mechanisms of immune response; macrophage activation; Cell mediated cytotoxicity.

**Unit VII.(10h)** The complement system, classical and alternative pathway- biological functions; Immune-regulation helper and suppressor cells, immune response genes, immunological tolerance, immunosuppressive drugs and immunity. Preparations of vaccines and vaccination. Immunotherapy, Immunologic tolerance. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immune deficiencies, vaccines.

**Unit VII.(15h)**Hyper sensitivity reaction – type I reaction- components of type I reaction; mechanism of IgE-mediated degranulation, mediators, consequences, regulations, type II transfusion reactions, hemolytic disease of newborn, drug induced hemolytic anemia-type III- localized and centralized reactions. Immunological methods – interpretation and application of immunological diagnostic techniques. Immunohistochemistry- localization of antigen in cells and tissues. Hybridoma technology.

## References

1. Abbas Abdul K, Cellular and Molecular Immunology, W B Saunders Co
2. Alcamo Edward, Fundamentals of Microbiology, Jones & Barrett Publications, Massachusetts,
3. Ananthanarayanan R & Jayaram Panicker, Text Book of Microbiology, Orient Longman
4. Cappuccino James G & Sherman Natalie, Microbiology: A Laboratory Manual, Pearson Education (P), Singapore
5. Casida L E, Industrial Microbiology, New Age International publications, N. Delhi

6. Janeway Charles A and Travers Paul, Immunobiology, Blackwell scientific publications
7. Kuby Janis, Immunology, W H Freeman and company , New York
8. Lim Daniel V, Microbiology, West Publishing Co, New York
9. Mitchell Ralph, Environmental Microbiology, John Wiley & Sons Inc
10. Pelczar Michael J, Microbiology, McGraw Hill, N.Delhi
11. Reed Gerald, Prescott and Dunn's industrial Microbiology, C B S publications
12. Roitt Ivan J and Brostoff, D. Male, Mosby Publishers
13. Stainer Roger Y, General Microbiology, Macmillan, London
14. Tortora Gerard J et al, Microbiology : An Introduction, Benjamin /Cummings Co

## **BC2C06 STRUCTURAL BIOLOGY, BIOSTATISTICS AND BIOINFORMATICS( 4 credits, 90h)**

**Unit I.(18h)** Principles and practice of statistical methods in biological research. Basic statistics averages, statistics of dispersion, coefficient of variations, standard deviation, standard error, probability, distributions, tests of statistical significance, Students T-test, basics of correlation and regression, analysis of variance.

**Unit II.(18h)** Structural organization in proteins – Ramachandran Map and protein conformation. Role of individual amino acids in protein structure; amino acid propensities, Structure prediction methods. Protein engineering. Three dimensional structure of Hb, Immunoglobulins, Rubisco, Interferon, Interleukins and ATP-ase.

**Unit III.(18h)** Structure, conformation and properties of polysaccharides. Structure and conformation of nucleic acids-DNA and RNA; Different forms of DNA-A, B and Z types; Structure, properties and functions of different forms of RNAs. 3-D structure of tRNA. Organization of chromatin structure. DNA-protein interactions. Structure and properties of high-energy phosphate compounds such as ATP, GTP,CTP, phosphoarginine, acetyl phosphate and phosphocreatine. Crystallization techniques for biomolecules, Crystallography.

**Unit IV. (18h)** Computers and Bioinformatics: Computer, operating systems, File management. Technical writing- Preparation of a scientific report, Presentation of a review, Design of the experiment, Parameters used, Data obtained, Interpretation and summary

**Unit V.(18h)** Data bases, Biological data bases; sequencing and sequences of information networks, Protein information resources, Genome information resources, Internet sites, search tools, sequence including pair wise alignment, multiple sequences alignment, analysis packages; image analysis. Molecular modeling studies.

### **References**

1. Creighton Thomas E, Proteins: Structures and molecular properties, W H Freeman & Co New York
2. Lehninger's Principles of Biochemistry.W.H Freeman and company
3. Donald T Haynie, Biological thermodynamics, Cambridge university press
4. Keith Wilson & John Walker, Principles and Techniques of Biochemistry & Molecular biology Cambridge University Press

5. W W Daniel John, Biostatistics a foundation for analysis in the health sciences ( 7<sup>th</sup> ed 1999) Wiley & Sons, New York

### **BC2P03 . PRACTICAL III( 2 Credits, 5h/week))**

1. Assay of Alkaline and acid phosphatases in serum samples
2. Assay of serum amylase
3. Enzyme assays: Determination of optimum pH, optimum temperature, enzyme proportionality and time proportionality.
4. Ammonium sulfate fractionation of enzyme and desalting by dialysis/Sephadex G-25 filtration
5. Determination of total activity and specific activity of an enzyme.
6. Determination of Michaelis-Menten constant ( $K_M$ ) of an enzyme by Lineweaver-Burk method.
7. Determination of inhibitor constant ( $K_I$ ) of an enzyme by Dixon's method.
8. Extraction of enzymes from animal tissues and isoenzyme analysis by PAGE

### **BC2P04 . PRACTICAL IV( 2 Credits, 5h/week))**

1. Gram's staining
2. Acid fast staining
3. IMViC tests(indole test; methyl red test; Voges-Proskauer test, and citrate test).
4. Fermentation of carbohydrates
5. Antibiotic sensitivity test
6. Production of microbial enzymes- amylase, cellulase, lipase and pectinolytic enzymes
7. Widal test
8. VDRL test
9. ELISA
10. Immunodiffusion method
11. Immunoelectrophoresis
12. Complement fixation

## **SEMESTER III**

### **BCH 3C07 PLANT BIOCHEMISTRY AND ENVIRONMENTAL BIOCHEMISTRY( Credits 4, 72h)**

**Unit I. (15h)** Photosynthesis –Different photo systems; Light and drk reactions. Photosynthesis in C-4 plants. C-2 and C-3pathways, Photorespiration, Rubisco, CAM plants

**Unit II.(15h)** Plant pigments – structure, properties sand functions of chlorophylls, xanthophylls and carotenoids; lycopene. Secondary plant products– Flavanoids, polyphenols, coumarins, terpenoids, phytosterols steroidal alkaloids etc; Essential oils chemical composition and properties. Roles of secondary metabolites in plants.

**Unit III.(12h)** Plant alkaloids- Caffeine, theophylline, nicotine and caryophyllin. Lignin chemistry and functions; Chemistry and functions of pectin, tannins, hemicelluloses and cellulose; Chemistry of fibers. Lectins, Plant toxins ; Plant hormones and growth regulators –chemistry and functions. Plant Defense mechanisms; Phyto allelaxins – chemistry and functions.

**Unit IV.(15h)** Biochemistry of leaf senescence and abscission ; Biochemistry of fruit ripening.

Biochemistry of seed germination and dormancy. Biochemistry of nitrogen fixation –Nitrogenase enzyme – structure and functions. Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

**Unit V.(15h)**Biochemistry of humus formation. Bio-geochemical cycles – carbon cycle; nitrogen cycle, sulphur cycle, phosphorus cycle. Bioremediation and phytoremediation. Xenobiotic metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reactions/Conjugation: Methylation, Glutathione and amino acid conjugations.Detoxification. Biochemical basis of toxicity: Mechanisms of Toxicity: Disturbance of Excitable membrane function. Altered calcium Homeostasis. Covalent binding to cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.

### References

1. Buchanan B B and Gruissem W and Jones R L ,Biochemistry and Molecular biology of plants, Society of American Plant Physiologists
2. Anderson J W and Beardall J, Molecular activities of plant cell: An Introduction to Plant Biochemistry, Blackwell Science.
3. Bonner J and Varner J E, Plant Biochemistry, Academic Press, New York
4. Taiz L and Zeiger E, Plant Physiology, 2 nd Ed., Sinauer Associates, Inc Publishers,Massachusetts
5. Hopkins W G and Norman P. A, Introduction to plant physiology, John Wiley & Sons,, New York
6. Salisbury F B & Ross C W, Plant Physiology, 4 th Ed Wadsworth Publishing Company, California
7. Noggle G R and Fritz G J , Introductory Plant Physiology, Prentice Hall of India Pvt Ltd, N. Delhi
8. Stumpf, P. K. and Conn, E. E (1980). The Biochemistry of Plants: A Comprehensive Treatise. Academic Press.
9. Bell, E.A.; Charlwood, B.V. (Eds.) 1980. Encyclopedia of Plant Physiology, (New Series – Pub: Springer ) Vol. 8 : Secondary Plant Products.

### **BC3C08. MOLECULAR BIOLOGY, GENETIC ENGINEERING, PATENTING & IPR( Credits 4, 72h)**

**Unit I.(20h)** Chromosome- structure and organization. Chromatin, nucleosome, histones, Super coiling of DNA, Topoisomerases, mitochondrial DNA, chloroplast DNA. Nucleic acid as genetic information carriers. DNA replication, DNA polymerase and ligases. Regulation of DNA synthesis. Mechanism of transcription and its regulation. RNA polymerase. Post transcriptional modification. Role of histones in gene expression. Introns, exons, split genes, overlapping genes. Types of RNA; genetic code. Translation, regulation of gene expression, operons, eukaryotic gene expression, attenuation and anti-termination. DNA damage and repair. Human genome project. Genomics

**Unit II.(20h)** Restriction digestion of DNA, separation by isopycnic & agarose gel methods. Cloning vectors – plasmids, BACs, PACs & YACs, cutting & joining DNA molecules, linkers, adaptors & homopolymer tailing, DNA libraries – construction of DNA libraries, genomic & DNA libraries, PCR- different types like RT-PCR, long PCR, inverse PCR, quantitative PCR, differential display PCR, RAPD etc., probes- radio labelled DNA/RNA probes, synthetic oligonucleotide probes, cloning strategies – cloning in E.coli, yeast & gram positive bacteria, expression strategies for heterogenous genes, vector engineering & codon optimization, screening strategies, screening by hybridization,



colony hybridization, plaque lift assay, Northern, southern & western blotting, FISH, reporter assays, Genomic analysis

**Unit III.(12h)** DNA sequencing, nucleic acid microarrays, site directed mutagenesis & protein engineering, DNA introduction methods like calcium chloride facilitated uptake, micro injection, electroporation, particle bombardment, use of Ti plasmid in generating transgenic plants. Molecular markers in genome analysis: Restriction Fragment Length Polymorphism (RFLP), Random Amplified Polymorphic DNA (RAPD), Amplified Fragment Length Polymorphism (AFLP) analysis. RNA interference.

**Unit IV.(10h)** Ethical aspects of interfering in natural process; hidden dangers in altering genetic make-up. Objectives of the patent system, basic principles and general requirements of patent law, technological inventions and patent law, legal development, patentable subjects and protection in biotechnology, international convention for the protection of new varieties – Strasbourg convention, UPOV convention.

**Unit V.(10h)** The patentability of micro organisms – claims, characterization and repeatability, disposition in the culture collections, legal protection for plants and other higher organisms, new plant varieties by rights, tissue culture protocols, transfer of technology. Patentability of inanimate products of nature – vectors, Food and Drug Administration (FDA), Patent office practice – trade secrets, copy right, infringement problems, harmonization of patent law, intellectual property rights (IPR) and plant genetic resources, General Agreement on Tariffs and Trade (GATT) and trade-related aspects of intellectual property rights (TRIPS).

### **References**

1. Lodish Harvey et al, Molecular cell Biology, W. H. Freeman &
2. Friefelder, David, Essentials of Molecular Biology, Narosa Publications, N. Delhi
3. Prescott Lansing M, Harley John P & Klein Donald A, Microbiology, McGraw Hill, New York
4. Primrose S B, Principles of Gene Manipulation, Blackwell Science, U S A
5. Karp Gerald, Cell and Molecular Biology Concepts and Experiments, John Wiley & Sons Inc, New York
6. Lewin Benjamin, Genes, Wiley Eastern Ltd
7. Weaver Robert F, Molecular Biology, McGraw Hill
8. Sambrook Joseph & Russell David W, Molecular Cloning- A laboratory Manual, Cold Spring Harbor laboratory press, New York
9. W R Cornish, Intellectual property patents, copy right, trademarks and allied rights, Sweet and Maxwell, London
10. Walter E Hill, Genetic engineering: A primer, Taylor and Francis, London and New York

### **BC3C09 BIOTECHNOLOGY AND BIOSAFETY( 4 Credits, 72h)**

**Unit 1. (17h)**Totipotency. Tissue culture techniques and its applications. Callus formation; dedifferentiation, redifferentiation and morphogenesis. Composition of MS medium, Tissue

culture techniques in the production of secondary metabolites. Anther culture, Embryo culture, Somatic embryogenesis, Somaclonal variations. Protoplast fusion, Cybrids. Cell lines, cell clones, Hybridoma technology. Transgenic plants and animals. *Agrobacterium tumefaciens*, Ti plasmid and its applications, Biopesticides and bioinsecticides- *Bacillus thuringensis* Biopharming

**Unit II(15h)** Introduction to gene cloning and its potential applications. Restriction map. Production of vaccines, Gene therapy, Tissue engineering, Stem cell therapy.

**Unit III(15h)** Introduction to Environmental biotechnology, Biodegradation, Bioremediation, Biomagnification, Degradation of pesticides- residual metabolism. Role of microbes in abatement of pollution, Biofilms, Biosensors, Bioindicators, Biofertilizers, Biosurfactants.

**Unit IV(10)** Fermentation of foods; Fermentors and bioreactors, Production of antibiotics; enzymes, hormones, organic acids, alkaloids, steroids, alcohol. Production of Biopolymers. Single cell protein – Importance of spirulina. Genetically modified foods.

**Unit V(15h)** Biosafety – objectives, definition, recombinant DNA safety, classification of pathogenic microorganisms, biological containment and physical containment, biosafety levels. Guidelines for rDNA research activities – large scale experiments. Release to the environment, import and shipment, quality control of biological molecules produced by rDNA technology. Mechanism of implementation. Biosafety practices– code of practice, containment laboratory design and facilities. Large scale operations – physical containment condition for large scale fermentation experiment and production criteria for DNA.

**References:-**

1. Bhojwani S S & Razdan M K, Plant tissue culture Theory and Practice, Elsevier, London
2. Buchanan B B and Gruissem W and Jones R L, Molecular biology of plants, Society of American Plant physiologists
3. Casida L E, Industrial Microbiology, New Age International publications, N. Delhi
4. David W Mount, Bioinformatics-Sequence & genome analysis, Cold Spring Harbor Laboratory Press
5. De Robertis E D P & De Robertis E M F, Cell and Molecular Biology Saunders international edition
6. Freifelder David, Essentials of Molecular Biology, Narosa publishing House, N. Delhi
7. Hassan A Sadek, Bioinformatics- Principles and basic internet applications Trafford Publishing,
8. Karp Gerald, Cell and Molecular Biology Concepts and Experiments, John Wiley & Sons Inc, New York
9. Lewin Benjamin, Genes, Wiley Eastern Ltd
10. James Darnell, Harvey Lodish and David Baltimore; Scientific American Books, W. H. Freeman & Co., New York,
11. Micromanufacturing and Nanotechnology. N.P. Mahalik (Ed.) Springer.
12. Mitchell Ralph, Environmental Microbiology, John Wiley & Sons Inc
13. Prescott Lansing M, Harley John P & Klein Donald A, Microbiology, McGraw Hill, New York
14. Primrose S B, Principles of Gene Manipulation, Blackwell Science, U S A
15. Principles of Nanotechnology by G. Ali Mansoori. World Scientific, New Jersey.
16. Reed Gerald, Prescott and Dunn's Industrial Microbiology, C B S publications
17. Snustad Peter D & Simmons Michael J, Principles of Genetics, John Wiley & Sons Inc, USA

18. Weaver Robert F, Molecular Biology, McGraw Hill

### **BC3P05 Practical V(2 Credits, 5h/week )**

1. Using Swiss-Prot, GenBank and PDB
2. Similarity search - BLAST
3. Multiple Sequence Alignment - CLUSTAL W
4. Secondary Structure Prediction of Protein
5. Protein/Nucleotide Sequence Analysis using EMBOSS
6. Molecular Visualisation of Protein- RASMOL
7. Small molecule building using ISIS Draw and visualization using Rasmol
8. Small molecule building using ChemsSketch and visulisation using 3D viewer and Rasmol
9. Small molecule visualization using SPDBV
10. Homology modeling using SPDBV
11. Biostatistics problems

### **BC3E01 NEUROBIOCHEMISTRY(4 credits, 72h)**

**Unit I (24h)**Role of the Nervous System in Homeostasis: Cellular organization of specific regions such as cerebellum, cerebral cortex, hippocampus, retina, evolution of the nervous system – a comparative aspect. Electrophysiology of Channels: Electroencephalogram (EEG) patterns. Chemical Composition of Brain: Formation, structure and biochemistry of myelin, chemistry of major brain lipids, developmental changes, lipid composition, biosynthesis and catabolism of major lipids, characteristics of brain lipids, regional variations. Neurotransmitter: Chemistry, synthesis, storage and release of nervous neurotransmitters, transmitter action, synaptic modulation and mechanism of neuronal integration.

**Unit II. (24h)**Biochemical aspects of muscle disease, muscular dystrophies, myotonic dystrophy, periodic paralysis, glycogen storage diseases affecting muscle functions. Blood brain barrier basic(BBB) functions. Structure of the synapse, correlation of structure and function at the synapse,transmission across the synapse, pre and post synaptic events, membrane potential in the steady state action, action potential and propagation of nerve impulse.

**Unit III.(24h)** Neurotoxic agents and diseases related to them. Chemistry of neuroleptics and anxiolytics, antidepressants, hallucinogenic agents, biochemical theories of mental disorders. Neurodegenerative Disorders: Parkinson's , Alzheimer's diseases, amyotrophic lateral sclerosis, senile dementia.

### **References**

1. Basic Neurochemistry by Siegel.
2. Elements of Molecular Neurotoxicology by CUM Smith.
3. Neuromatomy Grossman & Neavy.

### **BCH3E02 NUTRITIONAL BIOCHEMISTRY(4 Credits, 72h)**

**Unit I. (10h)**Composition of human body. Energy content of foods. Measurement of energy

expenditure: direct & indirect calorimetry. Definition of basal metabolic rate (BMR) and specific dynamic action (SDA) and factors affecting these. Thermogenic effects of foods. Energy requirements of man and woman and factors affecting energy requirements.

**Unit II.(12h)** Dietary requirements and sources of available and unavailable carbohydrates. Physicochemical properties and physiological actions of un-available carbohydrates (dietary fibre).Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for man and concept of protein quality. Cereal proteins and their limiting amino acids. Protein requirement at different stages of development. Major classes of dietary lipids. Properties and composition of plasma lipo-proteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

**Unit III.(10h)** Electrolyte concentrations of body fluids. Acid base regulation by the human body.Concept of metabolic and respiratory acidosis and alkalosis.

**Unit IV.(10h)** Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper. Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water-soluble vitamins. Hypervitaminosis symptoms of fat-soluble vitamins. Nutritional requirements during pregnancy, lactation and of infants and children.

**Unit V. (10h)** Food processing and loss of nutrients during processing and cooking. Anti-nutrients: Naturally occurring food - born toxicants: Protease inhibitors, Hemagglutinins, Hepatotoxins, Allergens, Oxalates, Toxins from mushrooms, Animal food stuffs and sea foods. Protein energy malnutrition (PEM): etiology, clinical features, metabolic disorders and management of marasmus and kwashiorkor .

**Unit VI. (10h)** Techniques for the study of starvation. Protein metabolism in prolonged fasting. Protein sparing treatments during fasting. Basic concept of High protein, low caloric weight reduction diets. Definition and classification. Genetic and environmental factors leading to obesity. Obesity related diseases and management of obesity. Role of leptin in regulation of body mass.

**Unit VII.(10h)** Role of diets & nutrition in the prevention and treatment of diseases: Dental caries,Fluorosis, Hyperlipidemia, Atherosclerosis. Food allergy, Definition, Role of antigen, host and environment. Types of Hypersensitivities. Diagnosis and management of allergy.

## References

1. Modern Nutrition in Health and Diseases by Michael G. Wohl, Robert S. and Goodhart, Lea & Febiger,U.S
2. Human Nutrition and Dietetics, S Davidson and J R Passmore; ELBS, Zurich.
3. Tietz Fundamentals of Clinical Chemistry by Carl A Burtis & E R Ashwood (eds.) (5th Edn.) Saunders WB Co.
4. Lecture Notes on Clinical Biochemistry – L G Whitby, A F Smith, G J Beckett, S M Walker, Blackwell Scientific publishing

**BC3E03 . PROTEIN CHEMISTRY(4 Credits, 72h)**

**Unit I.(14h)** Chemical structures and classifications of amino acids. Chemical properties of amino acids; Amino acid derivatives; Non-protein amino acids. Biological amines and their functions; small peptides and cyclic peptides and their biological functions. Proteins: Different types;classifications, physicochemical properties of proteins

**Unit II.(14h)** structural organization of proteins, primary secondary, tertiary and quaternary structures. Protein structure – 3-D conformation of a protein molecule. Protein function in terms of biological processes, molecular function and cellular components. e.g. structural, storage, transport, hormonal, receptor, contractile, defensive, enzymatic etc.

**Unit III.(20h)** Enzymes, catalytic mechanism, active site, cofactors, coenzymes, measurement of enzyme activity, specific activity, enzyme kinetics,  $K_M$  value, Lineweaver-Burk plot, Enzyme inhibitors, activators, enzyme regulation, allosteric enzymes, enzyme immobilization, ELISA

**Unit IV.(10h)** Protein sample preparation, Separation of macromolecules (and organelles) in cells by ultra-centrifugation, Chromatography and electrophoresis, Separation techniques –2-D gel and polyacrylamide gel electrophoresis (PAGE).Protein identification – mass determination and Edman degradation

**Unit V.(14h)** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Protein data bases

### References

1. Conn E E and Stumpf P K, Outlines of Biochemistry, Wiley, N. Delhi
2. Creighton Thomas E, Proteins: Structures and molecular properties, W H Freeman & Co New York
3. Garrett Reginald H and Grisham Charles M, Biochemistry, Saunders College Publishing, Philadelphia
4. Keith Wilson & John Walker, Principles and Techniques of Biochemistry & Molecular biology Cambridge University Press
5. Lehninger Principles of Biochemistry. W.H Freeman and company
6. Plummer David T, An introduction to practical Biochemistry, Tata MacGraw Hill
7. SK Sawhney, R. Singh, Introductory Practical Biochemistry, Narosa publishing house
8. Stryer Lubert & Hall John E, Biochemistry, Freeman and company
9. Voet Donald & Voet Judith, Biochemistry, John Wiley & sons, US

### BC3E04 . CLINICAL AND DIAGNOSTIC BIOCHEMISTRY(4Credits, 72h)

**Unit I.(15h)** Basic understanding of clinical samples – Blood, CSF, urine, bile; biopsy specimens. Methods for collection and preservation of samples. Instruments used in an automated Biochemistry laboratory. Auto-Analyzers, spectrophotometer, colorimeter, hematology counter, Blood gas analyzers; ELISA reader

**Unit II.(22h)** Histochemical techniques. Disorders of carbohydrate metabolism-glycogen storage diseases; Diabetes mellitus; Galactosemia and lactose intolerance. Mucopolysaccharides.

Disorders of protein metabolism-protein energy malnutrition(PEM); Phenylketonurea and alkaptonurea; Tyrosinaemia; maple syrup urine disease (MSUD); Cystienurea; methylmalonyl urea. Urea cycle disorders; albinism. Glucose tolerance tests. Disorders of lipid metabolism- Hyperlipidemia, Hypercholesterolemia; Metabolic acidosis, disorders of ketone body metabolism, sphingolipidosis; diseases associated with lipoprotein metabolism- atherosclerosis and coronary artery diseases; fatty liver, and lipotrophic factors.

**Unit III.(20h)** Disorders of nucleic acid metabolism-Purine and pyrimidine metabolism; Uric acid and gout ; Gouty arthritis. Disorders of hormonal imbalance – Hyper and hypothyroidism, growth hormone imbalance, disorders of sex hormone imbalance, Organ functions and function tests- Liver functions and liver function test. Hepatitis, cirrhosis; jaundice, hepatic coma. Tests for the assessment kidney functions.

**Unit IV. (10h)**Cardiac function tests. Gastric function test. Disorders associated with vitamin deficiency. Disorders of mineral metabolism. Disorders of porphyrin and heme metabolism – Porphyrins – different types, Jaundice. Disorders of clotting mechanisms – Agranulocytosis; different types of anemias. Hypertension, Hematuria, thrombocytosis; Hemophilia; sickle cell anemia. Regulation of physiological pH- Different mechanisms. Buffer systems of the body. Quality control in Biochemical analysis. Concepts of accuracy, precision, reliability reproducibility and other factors of quality control; normal values, therapeutic index. Muscular dystrophy; hemophilia. Disease related to digestion and absorption of food. Achlorohydrria; ulcers gastritis; *H.pylori* - induced gastritis.

**Unit V.(5h)** Principles of diagnostic enzymology. Clinical significance of aspartate amino transferase, alanine aminotransferase, creatine kinase, aldolase, lactate dehydrogenase, Enzyme tests in determination of myocardial infarction, enzymes of pancreatic origin and biliary tract

### References

1. Devlin Thomas M, Text Book of Biochemistry with clinical correlations, Wiley Liss inc, New York
2. Zubay Geoffrey, Biochemistry, W.M. C Brown publishers
3. Murray Robert et al, Harper's Biochemistry, Appleton & Lange
4. Vasudevan D M and Sreekumari S, Text Book of Biochemistry for medical students, Jayapee Brothers, N. Delhi
5. Harold Harper, Review of Physiological chemistry, Marusan Co
6. Conn E E and Stumpf P K, Outlines of Biochemistry, Wiley, N. Delhi
7. Voet Donald & Voet Judith, Biochemistry, John Wiley & sons, US
8. Garrett Reginald H and Grisham Charles M, Biochemistry, Saunders College Publishing, Philadelphia
9. Kaplan Lawrence A et al, Clinical Chemistry, Mosby, Missouri

### SEMESTER IV

#### **BC4P06 PRACTICAL VI ( 3 credits, 8h/week)**

1. Assay of cellulase activity by agar diffusion method.
2. Estimation of ascorbic acid from plant tissues.
3. Estimation of dissolved oxygen in water
4. Preparation of media and sterilization techniques in tissue culture
5. Callus culture
6. Suspension culture of plant cells
7. Estimation of RNA by colorimetric and spectrophotometric methods.
8. Extraction of DNA and estimation of DNA by colorimetric and spectrophotometric methods.
9. Isolation of RNA from yeast.
10. Agarose gel electrophoresis of DNA.
11. Transformation
12. Hyperchromic shift on DNA melting
13. Isolation of plasmids
14. Bacterial conjugation

#### **BC4CPr Project work and viva voce( 4+3 credits)**

General instructions: The project work shall be preferably carried out within the institution. In case the project work is carried out partially or fully outside the institution, ample justification for same must be furnished in the authorized format.

While selecting topics for the project, emphasis must be given to local issues/environment.

The project shall be submitted in a generally accepted standard format. Survey of literature, use of up-to-date experimental methods, analyses of data with appropriate statistical tools, discussion etc must be adhered to.

#### **BC4E05 . GENETICS FOR BIOLOGISTS (4Credits, 72h)**

**Unit I.(14h)** Totipotency, Requirements for cell and Tissue cultures; Explant culture; callus formation, shoot culture and Micropropagation; cell culture; Protoplast fusion and somatic hybridization; Another and Pollen culture; Somaclonal variation. Possible approaches for tackling genetic disorders; Diagnosis of genetic defects; Positive eugenics; Negative eugenics; genetic counseling (antenatal diagnosis, fetus sexing).

**Unit II.(22h)** Principles of plant/animal breeding; Techniques of plant/plant breeding; Goal and objectives of plant/plant breeding; methods of crop and livestock improvement. Restriction Maps and Molecular Genetic Maps. Restriction Mapping. Restriction fragment length polymorphisms (RFLPs); Linkage and recombination between molecular and phenotypic markers; Random amplified polymorphic DNA (RAPDs) using PCR. Chromosome walking; reverse genetics and chromosome jumping.

**Unit III.(16h)** Restriction enzymes in cloning; Techniques used in recombinant DNA technology (Polyacrylamide gel electrophoresis, Southern, Northern and Western blotting); Cloning vectors for recombinant DNA; cloning in bacteria, Molecular probes, Construction and screening of genomic and c DNA libraries; PCR and its applications.

**Unit IV.(10h)** Isolation of genes (genes with Tissue specific expression; mutant complementation, transposon tagging); Sequencing of genes (Maxam-Gilbert' method); Synthesis of genes (organochemical synthesis of tRNA gene and interferon gene).

**Unit V.(10h)** Gene transfer methods for animals and plants; Agro-bacterium mediated gene transfer, electroporation and particle gun. Transgenic animals (mouse and rabbit); Transgenic plants (Herbicide insect and virus resistance).

### References

1. General Genetics Adrian M. Srb, Ray D. Owen, and Robert S. Edgar. W.H. Freeman and company
2. Benjamin Lewin Genes, Oxford University Press.
3. Molecular Biology of Gene, Watson *et al.* W.H Freeman and company

### BC4E06. BIOCHEMICAL AND ENVIRONMENTAL TOXICOLOGY (4 Credits, 72 h)

**Unit I.(10h)** Eco-toxicology and its environmental significance. Toxic effects: Basis for general classification & nature. Dose – Response relationship: Synergism and Antagonism, Determination of ED50 & LD50. Acute and Chronic exposures. Factors influencing Toxicity. Pharmacodynamics & Chemodynamics.

**Unit II.(15h)** Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reactions/Conjugation: Methylation, Glutathione and amino acid conjugations. Detoxification. Mechanisms of Toxicity: Disturbance of Excitable membrane function. Altered calcium Homeostasis. Covalent binding to cellular macromolecules & Genotoxicity. Tissue specificity of Toxicity.

**Unit III.(15h)** Principles & Procedures of testing for acute toxic effects: Regulatory guidelines, Mammalian systems affected & the clinical signs of Systemic Toxicity. Factors affecting acute Toxicity studies. Toxicity testing: Test Protocol, Genetic toxicity testing & Mutagenesis assays: *In vitro* test systems – Bacterial mutation tests: Reversion test, Fluctuation tests and Eukaryotic Mutation Tests. *In vivo* Mammalian Mutation tests – Host-mediated assay & Dominant Lethal Test. Use of *Drosophila* in Toxicity testing. DNA repair assays. Chromosome damage test. Toxicological evaluation of Recombinant DNA – derived proteins.

**Unit IV.( 12h)** Pesticide toxicity: Insecticides: Organochlorines, Anticholinesterases – Organophosphates and Carbamates. Fungicides. Herbicides. Environmental consequences of pesticide toxicity. Biopesticides. Diagnosis of toxic changes in liver and kidneys: Metabolism of haloalkanes, haloalkenes & paracetamol with their toxic effects on tissues.

**Unit V.(10h)** Food toxicology: Role of diet in cardio-vascular diseases and cancer. Toxicology of food additives. Metal toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors affecting metal toxicity – effect of light, temperature & pH.

**Unit VI.(10h)** Air pollution: Common air Pollutants & their sources. Air pollution & ozone. Air pollution due to chlorofluorocarbons (CFCs) and asbestos. Occupational toxicology & assessment of occupational hazards: Industrial effluent toxicology & Environmental health. An overview of



regulatory agencies: Responsibilities of regulatory agencies. Management of Toxicological risk. Regulatory approaches. Regulatory systems & organizations.

### **References**

1. General and Applied Toxicology by Marrs and Turner, Macmillan Press Ltd.
2. Basic Environmental Toxicology by Lorriss G. Corkerthm and Barbara S S Shane CRP Press Inc.
3. Introduction to Food Technology by Takayurki Shibamoto & Leonard F. Bzeldanes.
4. Molecular Biotechnology by Barnard R Glick & J J Pastmak.

### **BC4E07 BIOCHEMICAL ENGINEERING(4Credits, 72h)**

**Unit I.(12h)** Introduction to bioscience. Types of Microorganisms: Structure and function of microbial cells. Fundamentals of microbial growth, batch and continuous culture. Isolation and purification of enzymes from cells. Assay of Enzymes.

**Unit II.(20h)** Functioning of cells and fundamental molecular biology. Metabolism and bioenergetics, Photosynthesis, carbon metabolism, EMP pathway, tricarboxylic cycle and electron transport chain, aerobic and anaerobic metabolic pathways. Synthesis and regulation of biomolecules, fundamentals of microbial genetics, role of DNA and RNA.

**Unit III.(16h)** Enzyme technology and kinetics. Applied Enzyme catalysis, Applications of enzymes in industry and medicine. Immobilization of enzymes. Kinetics of enzyme catalytic reactions involving isolated enzymes. Reversible inhibition.

**Unit IV.(12h)** Reactions catalysed by enzymes, reactors, analysis. Reactor Design and Analysis for soluble enzyme systems. Cofactor regeneration. Membrane reactor. Effect of mass transfer in immobilized enzyme particle systems. Reactors for immobilized enzyme systems.

**Unit V.(12h)** Bio reactors, effect of transport processes: Introduction to Bioreactor design: continuously stirred aerated tank bioreactors. Mixing power correlation. Determination of volumetric mass transfer rate of oxygen from air bubbles and effect of mechanical mixing and aeration on oxygen transfer rate, heat transfer and power consumption. Multiphase bioreactors and their applications. Downstream processing and product recovery in bioprocesses.

### **References**

1. J. E. Bailey and D. F. Ollis. "Biochemical Engineering Fundamentals", McGraw Hill, New York
2. Trevan, Boffey, Goulding and Stanbury, "Biotechnology", Tata McGraw Hill Publishing Co., New Delhi
3. M. L. Shuler and F. Kargi, "Bioprocess Engineering: Basic concepts", Prentice Hall

### **BC4E08 CANCER BIOLOGY(4Credits, 72h)**

**Unit I. (14h)** Tumorigenesis. Chemical and physical carcinogenesis – theories of carcinogenesis – transformation of animal cells by tumor viruses – characteristics of transformed cells – virus host interactions – morphological and biochemical studies – oncogenes.

**Unit II. (14h)** Mechanisms of tumor metastases. Metastatic cascade – survival of tumors in blood and lymphatics – invasion characteristics of cancer causing agents – role of growth factors in carcinogenesis – tumor markers – cell adhesion molecules – extracellular matrix molecules – proteoglycans and tumor metastasis.

**Unit III. (12h)** Antitumor agents. Antibiotics, toxins, immunoconjugates and immunomodulators, chemoprevention of cancer through dietary and nutritional agents, live and killed viral vaccines, vaccines based on vaccinia virus.

**Unit IV. (20h)** Classification of viruses. Virus at molecular level; replication and plaque assay; LD50, host specificity, physical and chemical properties; various types of viruses including DNA, RNA viruses.

**Unit V. (12h)** Viral vectors. Strategies for developing viruses as cloning vectors; vaccinia and cytomegalovirus (CMV) vectors; properties, selection and cloning strategies.

## **References**

1. Maly B.W.J. Virology a practical approach, IRL Press, Oxford
2. Dimmock N.J. and Primrose S.B. Introduction to modern virology, Wiley-Blackwell.
3. Franks L. M. and Teich N.M. An introduction to cellular and molecular biology of cancer, Oxford University press

**Model question paper**  
**M.Sc Biochemistry (CUCSS, PG)**  
**(pattern only)**

TIME: THREE HOURS

MAXIMUM WEIGHTAGE: 36

Section A

Answer any 14 questions. Each question carries weightage of 1

- 1
- 2
- 3
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14×1=14 weightage

Section B

Answer any 7 questions. Each question carries weightage of 2

- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25

7×2=14 weightage

Section C

Answer any 2 questions. Each question carries weightage of 4

- 26

27  
28

2×4=8weightage