

**SCHEME FOR B.Sc. BIOCHEMISTRY DEGREE (LRP/ ALTERNATIVE PATTERN)  
UNDER CHOICE BASED CREDIT SEMESTER SYSTEM UG (CBCSS-UG)**

Sem	Course type	Code	Name Of Paper	Hours /week	Credits
<b>First</b>	Common	ENGL A01	Common English Course 1	4	3
	Common	ENGL A02	Common English Course II	5	4
	Additional Language	A07	Additional Language Course I		4
	Complementary		Food Science <b>OR</b> General Microbiology + Practical I	4	2
	Complementary		General Chemistry	4	2
	Core	BCH1B01	Introduction To Biochemistry & Cell Biology	3	3
<b>Second</b>	Common		Common English Course III	4	3
	Common		Common English Course IV	5	4
	Additional Language	A08	Additional Language Course II		4
	Complementary		Fundamentals of Nutrition <b>OR</b> Microbial Metabolism & Genetics + Practical II	4	2 3
	Complementary		Physical Chemistry	4	2
	Core	BCH2B02	Biomolecules	3	3
<b>Third</b>	Complementary		Nutrition through Lifecycle <b>OR</b> Applied Microbiology+ Practical III	5	2
	Complementary		Organic Chemistry	5	2
	General	A11	General Course I	4	4
	General	A12	General Course II	4	4
	Core	BCH3B03	Techniques in Biochemistry	3	3
	Core	BCH3B04	Enzymology	2	2
	Core	BCH3B05	Practical I (core)	2	-
<b>Fourth</b>	Complementary		Dietetics + Practical –Dietetics <b>OR</b> Medical Microbiology & Immunology + Practical IV	3+2	2 3

Fifth fourth	Complementary		Physical and Applied Chemistry	3	2
	Complementary		Chemistry Practical	2	2
	General	A13	General Course III	4	4
	General	A14	General Course IV	4	4
	Core	BCH4B06	Intermediary Metabolism I	3	3
	Core	BCH4B07	Intermediary Metabolism II	2	2
	Core	BCH3B05& BCH4B08	Practical I (Carbohydrates, Lipids, Amino Acids, Proteins, Nucleic Acids, and Techniques)	2	4*
Fifth	Core	BCH5B09	Plant Biochemistry	2	2
	Core	BCH5B10	Human Physiology	3	3
	Core	BCH5B11	Immunology & Microbiology	4	4
	Core	BCH5B012	Clinical & Nutritional Aspects of Biochemistry	4	4
	Core		Open course	2	3
	Core	BCH5B013	Practical II ( Clinical and Enzymology)	10	-*
Sixth	Core	BCH6B014	Classical Genetics and Molecular Biology	4	4
	Core	BCH6B015	Recombinant DNA Technology	4	4
	Core	BCH6B016	Molecular Endocrinology	3	3
	Core	BCH5B013& BCH6B017	Practical II ( Clinical and Enzymology)	-	4
	Core	BCH6B018	Practical III ( Molecular Biology, Immunology and Nutritional Biochemistry)	10	5
	Core	BCH6B019	Project	4	2

- **No exams for practicals in odd semester**

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**SCHEME FOR B.SC. BIOCHEMISTRY DEGREE (LRP/ ALTERNATIVE PATTERN)**  
**UNDER CHOICE BASED CREDIT SEMESTER SYSTEM UG (CBCSS-UG)**  
**CORE COURSES offered by B.Sc. Biochemistry**

Sem	Code	Name Of Paper	Hours/ week	Credits	Marks		
					Internal	External	Total
First	BCH1B01	Introduction To Biochemistry & Cell Biology	3	3	15	60	75
Second	BCH2B02	Biomolecules	3	3	15	60	75
Third	BCH3B03	Techniques in Biochemistry	3	3	15	60	75
	BCH3B04	Enzymology	2	2	15	60	75
	BCH3B05	Practical I (Carbohydrates, Lipids, Amino Acids, Nucleic Acids, and Techniques)	2	-	-	-	-
Fourth	BCH4B06	Intermediary Metabolism I	3	3	15	60	75
	BCH4B07	Intermediary Metabolism II	2	2	15	60	75
	BCH3B05& BCH4B08	Practical I (Carbohydrates, Lipids, Amino Acids, Proteins, Nucleic Acids, and Techniques)	2	4	20	80	100
Fifth	BCH5B09	Plant Biochemistry	2	2	15	60	75
	BCH5B010	Human Physiology	3	3	15	60	75
	BCH5B011	Immunology & Microbiology	4	4	20	80	100
	BCH5B012	Clinical & Nutritional Aspects of Biochemistry	4	4	20	80	100
		Open course	2	3	15	60	75
	BCH5B013	Practical II ( Clinical and Enzymology)	10	-	-	-	-
Sixth	BCH6B014	Classical Genetics and Molecular Biology	4	4	20	80	100
	BCH6B015	Recombinant DNA Technology	4	4	20	80	100
	BCH6B016	Molecular Endocrinology	3	3	15	60	75
	BCH5B013& BCH6B017	Practical II ( Clinical and Enzymology)	-	4	20	80	100
	BCH6B018	Practical III ( Molecular Biology, Immunology and Nutritional Biochemistry)	10	5	20	80	100
	BCH6B019	Project	4	2	15	60	75
				<b>58</b>			<b>1525</b>

**Common courses offered by B.Sc. Biochemistry course in 3<sup>rd</sup> and 4<sup>th</sup> semesters (Designed by the Board)**

Sem	Code	Name Of Paper	Hours/week	Credits	Marks		
					Internal	External	Total
Third	A11	General Course I	4	4	20	80	100
	A12	General Course II	4	4	20	80	100
Fourth	A13	General Course III	4	4	20	80	100
	A14	General Course IV	4	4	20	80	100
	Total			<b>16</b>			<b>200</b>

**OPEN COURSES offered by BSc. Biochemistry course in 5<sup>th</sup> semester  
(Semester 5: Credit: 3 : hours/ week 2)**

1. BCH5D01 Elementary Biochemistry
2. BCH5D02 Life Style Diseases
3. BCH5D03 Clinical Diagnosis of Common Diseases

**DISTRIBUTION OF DIFFERENT COURSES AND THEIR CREDITS**

Semester	Course type	No of Courses	Credits
I and I	Common English Course	4	14
I and II	Additional Language Course	2	8
III and IV	General	4	16
I to IV	Complementary	10	24
I to VI	Core	16	53
V	Open (other dept.)	1	3
VI	Project (core)	1	2
<b>Total</b>			<b>120</b>

**Total credits for the core courses 55**

**Credits for the open course 3**

**Total marks for the core course 1525**

## SEMESTER I

### BCH1B01: INTRODUCTION TO BIOCHEMISTRY & CELL BIOLOGY

TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3

#### UNIT I: General Introduction & Laboratory Practices (10 hrs)

A brief study of the foundations of biochemistry (cellular, chemical & physical foundations – fundamental study only). Laboratory safety requirements & precautions. Safe handling & disposals of chemicals, biological & other samples. Radioactive materials. Management of laboratory accidents & injuries.

#### UNIT II: Water, Acids, Bases & Buffer (15 hrs)

Dissociation of water, ionic product of water, concepts of pH, pOH, simple numerical problems of pH, determination of pH using indicators, pH meter & theoretical calculations. Dissociation of weak acids & electrolytes, bronsted theory of acids and bases, shapes of titration curve of strong and weak acids and bases. Meaning of  $K_a$  and  $pK_a$  values, buffers and buffer action. Buffers in biological system. Henderson-Hasselbalch equation with derivation. Simple numerical problems involving the application of this equation.

Molecular interactions (Brief study): Noncovalent interactions: Hydrogen bonding, Vander Waal interactions, electrostatic interactions, hydrophobic interactions, Covalent interactions.

#### UNIT III: Solutions (8hrs)

Meaning of normality, molarity, molality, percentage solution, mole fractions: simple numerical problems from the above. Principle of diffusion & osmosis. Biological importance of osmosis. Definition of osmotic pressure, isotonic, hypotonic & hypertonic solutions. Relationship of osmotic pressure to gas laws. General equation for dilute solutions, the influence of ionization & molecular size on osmotic pressure.

Meaning of true solution, colloidal solution, and coarse suspension. Distinction between lyophilic and lyophobic sols. Elementary study of charge on colloids, Tyndall effect. Donnan equilibrium & its application in the biological system. Membrane permeability, Emulsion & emulsifying agents.

#### **UNIT IV: Ultrastructure of cell (10hrs)**

Ultrastructure of cell: prokaryotic and eukaryotic cell. Nucleus, chromosomes, mitochondria, chloroplast, ribosomes, endoplasmic reticulum, Golgi complex, lysosomes, microfilaments, microtubules and intermediate filaments, glyoxysomes, and peroxisomes. Plasma membrane-structure & composition. Subcellular organelles and marker enzymes.

#### **Unit V: Transport mechanisms (6 hrs)**

Transport across the membranes – definition. Simple diffusion facilitated transport – symport, uniport & antiport. Active transport ( $\text{Na}^+$ -  $\text{K}^+$  ATPase). Ion channels, ionophores.

#### **UNIT VI: Cell-Cell Interactions (13 hrs)**

Cell-cell interaction and cell-matrix interaction. Cell-cell adhesion, Catherins, desmosomes, gap junction & tight junction, Cell signaling (A brief study).

#### **UNIT VII: Cell Cycle & Cell Death (10 hrs)**

Cell Cycle: Different phases including cell division - mitosis & meiosis.

Cell Death: Apoptosis: Intrinsic and extrinsic pathways. Difference between apoptosis & necrosis.

#### **References**

1. D.L. Nelson and M. M. Cox. Lehninger's Principles of Biochemistry: Worth Publishers, 41 Madisons Avenue New York, USA.
2. B. R. Puri, L.R. Sharma, and S. P. Madan. Principles of Physical Chemistry: Vishal Publishing Company. Gumber Market, Old Railway Road, Jalandhar.
3. E.S. West, W.R. Todd, H.S. Mason, and J.T. van Bruggen, A Text Book of Biochemistry. Oxford and IBH Publishing Co., New Delhi, 1974.
4. R.N Roy, A Textbook of Biophysics: For Medical Science and Biological Science Students, New Central Book Agency; 2nd Revised edition edition, 2001
5. Debajyoti Das. Biochemistry, Academic Publishers, 1978.
6. Pranab Kumar Banerjee. Introduction to Biophysics, Publishers: S. Chand& Company Ltd. 2008.

7. Hiram. F. Gilbert. Biochemistry: A Students survival Guide by Publishers: McGraw-Hill, 2002.
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- 11.J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry Publishers: S. Chand & Co Ltd. New Delhi. 2008
- 12.Cooper GM. The Cell: A Molecular Approach. 2nd edition. Sunderland (MA): Sinauer Associates; 2000
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- 14.Gerald Karp. Cell Biology (7th ed.) John Wiley & Sons. 2014.
- 15.Lodish H, Berk A, Zipursky SL, et al. Molecular Cell Biology. 6th edition. New York: W. H. Freeman; 2007.
- 16.Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. Biochemistry. 9th edition, W. H. Freeman and Company. New York, 2019.
- 17.A.C. Deb, Fundamentals of Biochemistry, 7th Edition, New Central Book Agency-Kolkata, 2001.
- 18.B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Molecular Biology of the Cell, Garland Publishing Inc., New York, 1983.
- 19.E.D.P. Robertis and De Robertis, Cell and Molecular Biology. Published by Lippincott Williams & Wilkins, 1981.
- 20.Chris Smith and Ed Wood. Cell Biology, Garland Science, 1996.

## **SEMESTER II**

### **BCH2B02: BIOMOLECULES**

**TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3**

#### **Unit I Carbohydrates (10 hrs)**

Definition and classification, Isomerism of carbohydrates: optical isomerism and stereoisomerism, 'd' and 'l' D and L forms of compounds. Glyceraldehyde as an example. R and S nomenclature of enantiomers. Examples of epimers, mutarotation and its explanation, anomeric forms. Classification of monosaccharides, linear and cyclic structure (glucose, galactose, mannose, ribose, and fructose). Reactions and characteristics of aldehyde and keto group, action of acids and alkalies on sugars, reactions of sugars due to hydroxyl group. Disaccharides- structure, occurrence, chemistry, and functions of sucrose, lactose, maltose, isomaltose and cellobiose. Homopolysaccharides: occurrence, structure, chemistry, and functions of cellulose, starch, glycogen, chitin and inulin. Heteropolysaccharides: occurrence, types, composition, and function. Sugar derivatives: sugar alcohols, sugar acids, amino sugars, deoxy sugars, and their relevance.

## **Unit II. Lipids (8 hrs)**

Definition, basic ideas about the biochemical functions of lipids. Classification of fatty acids, physical and chemical properties of fatty acids saponification number, acid number and iodine number and their application. Structure of the following fatty acids – stearic acid, oleic acid, linoleic acid. Essential and non-essential fatty acids with examples. Classification of lipids with structure and examples- simple lipids; (triacylglycerol), Compound lipids: storage and membrane lipids. Structure and functions of phospholipids and glycolipids derived lipids; Steroids: Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol. Eicosanoids – definition & classes only.

## **Unit III Amino acids and Proteins (6 hrs)**

Amino acids: Definition, stereoisomerism, the structure of 20 'protein amino acids' - Three letter and single letter abbreviations of amino acids, and novel amino acids: selenocysteine and pyrrolysine.

Classification of amino acids based on charge and polarity, general reactions of amino acids-side chain, carboxyl and amino group- essential and nonessential amino acids.

Ionization of amino acids. Zwitterion, isoelectric point for amino acids.

## **Unit IV Proteins (10 hrs)**

Basic ideas about the classification (including solubility characteristics) and functions of proteins. Peptides: Formation of the peptide bond. Structure of glutathione, oxytocin, and



vasopressin. Elementary study of primary, secondary, tertiary and quaternary structure of proteins, Ramachandran's plot, forces stabilizing the proteins. Endpoint determination of primary structure- N-terminal, C-terminal residues (one method each). Chemical reactions, purification, precipitation reactions - salt and heavy metal precipitation, denaturation, renaturation and precipitation of proteins. Color reactions for proteins. Sequencing of proteins (basic principles of the methods employed).

### **Unit V Nucleic acids (8 hrs)**

Structure of common purine and pyrimidine bases, tautomeric forms of bases, structure of nucleosides and nucleotides.-unusual bases in nucleic acids. cAMP structure. DNA: Double helix (Watson and Crick model) A, B, and Z forms of DNA, physical properties of DNA (conformational variants). Introduction to circular DNA, supercoiling, helix to random coil transition – denaturation of nucleic acids, hyperchromic effect, T<sub>m</sub>-values, cot curves, and their significance. Types of RNA- (t-RNA, r-RNA, m-RNA). Elementary study of the structures of these RNAs. Sequencing of DNA (basic principles of the methods employed).

### **Unit VI. Vitamins and Minerals (6hrs)**

Definition, classification- fat soluble and water soluble-, sources, chemical nature (without structure), functions of vitamins. Macro minerals (Ca, P, Mg, Na, K, Cl) and micro minerals/trace elements (Co, I, Fe, Mn, Zn, and F)-their sources, daily requirements, functions and deficiency diseases.

### **UNIT VII Introduction to bioinformatics (6 hrs)**

Importance, scope of Bioinformatics. Introduction to Biological databases, Types of Biological data bases, primary and secondary sequence databases. Genbank, SCOP, NCBI, gene bank, CATH, Expasy, PIR, Prosite, PDB. Basics of sequence alignment -pair wise and multiple sequence alignment- Global and local alignment. BLAST, FASTA. Application of Bioinformatics - Drug designing and molecular docking, Homology modeling, Phylogenetics, Microarrays.

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1. D.L. Nelson and M. M. Cox. Lehninger's Principles of Biochemistry: Worth Publishers, 41 Madisons Avenue New York, USA.

2. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance. Principles of Biochemistry, Publisher McGraw-Hill Education, 1995
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- 19.David. W. Mount .Bioinformatics: Sequence and Genome Analysis.CBS publishers.

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- 21.S.C.Rastogi, N Mendiratta, P.Rastogi. Bioinformatics methods and Application: genomics, proteomics and drug discovery, Prentice Hall India Learning Private Limited, 2013.
- 22.T.K Atwood and D.J Parry. Introduction Bioinformatics, Smith Publisher. Pearson Education Pvt Ltd. 2002.

### **SEMESTER III**

#### **BCH3B03    TECHNIQUES IN BIOCHEMISTRY**

**TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3**

#### **Unit I Cell disruption techniques (6 hrs)**

Methods of tissue homogenization. Salt and organic solvent extraction and fractionation. Dialysis, Reverse dialysis, ultra filtration, lyophilization, sonication, protein crystallization (brief study).

#### **Unit II Chromatography (10 hrs)**

Principle, procedure and application of following chromatographic techniques: partition chromatography- paper chromatography, adsorption chromatography, TLC, HPTLC, ion exchange chromatography, gel chromatography, affinity chromatography, GLC and HPLC.

#### **Unit III Electrophoresis (10 hrs)**

Principle, procedure and application of free flow, zone electrophoresis (Paper electrophoresis, membrane electrophoresis Gel electrophoresis, PAGE, SDS-PAGE and disc PAGE). Isoelectric focussing, high voltage electrophoresis, pulse field electrophoresis, immunoelectrophoresis. 2D electrophoresis.

#### **Unit IV Centrifugation (8hrs)**

Principle of sedimentation technique. Relationship with rpm and radius of rotation. RCF and centrifugal force (xg). Different types of centrifuge and rotors. Principle, procedure and

application of differential centrifugation, density gradient centrifugation, ultra centrifugation, rate zonal centrifugation, isopycnic centrifugation.

### **Unit V Colorimetry and spectrophotometry (10 hrs).**

Laws of light absorption -Beer - Lambert law. UV and visible absorption spectra, molar extinction coefficient and quantitation. Principle and instrumentation of colorimetry and spectrophotometry. Principle of nephelometry, fluorometry, atomic absorption and emission spectrophotometer.

### **Unit VI. Radio isotopic methods (10 hrs)**

Isotopes, isobars, ionizing and nonionizing radiations. Principle and application of RIA. Measurement of radioactivity by GM counter and Scintillation counter. Autoradiography.

### **References**

1. Pranab Kumar Banerjee. Introduction to Biophysics by Publishers: S. Chand & Company Ltd. 2008.
2. Friefelder D. Physical Biochemistry- Application to Biochemistry and Molecular Biology. WH Freeman and Company
3. Ed. K. Wilson and J. Walker. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
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- 15.Avinash, Biophysical Chemistry Principles & Techniques Handbook, 2003
- 16.Upadhyay, Kakoli Upadhyay, Nirmalendu Nath , Biophysical chemistry, Himalaya Publishing House
- 17.Gurumani N. Research Methodology For Biological Sciences. Mjp Publishers, 2006
18. M.S. Yadav. Instrumental Methods Of Chemical Analysis Publisher: Campus Books International, 2006

#### **BCH3B04 ENZYMOLOGY**

**TOTAL HOURS: 36, CREDITS: 2, HOURS/WEEK: 2**

##### **Unit I Introduction and Classification of enzymes (4 hrs)**

Introduction to enzymes. History. Proteins as enzymes.(Briefly mention about ribozymes and abzymes). Definition and examples of holoenzyme, apoenzyme and prosthetic group.

Classification of enzymes: IUPAC system of classification and nomenclature of enzymes: (Class and subclass with one example).

Units of activity; specific activity- definition and significance. International unit (IU) and Katal.

##### **Unit II Coenzymes and cofactors (5 hrs)**

Definition: examples of a) metal ions b) coenzymes c) prosthetic group. Coenzymes and their functions- NAD, NADP<sup>+</sup>, FAD, FMN, lipoic acid, TPP, pyridoxal phosphate and biotin. ( structure and one reaction each)

### **Unit III Enzyme catalysis and Mechanism of enzyme action (4 hrs)**

Specificity of enzymes and types (with example), Concept of active site, 'Lock and key' model of Emil Fischer, Koshland's induced fit theory of enzyme catalysis. Nature of non-enzymatic and enzymatic catalysis. Transition state, energy of activation.

### **Unit IV Enzyme kinetics (5 hrs)**

Order of reactions. Study of the factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators -Derivation of Michaelis - Menten equation.  $K_m$  value determination and its significance, Definition of  $V_o$  and  $V_{max}$  value of enzyme catalyzed reaction and its significance, Lineweaver-Burk plot (Only for single substrate enzyme catalyzed reaction).  $K_{cat}$  (turnover number) and significance.  $K_{cat}/K_M$  ratios for determining catalytic efficiency.

### **Unit V Enzyme regulation (8 hrs)**

Enzyme inhibition: Reversible and irreversible – examples. Reversible- competitive, noncompetitive and uncompetitive inhibition - explanation of inhibition types with double reciprocal plot and examples of each type of enzyme inhibition. Antibiotic inhibitors of enzymes- penicillin, sulfa drugs, methotrexate etc. Inhibitors as tools in biochemical studies.

Types of enzyme regulations in body- reversible covalent modification with examples of phosphorylation and adenylation (glycogen phosphorylase and glutamine synthetase); allosteric regulation (aspartate transcarbamoylase); isoenzymes (lactate dehydrogenase and creatine phosphokinase); zymogens (pepsin, trypsin). Multienzyme complex and their role in regulation of metabolic pathways (Brief study).

### **Unit VI Isolation, purification and characterization of enzyme (4hrs)**

General protocol: Solubilization, and extraction from sample; fractional precipitation (salting out, pH, heat, organic solvents etc.). Purification: by chromatography (exclusion, ion exchange,

adsorption, affinity); by electrophoresis (PAGE); isoelectric focusing. Criteria of purity: immunological, ultracentrifugation etc.

### **Unit VII Immobilization of enzymes (4 hrs)**

Different methods of immobilization of enzymes (brief mention only). Industrial and clinical uses of enzymes: detergent enzymes, as food additive, and in other industrial application (give examples: thermo stable alpha amylase, papain, chymotrypsin etc.). Use of enzymes in ELISA.

### **References**

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H.Freeman and Company, N.Y., USA.
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13. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. Robert A. Copeland. Wiley-VCH, Inc.2000
- 14.J. L. Jain Sunjay Jain and Nitin Jain. Fundamentals of Biochemistry by, Publishers: S. Chand & Co Ltd. 2008
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Robert A. Copeland. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. John Wiley & Sons, Inc., Publication, 2000.

### **BCH3B05: PRACTICAL I**

**(CARBOHYDRATES, LIPIDS, AMINO ACIDS, NUCLEIC ACIDS, AND TECHNIQUES)**

**TOTAL HOURS: 36, HOURS/WEEK: 2**

1. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
2. Standardization of pH meter, preparation of buffers, emulsions.
3. Qualitative analysis: Carbohydrates- general reactions of carbohydrates, Proteins, amino acids and lipids
4. Schematic analysis of biochemical substance in the given solution or biological solutions (carbohydrate, protein, amino acid and lipids)

#### **References:**

1. T.N. Pattabiraman. Laboratory manual & practical Biochemistry, 4th Edition, All India publishers and distributors, 2015
2. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Cambridge University Press 2010
3. David Plummer. An Introduction to Practical Biochemistry, McGraw Hill Education, 2017
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5. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
6. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
7. Vasudevan, Practical textbook of Biochemistry for medical students, Jaypee Brothers Medical Publishers, 2013
8. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
9. Beedu Sasidhar Rao & Vijay Deshpande Experimental Biochemistry: A Student Companion, I.K International Pvt. LTD, New Delhi
- 10.S. K. Sawhney & Randhir Singh. Introductory Practical biochemistry, Narosa Publishing House, New Delhi.
- 11.R.C. Gupta & S. Bhargava. Practical Biochemistry, CBS Publishers and Distributors, New Delhi.
- 12.Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company
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#### **SEMESTER IV**

#### **BCH4B06 INTERMEDIARY METABOLISM I**

**TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3**

#### **Unit I. Bioenergetics (6 hrs)**

Introduction, Thermodynamics (Brief study) and relevance in biological system (Brief study). Free energy change. Difference between  $\Delta G$  and  $\Delta G^{\circ}$ . Requirement of free energy for cells,

coupling reactions, free energy of ATP hydrolysis, ATP as universal currency in biological system, Role of high energy phosphates in energy transfer -redox potential, biological oxidation.

### **Unit II Introduction (6 hrs)**

Catabolism and anabolism, metabolic pathways, experimental approaches in metabolism. Compartmentalization of metabolic pathways in cells and energy conversation. Approaches to study metabolism: using intact animals, bacterial mutants, *in vitro*, and radioactive isotopes

### **Unit III Carbohydrate metabolism (15 hrs)**

Structures, energetics and regulation of pathways : Glycolysis (aerobic and anaerobic), entry of other sugars into glycolytic pathway, TCA cycle, HMP shunt, gluconeogenesis, galactose and fructose metabolism, anaplerotic reactions, glyoxalate cycle. Synthesis of starch. Glycogen Metabolism: Glycogenesis, glycogenolysis and Cori cycle. Regulation of committed step in each pathway.

### **Unit IV Electron Transport Chain (15 hrs)**

Structure of mitochondria, sequence of electron carriers: NADH ubiquinone dehydrogenase, Succinate dehydrogenase, cytochrome reductase and cytochrome oxidase (outline of electron transport chain), Structure of ATP synthase -inhibitors of electron transport chain. Oxidative phosphorylation: Sites of ATP production, Chemiosmotic theory (an outline), P/O ratio, inhibitors and uncouplers, transport of reducing potentials into mitochondria.

### **Unit V Metabolism of lipids (12 hrs)**

Fatty acid synthase complex, Biosynthesis of fatty acids, Fatty acid elongation.  $\beta$ -oxidation of palmitic acid and its energy balance sheet. Ketogenesis; Cholesterol biosynthesis (structure not needed) and significance. Synthesis of steroid hormones from cholesterol (structure not needed). A brief account of committed steps in steroid metabolic pathway.

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3. Debajyoti Das. Biochemistry, Academic Publishers, 1978.

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13. Richard J. Simmonds. Chemistry of Biomolecules: an Introduction. Publisher: Royal Society of Chemistry.
14. Christopher K. Mathews, Kensal E. van Holde, Kevin G. Ahern. Biochemistry. Published by Pearson; 3 edition, 1999.
15. Geoffrey L. Zubay, William W. Parson, Dennis E. Vance. Principles of Biochemistry, Publisher McGraw-Hill Education, 1995
16. Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. Biochemistry. 9th edition, W. H. Freeman and Company • New York, 2019.
17. A.C. Deb, Fundamentals of Biochemistry, 7th Edition, New Central Book Agency-Kolkata, 2001.
18. E. E. Conn and P. K. Stumpf, Outlines of Biochemistry, John Wiley & Sons, New York, 1987.
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21. Richard J. Simmonds. Chemistry of Biomolecules: an Introduction. Publisher: Royal Society of Chemistry.

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24. Ferrier, Lippincott's Illustrated Reviews Biochemistry, Wolters Kluwer India Pvt. Ltd 2017.

## **BCH4B07 INTERMEDIARY METABOLISM II**

**TOTAL HOURS: 36, CREDITS: 2, HOURS/WEEK: 2**

### **Unit I (12 hrs)**

Metabolism of amino acids and proteins: Protein turn over, proteolytic enzymes. transamination, oxidative deamination, reductive amination, non-oxidative deamination and decarboxylation of amino acids. Brief outline of metabolism of aromatic amino acids (reactions with structures), glycine, valine and methionine. Metabolic fate of amino acids- glucogenic, ketogenic and gluco-ketogenic. Urea cycle. Details on committed steps in the cycle.

### **Unit II (12 hrs)**

Metabolism of nucleotide -Biosynthesis of purine and pyrimidine nucleotides –de novo and salvage pathway (structure not required); end products of purine and pyrimidine metabolism. Details on committed steps in the metabolic pathway.

### **Unit III Photosynthesis and plant metabolism (12 hrs)**

Ultra structure and organization of chloroplast membranes, structure and functions of chlorophylls, xanthophylls and carotenoids and other plant pigments. Functions and mechanism of action of photoreceptor proteins in plants. Photosynthesis and pathway of carbon dioxide fixation: Light reactions, cyclic and noncyclic phosphorylation; Calvin cycle, C4 pathway, Crassulacean acid metabolism; regulation of photosynthesis; photorespiration and the glycolate pathway.

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- 16.Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. *Biochemistry*. 9th edition, W. H. Freeman and Company • New York, 2019.
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**BCH3B05+ BCH4B08: PRACTICAL I**  
**(CARBOHYDRATES, LIPIDS, AMINO ACIDS, NUCLEIC ACIDS, AND TECHNIQUES)**

**TOTAL HOURS: 54, CREDITS: 4 HOURS/WEEK: 2**

**Quantitative analyses**

1. Verification of Beer's law (Use  $\text{KMnO}_4$ ,  $\text{K}_2\text{CrO}_4$  or similar coloured solution for this experiment)
5. Experimental verification of molar extinction coefficient of any known compound.
6. Estimation of sugars (by any two methods only)
7. Amino acid estimation by ninhydrin method
8. Protein estimation by Biuret method.
9. Protein estimation by Lowry et.al method.
10. Cholesterol estimation by Zak's method or any other convenient method.

2. Fractional precipitation of protein from crude tissue extracts (Avoid plant tissue with phenolics in it. May use pulses or animal tissues )
11. Separation of sugars and amino acids by paper chromatography
12. Separation of lipids and amino acids by thin layer chromatography (TLC)
13. Separation of serum protein by agarose gel electrophoresis (Demonstration)
14. Dialysis using dialysis membrane
15. SDS- PAGE ( Demonstration )

**References:**

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2. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Cambridge University Press 2010
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12. Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company
13. Williams. B.L. and Wilson. K.A Biologist's Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold Ltd. London
14. Upadhayay A, Upadhayay K and Nath N. Biophysical chemistry. Principles and Techniques. , Himalaya publishing house.
15. Cark Jr J. M. and Switzer R.L., Experimental Biochemistry. W.H. Freeman and Company.

## **SEMESTER V**

### **BCH5B09 PLANT BIOCHEMISTRY**

**TOTAL HOURS: 36, CREDITS: 2, HOURS/WEEK: 2**

#### **Unit I Structure, chemistry and function of plant cell (9 hrs)**

An over view of plant cell and sub cellular components of the plant cell. Structure and organization of primary cell wall. Structural features, unique functional roles and chemical composition of membranes of plant cell organelles; nucleus, endoplasmic reticulum, microtubules, plant microbodies, plasmolemma, plastid, vacuole and Golgi body. Importance of sucrose as transport form of sugar in plants. Brief account of separation of plant subcellular constituents.

#### **Unit II Mineral and other metabolisms (9hrs)**

Mineral metabolism: Essentiality and functions- magnesium, iron, manganese, zinc, copper, molybdenum, calcium, potassium, chlorine and boron and potassium (Brief study).

Sulfate metabolism: Sulfate reduction and assimilation. Pathway of cysteine and methionine synthesis.



Nitrate metabolism: Nitrate reduction- nitrate reductase- physiology and regulation; nitrite metabolism (nitrite reductase). Nitrogen fixation: Nitrogen cycle; symbiotic and non-symbiotic nitrogen fixation. Biochemistry of nitrogen fixation

### **Unit III Plant growth substances (8h)**

Plant growth regulators: Auxins, cytokinins, abscisic acid and related compounds, gibberellins, and ethylene; chemical nature, physiological roles, distribution in plants, mode of action.

A brief account of the biochemical aspects associated with fruit ripening, senescence, seed dormancy and germination.

### **Unit IV Secondary metabolites (10 hours)**

A brief account of important classes of secondary metabolites: Alkaloids, terpenoids, phenolics etc (Structures not necessary. Give examples of the compounds and the plants in which present and their importance).

A brief study on Allelopathy with examples. Xenobiotic and plant metabolism (A brief study)

### **References**

1. Florence K. Gleasen And Raymond chollet, plant biochemistry, Johns and Bartlet Learning publications.
2. V. K. Jain, Fundamental of Plant physiology, S. Chand publications,2000.
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20. Muriel Wheldale. The Principles of Plant Biochemistry Onslow, ,Publisher: Cambridge University Press 1931

## **BCH5B10 HUMAN PHYSIOLOGY**

**TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3**

### **Unit I Introduction to physiology (8 hrs)**

Functional organization of human body, extracellular and intracellular fluids, constituents and characteristics of extracellular fluid, homeostasis, overview of coordination between major functional systems of human body, physiological significance of carbohydrates and lipids.

### **Unit II Digestion and absorption (12 hrs)**

Functions of different gastro intestinal organs in digestion and absorption, secretion of digestive fluids and enzymes, activation of digestive enzymes, gastro intestinal hormones, epithelial transport of solutes, Digestion and absorption of carbohydrates, proteins, lipids, vitamins and minerals, composition and function of bile, metabolism of bile acids.

### **Unit III Biochemistry of Blood: (12 hrs)**

Constituents of blood types of blood cells, components of plasma, plasma proteins-types and functions. Formation of blood cells, differentiation of RBC, red cell antigens and blood groups, Mechanism of blood clotting (intrinsic and extrinsic pathway). Clotting factors and anticoagulants, Structure and function of hemoglobin, types of haemoglobin, formation and destruction of haemoglobin, blood pressure, standard units of blood pressure, clinical methods of measuring systolic and diastolic pressures, vasoconstrictors and vasodilators.

### **Unit IV Biochemistry of respiration and renal function (12 hrs)**

Pulmonary volumes, pulmonary capacity, Blood flow through lungs and its distribution, Transport of oxygen and carbon dioxide in blood, role of haemoglobin, carbonic anhydrase, chloride shift, oxygen dissociation curve and Bohr effect, role of 2,3-bisphosphoglycerate, respiratory exchange ratio. Brief study on oxygen toxicity, free radical formation, antioxidants.

Structure of nephrons, renal excretory mechanism, glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion. Composition of urine, regulation of water and electrolyte balance.

Respiratory and renal regulation of pH.

## **Unit V Biochemistry of Specialized tissues (10 hrs)**

Muscle- types of muscles, muscle proteins, organization of contractile protein and mechanism of muscle contraction (Sliding filament theory), fuel metabolism in muscle, Maintenance of ATP availability in active muscle, role of creatine and creatine kinase.

Neurons- structure, mechanism of nerve impulse transmission, neurotransmitters, acetyl choline, GABA, serotonin, dopamine.

Bone-Role of calcium, phosphorus, vitamin D and hormones in bone metabolism. Collagen in bone formation.

Biochemistry of vision - Structure of eye, visual cycle, mechanism and regulation of vision.

### **References**

1. Arthur. C. Guyton, and John. E Hall. Textbook of medical physiology. Saunders Elsevier Publications, A division of Reed Elsevier India Pvt .Ltd. New Delhi
2. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers
3. Gerad J Tortora, Bryan Derrickson, Principles of Anatomy and Physiology ( Pub) John Wiley and sons Inc
4. Chatterjee. Human physiology, Medical Allied Agency.
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7. Stephen Reed. Essential Physiological Biochemistry An organ-based approach., Wiley-Blackwell Publishers
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**BCH5B11 IMMUNOLOGY & MICROBIOLOGY**

**TOTAL HOURS: 72, CREDITS: 4, HOURS/WEEK: 4**

## **Unit I Overview of immune system (9 hrs)**

Immunity & types: innate, acquired, passive & active. Barriers of innate immunity, Collaboration of Innate and adaptive mechanisms for an effective immune response. Hematopoiesis. Structure, functions and properties of Immune cells: Stem cell, T cell, B cell, NK cell, macrophage, neutrophil, eosinophil, basophil, mast cell, dendritic cell. Organs of the Immune system: Primary and secondary lymphoid organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT Cells.

## **Unit II Antigens, antibodies & MHCs (9 hrs)**

Antigens: Factors that influence immunogenicity, epitopes, haptens.

Immunoglobulins: Structure of immunoglobulins, Classes of immunoglobulins and their functions. Production of Monoclonal antibodies and application. Major histocompatibility complex (elementary study): Structure, Peptide interaction with MHC, MHC restriction, Processing and presentation of antigens. Antigen-antibody interactions: Precipitation reaction, Immunodiffusion, agglutination, ELISA, RIA, Immunoprecipitation, Immunofluorescence. Western blotting.

## **UNIT III Humoral & cell mediated immune responses (10 hrs)**

T-Cell & B-cell receptors. Humoral & cell mediated immune responses. Cytokines -structure and function, Classification and types of cytokines according to the function, Cytokine related diseases. Complement system: The function of complement, the complement components, complement activation pathways. Complement deficiencies. Immunodeficiency diseases: Phagocytic, humoral and cell mediated deficiencies.

## **UNIT IV Hypersensitivity and autoimmunity (10 hrs)**

Hypersensitivity- Gell and Coombs classification- IgE mediated Type I hypersensitivity, Antibody-mediated cytotoxic (Type II) hypersensitivity, Immune complex mediated (Type III) Hypersensitivity, DTH( delayed type hypersensitivity T cells) (Type IV) hypersensitivity.

Autoimmunity: autoantibodies and their devastating role. Autoimmune diseases- Definition & classification (Organ specific and systemic autoimmune diseases like HIV, systemic lupus

erythomatus, Multiple sclerosis, Rheumatoid arthritis, scleroderma, Myasthenia garavis, Insulin depended diabetic mellitus.). Tumor & transplantation immunology – brief outline study

#### **UNIT V Vaccines (5 hrs)**

Types of vaccines. Vaccines from whole organisms, Polysaccharide vaccines, Toxoids as vaccines, Vaccines from recombination vectors, DNA as vaccines, Vaccines from Synthetic peptides.

#### **UNIT VI Introduction to microbiology (10 hrs)**

History of microbiology, molecular level approaches used in microbial taxonomy, microscopy: bright field, dark field, phase contrast & electron microscopy (brief study). Specimen preparation & staining. Sterilization & disinfection: physical & chemical agents. Testing of disinfectants.

#### **UNIT VII Basics of microbiology (10 hrs)**

Structure of bacterial cell, virus, bacteriophage, fungi & protozoa. Cultivation of bacteria; nutritional types of bacteria: phototrophs, chemotrophs, auxotrophs & heterotrophs. Media: types & preparation. Microbial culture methods.

#### **UNIT VIII Branches of Microbiology (9 hrs)**

Air Microbiology: source of microbes in air, factors affecting the extent & type of microorganisms in air. Water Microbiology: microbiology of water & waste water. Bacteriological techniques for detecting water quality – presumptive test, confirmed & complete test. Soil Microbiology: Microflora of soil.

#### **References:**

1. Roitt. ,Immunology by Publisher: Mosby
2. Thomas J. Kindt, Richard A Goldsby, Barbara A. Osborne, and Janis Kuby. Immunology, W.H. Freeman and Co.
3. Peter J Delves, Seamus J. martin, Dennis R Burton, Ivan M. Roitt,. Essential Immunology, Blackwell Publishing, Massachussts, USA

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19. Michael Pelczar Jr. Microbiology. McGraw Hill Education. 2001

## **BCH5B012: CLINICAL & NUTRITIONAL ASPECTS OF BIOCHEMISTRY**

**TOTAL HOURS: 72, CREDITS: 4, HOURS/WEEK: 4**

### **Unit I Good clinical practices (6hrs)**

Good clinical practices: Basics and principles, Requirements for setting up of a clinical laboratory, SI units in clinical laboratory, collection, preparation, preservation and handling of clinical samples, quality control, Safety measures in clinical laboratory, Familiarization of biochemical charts from clinical labs. Automation in clinical laboratory- sample identification by bar coding-automation in analysis. Use of radioisotopes in diagnosis.

### **Unit II Analysis of body fluids (16 hrs)**

Blood: Routine examinations –TC, DC, ESR, PCV, blood groups and Rh factor incompatibility, prothrombin time, Bleeding & clotting time. Lipid profile: determination & significance of HDL-LDL ratio. Diagnostic Enzymology: Clinical significance of lactate dehydrogenase, Serum glutamate pyruvate transaminase, Serum glutamate oxaloacetate transaminase, acid and alkaline phosphatases, amylase & Isoenzymes. Importance of blood glucose, cholesterol, albumin, creatinine, Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> and phosphate, Total protein, albumin, globulin, albumin-globulin ratio etc. in diagnosis and monitoring of disorders.

Urine and CSF: Normal and abnormal constituents, procedures of qualitative analysis, interpretation and their clinical significance.

Chemistry, composition and functions of Lymph, Ascetic Fluid, Pleural Fluid & Synovial Fluid

### **Unit III Organ function tests (15 hrs)**

Normal functions of liver, liver function tests, diseases of the liver, disorders of bilirubin metabolism, hepatitis types, cirrhosis, alcoholic liver disease, hepatic tumor and biliary tract diseases.



Normal functions of kidney, Renal function tests, Glomerular filtration rate, Renal threshold and clearance values for urea and creatinine, disorders of kidney, renal failure and proteinuria, renal tubular disorders and renal stones.

Thyroid function tests- analysis of T3, T4 and TSH.

#### **Unit IV Inborn errors of metabolism (13 hrs)**

Brief introduction of inborn errors of metabolism-Diabetes mellitus: Analysis of fasting, post prandial and random sugar , glycated hemoglobin , significance of glucose tolerance test, hyperinsulinism and hypoglycemia, galactosemia, lactose intolerance, glycogen storage diseases, pentosuria, phenyl ketonuria, alkaptonurea, maple syrup urine, hyperlipidemia, atherosclerosis, sphingolipidosis. Disorders of purine and pyrimidine metabolism.

#### **Unit V Nutrition: (12 hrs)**

Role of diet in health, Concepts of nutrition, nutrients, balanced diet, Caloric values of foods, basal metabolic rate (BMR), factors affecting BMR, determination of BMR, respiratory quotient, nutritional significance of proteins, fats, carbohydrates, fiber, vitamins, minerals and trace elements. Nutritional profile of principal foods- Cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spices. Nutritional requirements concepts, Energy requirements, recommended Dietary Allowances for men, women, pregnant and lactating women, and children of various ages. Nitrogen balance, protein energy malnutrition, glycemic index.

#### **Unit VI Food safety and hygiene (5 hrs)**

Milk, fish, meat, fruits and vegetables, Food additives- colors, preservatives. Food adulteration, Food spoilage, Food borne diseases, Community nutrition programme, Social aspects of nutrition – problems, ecology, social action.

#### **References**

1. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin. Wiley Publishers.
2. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company  
Preventive and social medicine K. Park

3. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
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5. William J. Marshall & Stephen K. Angert. Clinical Biochemistry – Metabolic and Clinical aspects. All India publishers & distributors.
6. Harper's Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes & V.W. Rodwell.
7. Human Nutrition and Dietetics. Davidson and Passmore. Churchill Livingstone; 8th edition (1986)
8. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
9. M. Sawaminathan. Advanced text book on food & nutrition, Bapcco Publisher, 2015
10. B. Srilakshmi. Nutritional science B. Srilakshmi, New Age International, 2006
11. B. Srilakshmi. Food Science, New Age International, 2003
12. Food and Nutrition. Don Ross, Oxford Book Company, Jaipur.

**BCH5B013 PRACTICAL II (CLINICAL AND ENZYMOLOGY)**

**TOTAL HOURS: 36**

**HOURS/WEEK: 2**

**I. Clinical Biochemistry**

1. Preparation of Blood Serum & Plasma
2. Quantitative estimation in blood/ serum:
  - a) Glucose by Nelson–Somogyi Method (or any other method)
  - b) Cholesterol by Zak & Henly's Method
  - c) Urea by Diacetyl monoxime Method
  - d) Iron by  $\alpha$   $\alpha$  dipyridyl method
  - e) Total Protein by Biuret Method
  - f) Albumin: Globulin ratio

- g) Uric acid using Phosphotungstic acid reagent
  - h) Bilirubin by van den Bergh reaction
  - i) Hemoglobin content by Cyanmethaemoglobin method
  - j) Creatinine by Jaffe's method
  - k) Phosphorus
3. Qualitative tests for the normal and abnormal constituents of urine

## **II. Haematology**

Determination of hemoglobin, packed cell volume, erythrocyte sedimentation rate, total count, differential count, blood grouping, clotting and bleeding time.

## **III. Enzyme Assays**

- a) Urease/Trypsin
- b) Progress curve of Urease /Trypsin

## **IV. Clinical Enzymology**

- a) Assay of serum alkaline phosphatase
- b) Assay of Serum alanine amino transferase (ALT/SGPT)
- c) Assay of serum aspartate amino transferase (AST/SGOT)

## **References**

1. T.N. Pattabiraman. Laboratory manual & practical Biochemistry, 4th Edition, All India publishers and distributors, 2015
2. Varley, Harold. Practical Clinical Biochemistry. J. Chem. Educ., 1963.
3. David Plummer. An Introduction to Practical Biochemistry, McGraw Hill Education, 2017
4. S. Sadasivam and A. Manickam, Biochemical Methods. New Age International Pvt Ltd Publishers. 2018.
5. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
6. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
7. Vasudevan, Practical textbook of Biochemistry for medical students, Jaypee Brothers Medical Publishers, 2013

8. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
9. J.Ochei, Arundhati Kolhatkar. Medical Laboratory Science: Theory and Practice. McGraw Hill Education.2000
10. R.C. Gupta & S. Bhargava. Practical Biochemistry, CBS Publishers and Distributors, New Delhi.
11. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin. Wiley Publishers.
12. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company
13. K. Park. Park's Textbook of Preventive and Social Medicine

## **SEMESTER VI**

### **BCH6B014 CLASSICAL GENETICS AND MOLECULAR BIOLOGY**

**TOTAL HOURS: 72, CREDITS: 4, HOURS/WEEK: 4**

#### **Unit I. Mendalian genetics (10 hrs)**

Mendel's laws of inheritance, gene interaction, Dominance relationship-complete, incomplete and co-dominance, multiple alleles, linked genes. Chromosomal aberrations: Structural and numerical: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy

#### **Unit II. Gene mapping and gene transfer (10 hrs)**

Linkage, Crossing Over gene transfer and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence. Gene transfer techniques in prokaryotes and its utility in gene mapping-conjugation, transformation, transduction, interrupted mating techniques. Sex determination in *Drosophila*, pedigree analysis.

#### **Unit III Genome organization and transposons (10 hrs)**

DNA as a genetic material Chemical nature of gene, central dogma of molecular biology, Genome organization chromatin organization centromere telomere exons and introns C- value paradox. A brief study on prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements, Modes of transposition (brief study)

#### **Unit IV DNA replication, Mutation and Repair (16 hrs)**

DNA replication in prokaryotes. Chemistry of DNA synthesis, general principles - bidirectional replication, rolling circle model, Semiconservative, RNA priming Enzymes involved in DNA replication – DNA polymerases, DNA ligase, Primase, and other accessory proteins. Difference between prokaryotic and eukaryotic replication.

Mutation: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Mutagens: Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: Ames test.

DNA damage and repair (Direct repair DNA photolyases -Mismatch repair,-base excision repair-nucleotide excision repair).

Cytogenetics of cancer (brief account): Types of cancer, characteristics of cancer cells, definition of carcinogenesis.

#### **Unit V Transcription (10 hrs)**

Transcription in prokaryotes (- promoter sequences- sigma factor-RNA polymerase initiation, elongation and termination). Inhibitors of transcription. Difference between prokaryotic and eukaryotic transcription. Brief mention about post transcriptional processing.

#### **Unit VI Translation (10 hrs)**

Genetic code and wobble hypothesis. Translation in prokaryotes, Assembly line of polypeptide synthesis-ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Inhibitors of protein synthesis. Difference between prokaryotic and eukaryotic translation .Brief mention about the post translational modifications.

#### **Unit VII. Regulation of gene expression (6 hrs)**

Regulation of gene expression in prokaryotes. Operon concept, Lac operon, tryptophan operon.

## References

1. Benjamin Lewin, Genes: Pearson education Inc. upper Siddle River NJ.
2. Gerald Karp. Cell and Molecular biology, John Wiley & Son Inc. New York
3. D. L. Nelson and M. M. Cox. Lehninger's principles of Biochemistry, Worth Publishers, 41 Madisons Avenue New York, USA
4. Benjamin A. Pierce. Genetics : A conceptual approach, WH Freeman publications,2016
5. Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, Molecular Biology of the Gene 1987. The Benjamin/Cummings publishing company.
6. Lewin B. ,Genes V. Oxford University press. 1994.
7. Lodish, H, Baltimore D, Berk A, Zipursky SL, Matsudaira P, Darnell J. Molecular Cell Biology. Scientific American Books. 1995.
8. Freifelder D. Molecular Biology,Narosa Publishing Home. 1991.
9. D. Peter Snustard, Genetics, John wiley and sons publications,2011
10. Peter J. Russel. iGenetics A molecular approach. Pearson education India, 2016
11. B.D singh, Biotechnology, Expanding horizons. Kalyani publications, 2015
12. Burton E. Tropp, Molecular Biology: Genes to protein, Laxmi publications,2012
13. David.T.Suzuki, Antony J.F.Griffiths, et al, An introduction to genetic analysis,WH Freeman & Co. Ltd.1996
14. William S. Klug, M.R. Cummings, C.A. Spencer. Concepts of Genetics 10e,Pearson education India,2016

## **BCH6B015 RECOMBINANT DNA TECHNOLOGY**

**TOTAL HOURS: 72, CREDITS: 4, HOURS/WEEK: 4**

### **Unit I Recombinant DNA Technology (18 hrs)**

Brief study on basic principles and steps of recombinant DNA technology, restriction endonuclease, cloning vectors: plasmid vectors, phage vectors, cosmids, high capacity cloning vectors-bacterial artificial chromosome (BAC), phage P, vector PACs (P1 artificial chromosomes), Yeast artificial chromosome (YAC) and human artificial chromosomes. Cloning strategies – cloning in *E.coli*, yeast & gram positive bacteria.

### **Unit II Gene transfer methods and application of rDNA technology (18 hrs)**

Gene transfer methods: Electroporation, lipofection, cloning strategies, cDNA and genomic DNA libraries, cDNA cloning and cloning from genomic DNA.

Transgenesis in plant technology: plant tissue culture methods, methods of gene transfer to plants, Agrobacterium mediated transformation. Direct DNA transfer, protoplast transformation, plant virus as vectors.

Applications of recombinant DNA technology- Gene therapy. GM foods, modified plant and animal varieties, terminator gene technology (basic study).

### **Unit III Techniques in r DNA technology (18 hrs)**

DNA sequencing. DNA Amplification- PCR, types, Probes – DNA/RNA probes, synthetic oligonucleotide probes. Applications of PCR. DNA finger-printing, blotting techniques. Molecular markers – RFLP, RAPD, AFLP analysis.

### **Unit IV Animal cell culture (18 hrs)**

Basics of animal cell and tissue cultures, cell lines, stem cell, gene transfer methods in animal cells, transgenic animal-transgenic mice, cattle, sheep. Transgenic and knock out animals as models for human disease.

## References

1. T.A.Brown. Gene cloning and DNA analysis An introduction. Fifth edition, Blackwell publishing.
2. S B Primrose. Molecular Biotechnology: Panima Publishing Corporation.
3. U Sathyanarayana. Biotechnology. Books and Allied (p) Ltd.
4. James D. Watson, Gilman Michael, Jan Witkowski, Mark Zoller.Recombinant DNA: A Short Course, Freeman, W. H. & Company.
5. John E Smith. Biotechnology. Cambridge University Press
6. Sandhya Mitra. Genetic Engineering: Principles and Practice. Laxmi Publications.
7. B D Singh. Biotechnology. Kalyani Publishers.
8. Pamela Peter. Biotechnology: A guide to Genetic Engineering. William C Brown Pub.
9. John R. W. Masters. Animal Cell Culture A Practical Approach. Oxford University Press Inc., New York, 2000.
- 10.D. L. Nelson and M. M. Cox. Lehninger's principles of Biochemistry, Worth Publishers, 41 Madisons Avenue New York, USA
- 11.Keith Wilson and John Walker,Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Cambridge University Press 2010.
- 12.Glick BR and Pasternak JJ. Molecular Biotechnology. 3rd edition. ASM PressWashington D.C. 2003.
- 13.Sambrook J, Fritsch EF and Maniatis T. Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press. 2001.

### **BCH6B016 MOLECULAR ENDOCRINOLOGY**

**TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 3**

#### **Unit I Introduction (6 hrs)**

History of endocrinology, endocrine glands, hormones as chemical messengers.



Classification of hormones. Overview of circulation, Target tissue, modification and stimulus for hormone release. Regulation of hormone secretion: change in homeostasis, feedback control.

General characteristics of hormones- general mechanism of action, Types of hormone receptors: Signal transduction- plasma membrane receptors (G protein coupled receptors, cAMP, protein kinases, tyrosine kinases, inositol phosphate, calcium and calmodulin), steroid hormone receptors. Assay of hormones: ELISA

### **Unit II Hypothalamus and pituitary hormones (6 hrs)**

Hormones of the hypothalamus and pituitary- chemical nature, secretion, release and their biological functions.

### **Unit-III Thyroid & parathyroid hormones (6 hrs)**

Hormones of the thyroid & parathyroid- chemical nature, secretion, function & disorders of thyroid & parathyroid hormones.

### **Unit-IV Pancreatic & G.I. Tract hormones (6 hrs)**

Chemical nature & functions of Insulin, Glucagon. Secretion, release, chemical nature & functions of Gastrin, Secretin & Cholecystokinin .

### **Unit-V Adrenal gland hormones (6 hrs)**

Chemical nature & functions of Adrenal medullary (Catecholamines) & Cortex (glucocorticoids and mineralocorticoids) hormones.

### **Unit-VI Gonadal hormones (6hrs)**

Hormones of the testes and ovaries –chemical nature & functions of Androgens, Estrogens, Progesterone.

### **References**

1. Harper's Review of Biochemistry David. W. Martin Peter. M. Mayes Victor. W. Rodwell  
18th edition. Lange Medical Publications

2. Fundamentals of Biochemistry, J.L. Jain, S. Chand publications, 2004.
3. Principles of Biochemistry, David L. Nelson, Michael M.Cox, Lehninger, 4th edition, W.H.Freeman and company.
4. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry. Publishers: S. Chand & Co Ltd. New Delhi. 2008
5. Arthur. C. Gyton, and John. E Hall. Textbook of medical physiology. Saunders Elsevier Publications, A division of Reed Elsevier India Pvt .Ltd. New Delhi
6. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers Gerard J Tortora, Bryan Derrickson, Principles of Anatomy and Physiology ( Pub) John Wiley and sons Inc
7. Chatterjee. Human physiology, Medical Allied Agency.
8. White, A. Handler, P .and Smith E.L.Mammalian biochemistry. (Pub)Mc Graw Hill
9. G. William, F., Review of medical physiology –Mc Graw Hill Karan books publications
- 10.Stephen Reed. Essential Physiological Biochemistry An organ-based approach., Wiley-Blackwell Publishers
- 11.R.K. Murray, D. K. Granner, Peter A Mayer, Victor W Rodwell. Harper's Biochemistry, Lange Medical Publications, 1991
- 12.E.S. West, W.R. Todd, H.S. Mason, and J.T. van Bruggen, A Text Book of Biochemistry. Oxford and IBH Publishing Co., New Delhi, 1974.
- 13.Debajyoti Das. Biochemistry, Academic Publishers, 1978.
- 14.Anthony W. Norman, Helen L. Henry. Hormones. Academic Press, 2014
- 15.Mac Hadley, Jonathan Levine. Endocrinology, Pearson. 2006
- 16.Anthony W. Norman, Gerald Litwack. Hormones. Academic Press, 1997

**BCH5B013&BCH6B017 PRACTICAL II (CLINICAL AND ENZYMOLOGY)**

**CREDITS: 5**

**BCH6B018 PRACTICAL III (MOLECULAR BIOLOGY, IMMUNOLOGY AND  
NUTRITIONAL BIOCHEMISTRY)**

**TOTAL HOURS: 180, CREDITS: 5, HOURS/WEEK: 10**

Molecular Biology:

1. Isolation of nucleic acids, Electrophoretic separation of nucleic acids,
2. Estimation of DNA by diphenyl amine method
3. Estimation of RNA by orcinol method

Immunology:

1. Haemagglutination

Nutritional Biochemistry:

1. Titrimetric or colorimetric estimation of Vitamin C in food samples
2. Colorimetric determination of calcium in food samples
3. Colorimetric determination of iron in food samples
4. Colorimetric determination of inorganic phosphorus in food samples
5. Estimation of beta carotene by column chromatography
6. Isolation of proteins from milk.
7. Estimation of cholesterol in egg.
8. Estimation of total reducing sugar in honey /jaggery.
9. Estimation of glycogen from liver.
10. Estimation of pentose in grapes.
11. Estimation of inulin from Kyllinga rhizome/onion/dahlia tuber/asparagus stem/chicory roots etc.
12. Extraction and estimation of starch from potato

**References**

1. T.N. Pattabiraman. Laboratory manual & practical Biochemistry, 4th Edition, All India publishers and distributors, 2015

2. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
3. Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Keith Wilson and John Walker, Cambridge University Press 2010
4. S. Sadasivam and A. Manickam, Biochemical Methods. New Age International Pvt Ltd Publishers. 2018.
5. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
6. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
7. Vasudevan, Practical textbook of Biochemistry for medical students, Jaypee Brothers Medical Publishers, 2013
8. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
9. J.Ochei, Arundhati Kolhatkar. Medical Laboratory Science: Theory and Practice. McGraw Hill Education.2000
10. R.C. Gupta & S. Bhargava. Practical Biochemistry, CBS Publishers and Distributors, New Delhi.
11. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin. Wiley Publishers.
12. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company
13. K. Park. Park's Textbook of Preventive and Social Medicine

**BCH6B019 Project**

**TOTAL HOURS: 36, CREDITS: 2, HOURS/WEEK: 4**

## **OPEN COURSES**

### **BCH 5D01 ELEMENTARY BIOCHEMISTRY**

**Credits: 3 Total hours: 36 Hours per week: 2**

#### **UNIT I (2 hrs)**

Origin, nature and scope of Biochemistry and the molecular basis of life.

#### **UNIT II (3 hrs)**

Properties and significance of water as a solvent of life, pH, Buffer, Physiological buffer systems

#### **UNIT III (15 hrs) BIOMOLECULES**

Carbohydrates, classification and functions. Isomerism

Amino acids classification, peptide bond, features of peptide bond, classification and characterization of proteins, functions of protein, enzymes, and classification of enzymes. Protein denaturation, factors affecting the activity of an enzyme.

Micronutrients: Vitamins, classification ,and function --- macro and micro minerals of nutritional and functional significance.

Nucleic acids and their components. Phosphodiester bond, Structure of purine and pyrimidine. Nucleotide, nucleoside, Brief outline of the DNA double Helix

Lipids, classification, lipids and membranes. Properties of lipids

#### **UNIT IV ORGANIZATION OF THE CELL (4 hrs).**

Cell wall, Plasma membranes, Nucleus, Endoplasmic reticulum, mitochondria, transport processes across membranes.

#### **UNIT V (8 hrs)**

Introduction to metabolism and the concept of free energy. Energy rich compounds. Coupling of reactions. Glycolysis ( outline study), ATP generation

## **UNIT VI (4 hrs)**

Application of biochemistry in fields like medicine (diagnosis and treatment), industry, pharmaceuticals, agriculture, food, health and nutrition, environmental studies, enzyme technology, biotechnology, bioengineering, bioinformatics, toxicology, microbiology, and drug designing.

### **References**

1. Lehninger's Principles of Biochemistry - David L. Nelson and Michael M. Cox Worth W.H.
1. Freeman and Co
2. Text book of Biochemistry JL Jain Schand and Co Ltd New Delhi
3. Biochemistry U. Sathyanarayana Books and allied ( P) Ltd
4. Outlines of Biochemistry- Eric E Conn, Paul K Stumpf, George Bruening, Roy H John Wiley and sons New York

## **BCH 5D02 LIFESTYLE DISEASES**

**Credits: 3 Total hours: 36 Hours per week: 2**

### **UNIT I (4 hrs)**

General awareness

Basic biochemistry (Biomolecules- carbohydrates, lipids, proteins, nucleic acids, vitamins, minerals – brief outline), Life style, food habits, healthy habits, and unhealthy habits (brief description only).

### **UNIT II (8 hrs)**

Atherosclerosis: Characteristics, risk factors (modifiable & unmodifiable), ischemia, myocardial infarction - definition, Diagnosis ( electrocardiography , Exercise ECG – Stress test, Echocardiography ,Coronary angiography, Intravascular ultrasound, Magnetic resonance imaging), Prevention (lifestyle, diet, drugs ), Management ( drugs, angioplasty, stent, bypass surgery)

### **UNIT III (2 hrs)**

Hypertension: Characteristics, Causes, Diagnosis, Prevention and Management

### **UNIT IV (2 hrs)**

Stroke: Characteristics (ischemic and hemorrhagic), Causes, Diagnosis (neurological examination, scanning), Management – (Drugs, Mechanical thrombectomy, Angioplasty and stenting)

### **Unit V (4hrs)**

Diabetes mellitus: Classification – type 1, type 2, gestational, Type 2 diabetes: Glucose level, GTT, Glycated haemoglobin, Characteristics (polyuria, polydipsia, polyphagia), Causes, Diagnosis, Management (diet, exercise, drugs)

### **Unit VI (3hrs)**

Obesity: Classification according to BMI, symptoms, causes, diagnosis, treatment and management.

### **Unit VII (5hrs)**

Cancer: Introduction, Types-(benign, malignant), Metastasis (definition), Causes, Diagnosis (screening, blood tests, X-rays, CT scans & endoscopy), Prevention- (Dietary, Medication, Vaccination, Screening-Outline only) Management- (Surgery, Chemotherapy, Radiation, Palliative care).

### **Unit VII (4hrs)**

Nephritis: Function of kidney, Nephritis, Causes, Symptoms, Diagnosis (Kidney function test, Significance of Glomerular filtration rate (GFR) , Urine creatinine, Blood Urea Nitrogen, Blood creatinine, Creatinine clearance), Treatment, management (dialysis- peritoneal and hemodialysis).

### **Unit VIII (5hrs)**

Liver disease: Function of liver (brief outline), Liver disease (viral hepatitis, alcoholic liver disease, cirrhosis), symptoms, causes, diagnosis (Liver function test- Brief outline of serum

bilirubin, serum albumin, serum alkaline phosphatase, Aspartate amino transferase, alanine amino transferase, lactate dehydrogenase, treatment and management.

## **References**

1. Textbook of Medical Physiology, by Arthur C Guyton, John E Hall Prism Saunders.

1. Biochemistry – U. Satyanarayana, U. Chakrapani books and Allied (P) Ltd
2. Cell and Molecular Biology by Gerald Karp John Wiley & Sons,

## **BCH 5D03 CLINICAL DIAGNOSIS OF COMMON DISEASES**

**Credits: 3 Hours/week:2. Total hours: 36h.**

### **UNIT I (6 hrs)**

Diabetes Mellitus: Hypoglycemia, hyperglycemia, basic understanding of type 1 and type 2 diabetes, symptoms- polyuria, polydipsia, weight loss, polyphagia, blurred vision, susceptibility to infections. glycosuria, fasting blood sugar, postprandial blood sugar, random blood sugar, impaired glucose tolerance, oral glucose tolerance test, glucose challenge test, normal values, role of hemoglobin A1c in diagnosis, diagnosis of diabetic ketoacidosis and retinopathy.

### **UNIT II (6 hrs)**

Cardiovascular diseases: causes and symptoms of cardiovascular diseases, diagnostic methods: Blood tests- lipid profile, cholesterol and triglycerides, C reactive protein, creatine kinase, lactate dehydrogenase measuring blood pressure, Electrocardiogram (ECG), Echocardiogram, Coronary Angiography, Cardiac catheterization, Heart biopsy, Cardiac computerized tomography (CT) scan, Cardiac magnetic resonance imaging (MRI).

### **UNIT III (6 hrs)**

Liver diseases: Hepatitis-types, fatty liver, alcoholic liver disease, cirrhosis, cholestasis. Diagnosis: liver function tests-serum proteins, serum albumin, serum globulin, A/G Ratio, bilirubin, alanine transaminase, aspartate transaminase, gamma glutamyl transferase, alkaline phosphatase,



#### **UNIT IV(6 hrs)**

Thyroid disorders: functions of thyroid gland, Hypothyroidism, hyperthyroidism, goiter, Grave's disease, thyroiditis. Thyroid function tests: levels of triiodothyronine (T3), thyroxine (T4), free thyroxine estimate (FT4E), reverse T3, thyroid hormone binding ratio, thyroglobulin, antithyroid antibodies. Effects of drugs on thyroid function.

#### **UNIT V (6 hrs)**

Cancer: definition and classification, Tumor markers- cancer antigen 125, prostate-specific antigen (PSA), calcitonin, alpha-fetoprotein (AFP), human chorionic gonadotropin (HCG). Diagnosis; Complete blood count (CBC), Urine cytology, Blood protein testing, Tumor marker tests, x rays, CT scans, MRI scans, PET scans, biopsy, mammography, endoscopy, genetic testing.

#### **UNIT VI (6hrs)**

Neurological disorders: definition and classification, Epilepsy, Parkinson's disease, Amyotrophic lateral sclerosis(ALS), Multiple Sclerosis, Peripheral Neuropathy, Migraines, Huntington's disease, Alzheimer's disease. Diagnosis: genetic testing, neurological examination, X-rays, Fluoroscopy, Angiography, Biopsy, Brain scans, Cerebrospinal fluid analysis, Electroencephalography, Magnetic resonance imaging (MRI), Ultrasound imaging.

#### **References**

1. Arthur c. Guyton. Textbook of Medical Physiology. W.B Saunders Co
2. . Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Ed.Saunders Company.
3. Preventive and social medicine K. Park Banarsidas Bhanot Publishers
4. William J. Marshall & Stephen K. Angert.Clinical Biochemistry – Metabolic and Clinical aspects.
5. Orla Hardiman & Colin P. Doherty. Neurodegenerative Disorders A Clinical Guide. Ed. Springer, New York.

**Model Question Papers (Core)**

**BCH1B01 Introduction to Biochemistry and Cell Biology**

**Time: 2 hrs**

**Marks 60**

**Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. Define ionic product of water.
2. Differentiate between isotonic, hypertonic and hypotonic solution.
3. State Bronsted theory of acids and bases.
4. Write short notes on radioactive disposal.
5. Write notes on hydrophobic interactions.
6. Explain the mechanism of osmosis.
7. What are desmosomes?
8. Define simple diffusion.
9. Write notes on microfilaments.
10. Define apoptosis.
11. Name any two marker enzymes of lysosome.
12. What are ionophores?

**Section B**

**Answer any 6 questions. Each question carries 5 marks (ceiling 30marks)**

13. Explain Donnan membrane equilibrium and its applications in biological system.
14. Derive Henderson – Hasselbalch equation and its applications.

15. Write about biological Buffer systems.
16. Explain fluid mosaic model of plasma membrane.
17. Explain different components of ECM.
18. Write notes on cell–cell interactions.
19. Write short notes on cell signaling.

### **Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 marks)**

20. Explain cell cycle with different phases of cell division.
21. Explain about different molecular interactions in biological system.

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### **BCH2B02 BIOMOLECULES**

**Time: 2 hrs**

**Marks 60**

### **Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What are epimers? Give examples with structure.
2. What are essential fatty acids? Give example with structure.
3. Explain the reaction of glucose with a) mild oxidants and b) strong oxidants
4. Explain the features of a peptide bond.
5. Write notes on the amphoteric property of amino acid with an example.
6. Draw the structure and functions of glutathione.
7. Write the structure of AMP.

8. Write notes on Vitamin B<sub>5</sub> deficiency.
9. What are trace elements?
10. Define T<sub>m</sub> Value.
11. Define Iodine number, acid number and saponification number.
12. What do you mean by inert sugar?

### **Section B**

**Answer any 6 questions. Each question carries 5 marks (Ceiling 30 Marks)**

13. Write the structure of reducing disaccharides.
14. Write the structure and functions of phospholipids.
15. Give a brief account of Ramachandran Map and its importance.
16. Explain the structure of tRNA.
17. Describe denaturation and renaturation of proteins.
18. What is cot curve? Write its significance.
19. Give a brief account on Vitamin A.

### **Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 Marks)**

20. Describe the different levels of structural organization of proteins.
21. Describe in details the classification of carbohydrates.

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## **BCH3BO3 TECHNIQUES IN BIOCHEMISTRY**

**Time: 2 hrs**

**Marks 60**

## Section A

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. Define Beer-Lambert's law.
2. What is isoelectric pH?
3. Explain lyophilisation.
4. Write the principle of dialysis.
5. Explain the principle of ion exchange chromatography.
6. Write the different methods of tissue homogenization.
7. How do you determine molecular mass of a protein by gel filtration?
8. Write any four applications of RIA.
9. Define the term electrophoretic mobility.
10. What is the basis of centrifugation technique?
11. What are the applications of SDS-PAGE?
12. Write a note on different types of rotors used in centrifugation technique.

## Section B

**Answer any 6 questions. Each question carries 5 marks (Ceiling 30 Marks)**

13. What are the applications of HPLC?
14. Explain the principle and instrumentation of atomic absorption chromatography.
15. Explain the radioactive isotopes used as tracers in biological studies.
16. What is autoradiography?
17. Write a note on protein crystallization.

18. Explain RCF and centrifugal force.

19. Describe density gradient centrifugation.

### Section C

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 Marks)**

20. Explain in detail the principle, procedure and applications of PAGE.

21. Explain the principle and instrumentation of spectrophotometry.

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### BCH3B04 ENZYMOLOGY

**Time: 2 hrs**

**Marks 60**

### Section A

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What are zymogens? Give examples.
2. Define activation energy with diagrammatic representation.
3. Write the significance of  $k_m$  value.
4. What is turn over number ( $k_{cat}$ ) of an enzyme?
5. What is binding energy?
6. Draw the structure of biotin.
7. Explain the functions of PLP.
8. Draw the structure of lipoic acid and mention its function.
9. Write down the factors that control the enzyme activity.
10. What is competitive and non-competitive inhibition?
11. What are isoenzymes?

12. Explain multienzyme complex.

### **Section B**

**Answer any 6 questions. Each question carries 5 marks (Ceiling 30 Marks)**

13. Explain Induced fit model of enzyme.

14. Enumerate the different methods of enzyme immobilization.

15. Explain the allosteric type of regulation of enzyme.

16. Draw the structure of TPP and write any two reactions involving TPP.

17. Describe in details two nicotinamide coenzyme.

18. Explain in details LB plot.

19. What is isoelectric focusing?

### **Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 Marks)**

20. Give a detailed account of IUPAC classification of enzyme.

21. Derive Michaelis-Menton equation and write its significance.

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## **BCH4B06 INTERMEDIARY METABOLISM – I**

**Time: 2 hrs**

**Marks 60**

### **Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What are high energy compounds?
2. Define anabolism and catabolism?
3. Name two glycogen storage diseases.

4. Define P:O ratio.
5. What is the role of citrate in fatty acid synthesis?
6. Name any three diseases associated with lipid metabolism.
7. Give a brief account of the mitochondrial shuttle pathways of NADH.
8. Differentiate between glucokinase and hexokinase.
9. What are the methods commonly employed to study metabolism?
10. How pyruvate is converted to acetyl CoA?
11. What are uncouplers?
12. Write the rate limiting steps in the biosynthesis of cholesterol.

### **Section B**

**Answer any 6 questions. Each question carries 5 marks (Ceiling 30 Marks)**

13. Explain Cori cycle.
14. Explain HMP shunt and its importance.
15. Write a note on  $\beta$ -oxidation of fatty acids.
16. Write a note on the inhibitors of oxidative phosphorylation.
17. Describe the glyoxylate pathway.
18. What is the role played by carnitine in mitochondrial oxidation of long chain fatty acids?
19. Describe the synthesis of steroid hormones from cholesterol.

### **Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 Marks)**



20. Write an essay on mitochondrial electron transport chain.

21. Discuss the reactions of aerobic glycolysis and give an account of its energetics.

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**BCH4B07 INTERMEDIARY METABLISM II**

**Time: 2 hrs**

**Marks 60**

**Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What is mean by protein turn over
2. Explain the primary steps in the removal of amino group from amino acids
3. What are the significance of urea cycle
4. What is mean by oxidative deamination
5. Name two inhibitors of purine nucleotide biosynthesis
6. Which compounds contribute nitrogen atoms to purine and pyrimidine biosynthesis
7. What is mean by gout
8. Mention the role of nucleoside phosphorylase
9. What is mean by glycolate pathway
10. Explain the functions of chlorophylls.
11. What is mean by photorespiration.
12. What is phytochromes.

**SECTION B**

**Answer any 6 questions. Each question carries 5 marks (Ceiling 30 Marks)**

13. What are proteolytic enzymes
14. Which are the two important transaminases
15. Explain the oxidative deamination
16. Explain urea cycle
17. What is mean by salvage pathway of nucleotide biosynthesis
18. Explain purine catabolism and its disorders
19. Outline C4 and CAM pathways

**SECTION C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 Marks)**

20. Explain the biosynthesis of purine nucleotide.
21. Explain the light independent reactions of photosynthesis

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**BCH5B09 PLANT BIOCHEMISTRY**

**Time: 2 hrs**

**Marks 60**

**Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What is mean by tonoplast
2. What are the function of plant plastics
3. Explain plasmolemma
4. What is mean by essential mineral elements
5. What is micronutrients
6. What is nitrogen fixation
7. Distinguish between plant growth promoters and plant growth inhibitors
8. What are the function of Gibberellins
9. What is the role of Abscisic acid
10. Explain Allelochemicals
11. What is Xenobiotics
12. Why sucrose is the major transport form of sugar in plant.

**Section B**

**Answer any 6 questions. Each question carries 5 marks (ceiling 30marks)**

13. Explain the structure and function of cell wall
14. What you know about central vacuole
15. Outline the role of micro nutrients in plants
16. Give a detailed note on plant growth regulators
17. Explain the role of ethylene in fruit ripening
18. Discuss about seed dormancy
19. Briefly explain the hormonal regulation of plant senescence

**Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 marks)**

20. Explain symbiotic and nonsymbiotic nitrogen fixation

21. Give brief account of alkaloids and terpenoids.

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**BCH5B10 HUMAN PHYSIOLOGY**

**Time: 2 hrs**

**Marks 60**

**Section A**

**Answer any 10 Questions. Each question carries 2 marks (Ceiling 20 marks)**

1. What is mean by homeostasis
2. Mention the difference ECF and ICF
3. What are the physiological significance of lipids
4. Name any four gastrointestinal hormone
5. How pepsinogen is activated
6. What is mean by bile salt
7. What are anticoagulants
8. What is mean by differentiation of RBC
9. What is mean by pulmonary volume
10. Explain Bohr effect
11. What is sarcomere
12. What are the composition of urine

**Section B**

**Answer any 6 questions. Each question carries 5 marks (ceiling 30marks)**

13. Explain the digestion and absorption of carbohydrates
14. What are the composition and function of bile
15. Briefly explain the epithelial transport of glucose
16. Explain the structure and function of haemoglobin
17. Briefly explain the structure of nephron

18. What is the role of collagen in bone formation
19. Explore the mechanism and regulation of vision

### **Section C**

**Answer any 1 question. Each question carries 10 marks (Ceiling 10 marks)**

20. Explain the mechanism of blood clotting
21. Explain the structure of neuron and give note on the mechanism of nerve impulse transmission

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### **BCH5B11 IMMUNOLOGY AND MICROBIOLOGY**

**Time: 2 hrs and 30 min.**

**Marks 80**

### **Section A**

**Answer any 12 questions. Each question carries 2marks (Ceiling 25 marks)**

1. What is prezone phenomenon in antigen antibody reactions?
2. Write a brief note on live vaccine.
3. Define enrichment media
4. Brief the function of antigen presenting cell?
5. What is Phagocytosis
6. What is an antigen? What are the different types of antigens?
7. Write short notes on adjuvants.
8. What are phototrophs
9. What is Myasthenia Gravis.
10. Write abried note on dark field microscopy.
11. What are mordants.
12. How are cytokines classified?
13. What is the difference between magnification and resolution of a microscope?
14. What are T<sub>H</sub> cells
15. Where does B cells originate?

### **Section B**

**Answer any 7 questions. Each question carries 5 marks (ceiling 35marks)**

16. Discuss on the clonal selection of lymphocytes
17. Give a brief outline of Western Blotting
18. Briefly explain hematopoiesis
19. Explain the steps involved in water portability testing.
20. What are monoclonal antibodies? How are they produced
21. Write short note on T lymphocytes
22. Explain different sterilization techniques used in microbiology.
23. Explain hypersensitivity. How is it classified?

### **Section C**

**Answer any 2 questions. Each question carries 10 marks (Ceiling 20 marks)**

24. Explain the components and functioning of the complement system
25. Describe the maturation, activation and proliferation of B Cell receptors
26. What are the different classes of Immunoglobulins? Write on the various functions of different classes of immunoglobulins.
27. What is the principle of ELISA? Explain different types of ELISA.

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## **BCH5B12 CLINICAL & NUTRITIONAL ASPECTS OF BIOCHEMISTRY**

**Time: 2 hrs and 30 min.**

**Marks 80**

### **Section A**

**Answer any 12 questions. Each question carries 2 marks (Ceiling 25 marks)**

1. Write a short note on Alkaptonurea
2. Give the normal serum concentration of urea, creatinine and Uric acid.
3. Give three examples for myocardial infarction markers.
4. What is the role of vitamin A in night?
5. Write a short note on Gout.
6. Comment on the nutritive value of milk.

7. What are the usually adopted safety measures in a clinical laboratory?
8. How ESR is measured in a clinical laboratory?
9. Write a note on the clinical significance of Lactate Dehydrogenase.
10. Give a short note on HDL
11. What is Albumin-Globulin ratio? What is its clinical significance?
12. Give a brief account of renal function tests.
13. Describe the composition and functions of lymph.
14. Name the enzyme which is deficient in Lactose intolerance patient and give significance
15. Comment on the significance of monitoring fasting and post prandial blood sugar in a diabetic patient

### **Section B**

**Answer any 8 questions. Each question carries 3 marks (8×3=24marks)**

16. Write a note on food adulteration.
17. Explain the nutritional significance of different B vitamins
18. Give an account of protein malnutrition in children.
19. Write a note on atherosclerosis.
20. Explain thyroid function tests
21. Write a note on the determination of lipid profile.
22. Describe the composition and functions of lymph.
23. Give an account of the collection, preparation and preservation of serum in a clinical lab.

### **Section C**

**Answer any 2 questions. Each question carries 10marks (Ceiling 20 Marks)**

24. Give an account of the clinical significance, normal values and methods of estimation of any four serum enzymes of clinical interest.
25. What are the major disorders of liver? How liver function tests are used in their diagnosis and management.
26. Give an account of the nutritional significance of minerals and trace elements in humans.
27. Explain the nutritional importance of fat soluble vitamins.

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## **BCH6B14 CLASSICAL GENETICS AND MOLECULAR BIOLOGY**

**Time: 2 hrs and 30 min.**

**Marks 80**

### **Section A**

**Answer any 12 questions. Each question carries 2marks (Ceiling 25 marks)**

1. What is the role of rho factor in transcription
2. Write a short note on tRNA
3. What are topoisomerase
4. What is the significance of 16S rRNA
5. Give a short note on Okazaki fragments
6. What is Chargaff's rule?
7. What are introns and exons?
8. What is the function of Primase in replication?
9. Name one inhibitor of transcription and its mode of action
10. What is an Operon?
11. What are cosmids?
12. What is meant by semiconservative replication?
13. What is a repressor?
14. Differentiate between genotype and phenotype
15. What is the law of segregation?

### **Section B**

**Answer any 7 questions. Each carries 5 marks (Ceiling 35marks)**

16. Briefly explain post translational modifications.
17. What are the different types of RNA? Give an account of their function
18. Write note on wobble hypothesis
19. Describe the charging of t RNA
20. What are the functions of DNA polymerase
21. Differentiate between induction and repression
22. Explain the terms co-dominance and incomplete dominance with examples

23. Explain the initiation process of translation.

### **Section C**

**Answer any 2 questions. Each question carries 10 marks (Ceiling 20 marks)**

24. Briefly explain chromosomal aberrations

25. Describe DNA replication in prokaryotes

26. Describe the initiation elongation and termination of transcription in prokaryotes

27. Explain lac operon in detail

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### **BCH6B15 RECOMBINANT DNA TECHNOLOGY**

**Time: 2 hrs and 30 min.**

**Marks 80**

### **Section A**

**Answer any 12. Each question carries 2 marks (Ceiling 25 marks)**

1. What are vectors?
2. Write a short note on embryonic stem cells.
3. Briefly explain shot gun technique
4. What is a knockout strain?
5. Give a short note on reverse transcriptase.
6. What is cDNA library
7. Briefly explain the advantages of two genetically modified plants.
8. What are restriction endonucleases?
9. Write briefly on the use of klenow fragment of DNA Pol in cloning
10. What cloning strategy will you adopt, in case the vector, you are using do not have compatible restriction sites?
11. How can total cellular RNA be isolated?
12. Differentiate between totipotent, multipotent and unipotent stem cells.
13. Write a short note on RFLP technique
14. How does an expression vector differ from a normal cloning vector?
15. What is northern blotting



### **Section B**

**Answer any 7 questions. Each question carries 5 marks (Ceiling 35 marks)**

16. Write notes on protoplast transformation.
17. How can plants be used for generating vaccines?
18. What is the problem with bt Cotton
19. Is it possible to blunt a staggered DNA end? If so How?
20. Write notes on DNA fingerprinting.
21. Comment on BACs and YACs
22. Write notes on PCR technique.
23. Write notes on lipofection and calcium phosphate mediated gene transfer.

### **Section C**

**Answer any 2 questions. Each question carries 10 marks (Ceiling 20 marks)**

24. Explain in detail the procedure to generate a cDNA library.
25. Detail the various biosafety measures to be considered while generating recombinant protein.
26. What is a knockout mouse? Describe how it is generated?
27. Explain the agrobacterium mediated gene transfer.

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## **BCH6B 16 MOLECULAR ENDOCRINOLOGY**

**Time: 2 hrs**

**Marks 80**

### **Section A**

**Answer any 12 the questions. Each question carries 2 marks (Ceiling 25 marks)**

1. Write a short note on any one of the pituitary hormones.
2. What is the role of testosterone?
3. What are hormones?
4. Write a short note on any of the peptide hormones
5. Write the role of G proteins in hormonal action
6. Comment on the role of thyroxine
7. Name the hormones produced by hypothalamus

8. Why hormone like insulin cannot be administered by oral route?
9. Define signal transduction
10. What are protein kinases? What are their functions?
11. What is diabetes mellitus?
12. Draw the structure of cGMP
13. How hormones are classified based on structure? .Give examples
14. Give four examples of steroid hormones
15. Explain the functions of somatostatin

### **Section B**

**Answer any 7 questions. Each question carries 5 marks (Ceiling 35 marks)**

16. Explain mechanism of action of steroid hormones
17. Explain the role of calcium in signal transduction
18. What is the function of glucagon
19. Differentiate between the terms endocrine and paracrine?
20. What are the functions of catecholamines
21. Explain feedback regulation with an example
22. Comment on the role of corticosteroid hormones.
23. Write notes on ADH

### **Section C**

**Answer any 2 questions. Each question carries 10 marks (Ceiling 20 marks)**

24. Write an essay on hormones of thyroid
25. Describe the molecular mechanism of insulin action
26. Describe the functions of the hormones of testes and ovaries
27. Explain the mode of hormonal action.

### **B.Sc. BIOCHEMISTRY (COMPLEMENTARY)**

Total credits for the complementary courses: 12

Total marks for the complementary course: 375

The evaluation scheme for each course (complimentary) shall contain two parts:

(1) Internal evaluation (2) External evaluation

20% marks shall be given to the internal evaluation. The remaining 80% of marks shall be for the external evaluation.

Components of and marks for the internal evaluation of theory courses are given below:

Total marks for internal evaluation = 15

- (a) Attendance = 4 marks
- (b) Test paper = 7 marks
- (c) Seminar/viva/assignment = 4 marks

Scheme for practical examinations

- (a) Maximum marks for external evaluation = 60
- (b) Maximum marks for internal evaluation = 15
- (c) Total marks for the practical examination = 75

Components and marks for the internal evaluation of practical courses are given below:

- (a) Attendance = 4
- (b) Records = 7
- (c) Lab involvement = 4

For practical examination the question paper will have the following components:

- (a) Writing the Procedure
- (b) Qualitative analysis
- (c) Quantitative estimation

**For each practical examination the laboratory record has to be compulsorily submitted.**

Scheme for the evaluation of practical examination

Marks may be assigned for various components as follows:

1. For Qualitative Analysis:

- a) Result & Conclusion
- b) Confirmatory test 1
- c) Confirmatory test 2
- d) Neatly written scheme of experiments used for arriving at the final conclusion

## 2. For Quantitative Experiments

- a) Result of the reported value (minimum error)
- b) Calculation, presentation of the result (Graph)
- c) Procedure
- d) Skill

## SEMESTER 1

### BCH1C01 BIOCHEMISTRY 1

Credit: 3 Total hours of instruction: 54. Hours/week: 2.

#### **Unit 1:** (10hrs)

Introduction to Biochemistry - Nature and scope of Biochemistry. Biochemical evolution of organisms - simple molecules - biomolecules - organelle - cell - organism. Miller and Urey experiment. Ultrastructure of cell. RNA as first genetic material

#### **Unit 2:** (10hrs)

Carbohydrates- isomerism of carbohydrates - D and L isomerism, epimerism, anomerism - mutarotation. Optical isomerism - d and l isomerism.

Monosaccharides -Structure of following monomers (linear and cyclic) - glucose, fructose, galactose, mannose. sugar derivatives - 2-deoxy  $\beta$  D ribofuranose. Reducing action of sugars.

Disaccharides - glycosidic bonds, structure and importance of the following disaccharides - maltose, sucrose, lactose, trehalose

Polysaccharides- structure and importance of following - Homopolysaccharides - cellulose, glycogen/starch, cellulose, chitin. Heteropolysaccharides - heparin, sialic acids, hyaluronic acid.

#### **Unit 3:** (20hrs)

Amino acids and proteins. structure of 20 amino acids occurring in proteins; Color reactions of amino acids. zwitter ions and isoelectric pH; peptide bond; structure of proteins - levels of organization- Primary, secondary and tertiary structures. Proteins sequencing - Sanger's method and Edman's reaction. Reactions of proteins - Biuret, Lowry; Precipitation reactions (organic solvent precipitation - acetone, ethanol, salt precipitation - ammonium sulphate, heavy metal ions). Denaturation and renaturation of proteins

#### **Unit 4:**(8hrs)

Nucleic acids - structure of purines, pyrimidines, Nucleosides, Nucleotides ATP and cAMP.  
RNA - structure and types. DNA - structure, and types, Watson and Crick Model

**Unit 5: (6hrs)**

(Lipids - Structure and Classification of lipids - simple lipids (fats and oils), compound lipids (phospholipids, sphingo lipids) and derived lipids (steroids - cholesterol, ergosterol).  
Physiological functions of lipids.

Fatty acids -Classification, saturated and unsaturated, essential and nonessential - structures. Reactions of lipids - saponification and saponification number, rancidity, acid number and iodine number.

**BCH1C05 BIOCHEMISTRY PRACTICAL I (2 hours per week)**

1. Qualitative analysis: (Semester I)

Carbohydrates- general reactions of carbohydrates (mono, di and polysaccharides) Molisch test, anthrone reaction, phenol -sulphuric acid reaction.

Specific reactions of reducing sugars. Benedict's test, Fehling's test, picric acid test, ferricyanide test. Seliwanoffs test and osazone reaction of sugars.

Scheme for analysis of biochemical solution containing a single component;

Carbohydrate (Glucose, Fructose, Lactose, Maltose, Sucrose and Starch.

protein (Biuret test, Lowry's test, solubility pattern, xanthoproteic test, Millon's test, glyoxylic acid test, nitroprusside test, precipitation by heavy metal ions and alkaloidal reagents)

**SEMESTER II**

**BCH2C02 BIOCHEMISTRY II**

**Credit: 3 Total hours of instruction: 54. Hours/week: 2**

**Unit 1: (15hrs)**

Water - universal solvent. Dissociation of water - concept of pH and pOH; Henderson - Hassel Balch equation, buffers - buffer and buffer action; titration curves of strong and weak acids and

bases, meaning of  $K_a$  and  $pK_a$  values. methods of measurement of pH using pH meter, indicator solutions. Basic ideas about hydrogen bond and weak interactions.

**Unit 2:** (10 hrs)

Osmosis, osmotic pressure, diffusion, active and passive transport, facilitated diffusion. Glucose transporter; Colloids, and Donnan Membrane equilibrium.

**Unit 3.** (7hrs)

Blood - Plasma proteins, special proteins in blood, Coagulation of blood, acid-base balance and maintenance of pH of blood.

**Unit 4: (10hrs)**

Chromatographic techniques - principles and applications of paper, thin layer, gas, HPLC, gel filtration, ion exchange.

**Unit 5.** (6hrs)

Electrophoretic techniques - SDS - PAGE, native PAGE, immunoelectrophoresis

**Unit 6:(6hrs)**

Absorption photometry - Beer - Lambert's law, colorimeter, spectrophotometer

**BCH1C05 BIOCHEMISTRY PRACTICAL II (2 hours per week)**

1. Weighing, Preparation of solutions, standard solutions, inter conversion of concentrations from, gram, milligram, microgram , and ppm etc.

a) Percentage solutions, molar solutions, normal solutions

b) Standardization of pH meter,

c) Preparation of buffer,

2. Principles of colorimetry and Verification of Beer-Lambert law.

3. Demonstration experiments:

a) Separation of amino acids by paper chromatography



b) Separation of amino acids by TLC.

c) Separation of proteins by SDS - PAGE

### **SEMESTER III**

### **BCH3C03 BIOCHEMISTRY III**

Credit: 3 Total hours of instruction: 54. Hours/week: 3.

#### **Unit I. Enzymes (15hrs)**

Introduction to Enzymology - apoenzyme, holoenzyme, prosthetic group; lock and key hypothesis and induced fit hypothesis. Classification of enzymes; Seven major classes of enzymes with one example each.

Factors affecting velocity of enzyme-catalyzed reactions, Michaelis Menten equation,  $K_m$  and its significance The Lineweaver- Burk plot.

Enzyme specificity – group specificity, optical specificity, geometrical specificity and cofactor specificity.

Enzyme inhibition: Reversible and irreversible, determination of competitive inhibition using double reciprocal plot. Allosteric regulation of enzyme action with example. Activation of zymogen.

Applications of enzymes - Industrial and medical (outline study only), Bioremediation

#### **Unit II. Anaerobic Metabolism of Carbohydrates (15hrs)**

Introduction to metabolism. Digestion of carbohydrates and absorption. Reactions of glycolytic sequences with the names of enzymes and intermediates (without structures). Fate of pyruvate in alcoholic fermentation. Outline study of glycogenesis and glycogenolysis. Role of cyclic AMP and hormones in glycogen metabolism. Gluconeogenesis and pentose phosphate pathway (only outline without structures of intermediates).

#### **Unit III. Aerobic Oxidation of Carbohydrates (18 hrs)**

Decarboxylation of pyruvate – reactions of citric acid cycle (without structures of intermediates) only outline expected. Calculation of energy yield (as ATP) of aerobic and anaerobic oxidation of

carbohydrates. Redox reactions. The mitochondria – arrangement of electron carriers in the electron transport chain.

Substrate level phosphorylation, Oxidative phosphorylation – site of ATP formation in the chain. Chemiosmotic mechanism. High energy compounds with an example. Phosphate potential, principle of reversible reaction. Uncouplers and inhibitors of electron transport chain.

#### **Unit IV. Photosynthesis (6hrs)**

Light dependent and Light independent reactions in photosynthesis. Cyclic and non-cyclic photophosphorylation- Path of carbon in the dark reaction (C<sub>2</sub>, C<sub>3</sub> and C<sub>4</sub> pathways), Kranz anatomy; glyoxylate cycle, significance.

### **BCH1C05 BIOCHEMISTRY PRACTICAL III (2 hours per week)**

#### 1. Quantitative analysis

- a) Glucose estimation by Benedict's method, anthrone or arsenomolybdate methods
- b) Amino acid estimation by Ninhydrin method
- c) Protein estimation by Biuret method.
- d) Protein estimation by Lowry *et al.* method.

### **SEMESTER IV**

#### **BCH4C04 BIOCHEMISTRY IV**

Credit: 2 Total hours of instruction: 54. Hours/week: 3.

#### **Unit I. Metabolism of Lipids (12hrs)**

Outline study of lipid digestion and absorption. Outline study of  $\beta$ -oxidation scheme. ATP yield in  $\beta$ -oxidation – outline study of the cytoplasmic systems of fatty acid biosynthesis. Outline study of cholesterol synthesis without structure.

#### **Unit II. Metabolism of Amino acids and Proteins (13hrs)**

Digestion and absorption of proteins; Ketogenic and glucogenic amino acids. Metabolism of ammonia; Decarboxylation, deamination and transamination of aminoacids (without molecular mechanisms). Urea cycle. Cori cycle.

### **Unit III. Biochemical basis of inheritance. (20hrs)**

Central dogma of molecular biology. Replication in *E.coli* – Features of semiconservative mechanism, Ori C, replication fork, Okazaki fragments, DNA Polymerases, other enzymes and protein factors required for replication. Transcription (*E. coli*) – RNA polymerases, , coding and non-coding strands, initiation, elongation and termination, promoters, sigma and rho factors. Features of Genetic code. Translation – role of ribosome. Types of RNA and their role in protein synthesis. Activation of amino acids, initiation, elongation and termination of protein synthesis.

### **Unit IV. Hormones (9hrs)**

Classification of hormones based on chemical nature and mechanism of action; site of biosynthesis and important physiological functions of thyroxine, insulin, glucagon, epinephrine, glucocorticoids and growth hormones.

### **References**

1. E.S. West, W.R. Todd, H.S. Mason and J.T. Van Bruggen. Text book of Biochemistry. Pub.The Macmillan Company, Collier-Macmillan Ltd., London
2. Plant Metabolism: H.D. Kumar and H.N. Singh Pub. Affiliated East-West Press Pvt. Ltd. New Delhi
3. Principles of Biochemistry: Worth Publishers A.L. Lehninger, D.L. Nelson and M.M. Cox.
4. Cell and Molecular Biology by Gerald Karp John Wiley & Sons,
5. Biochemistry U. Sathyanarayana Books and allied ( P) Ltd.
6. Biochemistry, LubertStryer , 4th edition, W.H. Freeman & Co, 1995.

### **BCH1C05 BIOCHEMISTRY PRACTICAL IV (1 credit; 2 hours per week)**

1. Quantitative analysis

a) Cholesterol estimation by Zak's method.

b) DNA estimation by diphenylamine method

c) RNA estimation by orcinol method

2. Demonstration of Digestion of starch by salivary amylase.

References:

1. Introduction to Practical Biochemistry Plummer Mu, David T. Plummer. Tata McGraw Hill Publishing Company
2. The Tools of Biochemistry : Cooper, T.G. . John Wiley & Sons, New York.
3. Principles of physical Biochemistry: K.E. Van Holde, Kensal, Pearson Education Inc

**Model question paper**

**BIOCHEMISTRY I - BCH1C01**

**Time: Two Hours**

**Maximum Marks: 60**

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**Section A**

**Answer all the questions. Each question carries 1mark**

1. Isomerism is exhibited by

a. Proteins b. Carbohydrates c. Fats

2. Cholesterol is a

a. lipid b. protein c. carbohydrate d. vitamin

3. Salt of a fatty acid is

a. Ester b. Soap c. Detergent d. Perfumes

4. ----- is an example for basic amino acid

5. When positive and negative charges are present in the same molecule, it is said to be

\_\_\_\_\_

6. On denaturation, only the \_\_\_\_\_ structure of protein is retained.

7. The phospholipid present in lecithin is \_\_\_\_\_

8. Cellulose is composed of \_\_\_\_\_ units.

9. Name a heteropolysaccharide with anticoagulant activity

**(1 × 9 = 9 marks)**

**Section B**

**Answer any seven questions. Each question carries 3 marks**

10. Draw the figure of a plant cell and label the following parts.
- (a) organelle in which ATP is produced
  - (b) a structure not present in an animal cell
  - (c) organelle in which lipids are produced
11. What is isomerism? Explain the type of isomerism in carbohydrates that involves functional C atom. Give one example.
12. What are epimers? Explain using suitable diagrams.
13. Explain the physiological functions of lipids
14. Explain the formation of an ester bond, using a suitable example. How many ester bonds are present in AMP?
15. What is protein sequencing? Briefly explain Sanger's method for Protein sequencing.
16. Draw the structure of Serine. Draw the group present in aspartic acid but not in serine. Name a group present in both.
17. Explain, why DNA is more suitable to be the genetic material, compared with RNA.

**(3 x 7 = 21 marks)**

**Section C**

**Answer any 4 questions. Each question carries 5 marks**

18. (a) What is the difference between homopolysaccharides and heteropolysaccharides? Give one example each
- (b) Name the type of chemical bond that joins monomers of polysaccharides. Explain the formation of this bond using suitable diagram.
- 19.(a) Name the carbohydrate transported in phloem sap of plants.
- (b) Explain, why carbohydrates are always transported in this form, not as any other molecules.
- (c) Draw a structure of this molecule
20. Explain the functions of proteins in animal body
21. Outline the structure of cholesterol and discuss its functions
22. (a) What do you mean by the term "denaturation of proteins"?
- (b) Explain the causes and results of denaturation.



- 4 When blood passes through capillaries, the fluid part oozes out forming \_\_\_\_\_
5. When the rate of forward reaction equals that of backward reaction, the system is said to be in \_\_\_\_\_
6. Name a plasma protein present in blood
7. What is the full form of PAGE?
8. What is the law applicable to colorimetry?
9. What is the name of a carbon atom which is attached to four different atoms or groups?  
(1 × 9 = 9 marks)

### Section B

**Answer any seven questions. Each question carries 3 marks**

10. What you mean by diffusion?
11. Meaning of Normality?
12. Define pOH?
13. Differentiate Ka and pKa value?
14. What is a colloid?
15. What is the principle of HPLC?
16. Write a short note on Glucose transporters
17. Dissociation of water

(3 x 7 = 21

marks)

### Section C

**Answer any 4 questions. Each question carries 5 marks**

18. Write down the Henderson Hasselbalch equation and state its applications.
19. Write short note on Donnan membrane equilibrium
20. Explain the biochemistry of blood clotting
21. Titration curves of strong and weak acids and bases.
22. buffers - buffer and buffer action





4. Which of the following factors can affect enzyme activity?  
a. Temperature b. pH c. The presence of certain metal ions d. All of the above
5. Name the organelle in which the CO<sub>2</sub> released during respiration is formed
6. Chemiosmotic hypothesis was proposed by -----
7. How many CO<sub>2</sub> molecules are released when three molecules of Glucose are converted in to pyruvate?
8. How does a reaction center differ from other pigments in the photosynthetic machinery?
9. Hexose sugar consists of atoms of C, H and O. Name the compound from which the H atoms are obtained during photosynthesis.

(1 x 9 = 9

marks)

**Section B: Answer any seven questions; each question carries 3 marks**

10. What is a zymogen? Why is it produced inactive? How is it activated?
11. What is the active site of an enzyme? How does it differ from the allosteric site?
12. What is competitive inhibition? Give an example
13. Differentiate between aerobic and anaerobic oxidation
14. Can the Calvin cycle take place in the absence of light reaction? Why? Explain.
15. Explain the stages of Glycolysis in which substrate level phosphorylation takes place.
16. Explain the formation of lactic acid fermentation. Why is it essential for the organisms?
17. What are the differences between cyclic and non-cyclic photophosphorylation?

(3 x 7 = 21 marks)

**Section C: Answer any four questions; each question carries 5 marks**

18. Draw the structure of mitochondrion; name and label the following parts.
- the area where lactic acid fermentation takes place
  - the place where succinate dehydrogenase is located
  - the molecule responsible for the formation of ATP
  - the area with the highest concentration of  $H^+$  ions when the mitochondrion is actively engaged in ATP synthesis.
19. Explain with the help of suitable example, how is  $C_4$  pathway advantageous for some plants
20. Write all reactions of aerobic carbohydrate metabolism in which decarboxylation takes place? Name the organelle in which these reactions take place.
21. Explain the reactions of dark reaction in photosynthesis. Name the enzyme responsible for fixation of  $CO_2$  in  $C_3$  plants.
22. Explain the reactions of TCA cycle in which hydrogen carriers are reduced.
- (5 x 4 = 20 marks)

**Section D: Answer any two questions; each question carries 10 marks**

- 23.
- Draw Lineweaver Burk Plot. (3 marks)
  - Why is this plot advantageous over MM plot? Explain using a suitable diagram (3)
  - How is Lineweaver Burk Plot useful in the study of enzyme inhibition? Explain using suitable diagrams. (4 marks)
- 24.
- How many ATP are produced from one molecule of glucose by complete aerobic respiration in prokaryotes? Explain (4 marks)
  - What happens to pyruvate in the absence of oxygen? Explain (4 marks)
  - Explain link reaction (2 marks)
- (10 x 1 = 10 marks)

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**Model question paper**  
**BIOCHEMISTRY IV - BCH4C04**

**Time: Two Hours**

**Maximum Marks: 60**

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**Section A: Answer all questions; each question carries 1 mark**

1. ATP yield during the  $\beta$  oxidation of palmitic acid is  
(a) 149 (b) 131 (c) 129 (d) 12
2. The coenzyme needed for fatty acid oxidation is  
(a) NAD (b) NADP (c) TPP (d) Biotin
3. Transamination reaction are carried out by.-----  
(a) Aminotransferases (b) Aminoacid carboxylase (c) Aminoacid oxidases (d) Dehydrogenase
4. Rate limiting enzyme in cholesterol biosynthesis is  
(a) HMG CoA reductase (b) HMG CoA synthase (c) Acetyl CoA carboxylase (d) Cholesterol synthase
5. Diabetes mellitus is due to the deficiency of  
(a) Insulin (b) Glucagon (c) Epinephrine (d) Inulin
- 6.----- is the codon of methionine
7. Name the site of  $\beta$  -oxidation of fatty acids
- 8.----- enzyme is involved in the activation of amino acid during translation
9. Which of the following is not a female sex hormone  
a. estradiol b. estriol c. progesterone d. testosterone

(1 x 9 = 9

marks)

**Section B**

**Answer any 7 questions. Each question carries 3 marks**

10. What is the function of carnitine?
11. What are stop codons?
12. Explain the term 'central dogma'
13. What are Okazaki fragments?
14. What do you mean by "inborn errors of metabolism"?
15. What are the major physiological functions of thyroxine
16. Short note on fatty acid synthase complex.
17. Cori cycle.

(3 x 7 = 21 marks)

**Section C: Answer any four questions; each question carries 5 marks**

18. Explain decarboxylation, deamination and transamination with examples.
19. Outline the reactions involved in the beta oxidation of fatty acids
20. Give an account of genetic code
21. Explain termination of transcription in detail
22. Give a brief account of urea cycle

(5 x 4 = 20 marks)

**Section D: Answer any two questions; each question carries 10 marks**

24. Explain the fatty acid biosynthesis.
25. Explain the replication process in prokaryotes

(10 x 1 = 10 marks)

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