UNIVERSITY OF CALICUT

Abstract

General and Academic - Faculty of Science - Scheme and Syllabus of BSc Biochemistry Programme for affiliated colleges under CBCSS UG Regulations 2019, with effect from 2020 Admission - Anomaly Rectified- Implemented subject to ratification by the Academic council-Orders Issued.

G & A - IV - J

U.O.No. 10214/2022/Admn Dated, Calicut University.P.O, 20.05.2022

Read:-1. U.O.No. 10202/2020/Admn, dated, 03.11.2020

2. U.O.No. 5787/2021/Admn dated,31.05.2021
3. Item No.4 in the minutes of the meeting of the Board of Studies in Biochemistry (Single Board) held on 08.04.2022
4. Remarks of Dean, Faculty of Science dated 24.04.2022
5. Orders of the Vice Chancellor in the file of even no, dated 04.05.2022.

ORDER

1. The Scheme and Syllabus of B.Sc Biochemistry Programme for affiliated colleges (CBCSS) was implemented vide paper read (1) above and vide paper read (2) above , Outcome Based Education (OBE) was incorporated in the existing syllabus of B.Sc Biochemistry programme (CBCSS), with effect from 2020 Admission.
2. The meeting of Board of Studies in Biochemistry held on 08.04.2022 has approved anomaly rectified Scheme and Syllabus of BSc Biochemistry Programme in tune with the new CBCSS UG Regulations 2019 with effect from 2020 Admission vide paper read (3) above.
3. The Dean, Faculty of Science vide paper read (4) above has approved the anomaly rectified Scheme and Syllabus of BSc Biochemistry Programme for affiliated colleges under CBCSS UG Regulations 2019.
4. Considering the urgency, the Vice Chancellor has accorded sanction to implement anomaly rectified Scheme and Syllabus of BSc Biochemistry Programme in tune with the new CBCSS UG Regulations with effect from 2020 Admission, vide paper read (5) above, subject to ratification by the Academic Council.
5. The anomaly rectified Scheme and Syllabus of B.Sc Biochemistry Programme for affiliated colleges under CBCSS UG Regulations 2019 with effect from 2020 Admission is therefore, implemented subject to ratification by the Academic Council .
6. Orders are issued accordingly. (Syllabus appended)

Abdussamad M

Assistant Registrar

To

The Principals of all Affiliated Colleges

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE V/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

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Section Officer

UNIVERSITY OF CALICUT

CURRICULUM AND SYLLABUS

For

B.Sc. Biochemistry

(Choice Based Credit Semester System UG -CBCSS 2020)

(CORE, OPEN & COMPLEMENTARY COURSES)

(w.e.f. 2020 Admission)

Board of Studies in Biochemistry

University of Calicut

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
First	Common	A01	Common English Course 1	4	3
	Common	A02	Common English Course II	5	4
	Additional Language	A07	Additional Language Course I	5	4
	Complementary		Food Science + Practical I **OR** Microbiology- Complementary I + Practical I	2+2	2 -
	Complementary		General Chemistry	4	2
	Core	BCH1B01	Introduction to Biochemistry & Cell Biology	3	3
Second	Common		Common English Course III	4	3
	Common		Common English Course IV	5	4
	Additional Language	A08	Additional Language Course II	5	4
	Complementary		Fundamentals of Nutrition+ Practical II **OR** Microbiology- Complementary II + Practical II	2+2	2 3
	Complementary		Physical Chemistry	4	2
	Core	BCH2B02	Biomolecules I	3	3
Third	Complementary		Fundamentals of Nutrition+ Practical III **OR** Microbiology- Complementary III + Practical III	2+3	2 -
	Complementary		Organic Chemistry	5	2
	General	A11	General Course I	4	4
	General	A12	General Course II	4	4
	Core	BCH3B03	Biomolecules II	3	3
	Core	BCH3B04	Techniques in Biochemistry	2	2
	Core	BCH3B05	Practical I (core)	2	-*

Fourth	Complementary		Dietetics + Practical IV **OR** Microbiology- Complementary IV + Practical IV	2+3	2+4
	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	Enzymology	3	3
	Core	BCH4B07	Intermediary Metabolism I	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	2	3
	Core	BCH5B11	Immunology & Microbiology	4	4
	Core	BCH5B12	Intermediary Metabolism II	4	4
	Core		Open course	3	3
	Core	BCH5B13	Practical II (Clinical Biochemistry and Enzymology)	10	-*
Sixth	Core	BCH6B14	Intermediary Metabolism III	3	3
	Core	BCH6B15	Molecular Biology and genetic engineering	4	4
	Core	BCH6B16	Clinical & Nutritional Aspects of Biochemistry	4	4
	Core	BCH5B13&B CH6B17	Practical II (Clinical Biochemistry and Enzymology)	-	5
	Core	BCH6B18	Practical III (Molecular Biology, Immunology and Nutritional Biochemistry)	10	4
	Core	BCH6B19	Project work	4	2

*No exams for practicals in the odd semester

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

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 I	3	3	15	60	75
Third	BCH3B03	Biomolecules II	3	3	15	60	75

rd	BCH3B04	Techniques in Biochemistry	2	2	15	60	75
	BCH3B05	Practical I (Carbohydrates, Lipids, Amino Acids, Nucleic Acids, and Techniques)	2	-	-	-	-
Fourth	BCH4B06	Enzymology	3	3	15	60	75
	BCH4B07	Intermediary Metabolism I	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
	BCH5B10	Human Physiology	2	3	15	60	75
	BCH5B11	Immunology /& Microbiology	4	4	20	80	100
	BCH5B12	Intermediary Metabolism II	4	4	20	80	100
		Open course	3	3	15	60	75
	BCH5B13	Practical II (Clinical Biochemistry and Enzymology)	10	-	-	-	-
Sixth	BCH6B14	Intermediary Metabolism III	3	3	15	60	75
	BCH6B15	Molecular Biology and genetic engineering	4	4	20	80	100
	BCH6B16	Clinical & Nutritional Aspects of Biochemistry	4	4	20	80	100
	BCH5B13& BCH6B17	Practical II (Clinical Biochemistry and Enzymology)	-	5	20	80	100
	BCH6B18	Practical III (Molecular Biology, Immunology and Nutritional Biochemistry)	10	4	20	80	100
	BCH6B19	Project	4	2	15	60	75
Total				**58**			**1525**

COMMON COURSES OFFERED BY B.SC. BIOCHEMISTRY COURSE IN 3rdAND 4thSEMESTERS

Sem	**Code**	**Name of Paper**	**Hours/ week**	**Credits**	**Marks**		
					Internal	**External**	**Total**
Third	A11	General Course I: Biodiversity – Scope and Relevance (Theory)	4	4	20	80	100
	A12	General Course II: Research Methodology (Theory)	4	4	20	80	100
Fo	A13	General Course III: Natural Resource Management (Theory)	4	4	20	80	100

urt h	A14	General Course IV: Intellectual Property Rights (Theory)	4	4	20	80	100
	Total			**16**			**200**

General papers for Semester III and IV were implemented as per the decision of the Combined meeting of BOS Chairmen discussion on subjects following the LPR pattern.

OPEN COURSES OFFERED BY BSC. BIOCHEMISTRY COURSE IN 5TH SEMESTER (SEMESTER 5: CREDIT: 3: HOURS/ WEEK 3)

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 depts.)	1	3
VI	Project (core)	1	2
Total			**120**

Total credits for the core courses **55**

Credits for the open course **3**

Total marks for the core course **1525**

EVALUATION AND GRADING

Mark system is followed instead of direct grading for each question. The evaluation scheme for each course shall contain two parts: Internal evaluation (20%marks) and External evaluation (80% marks).

THEORY COURSE EVALUATION SCHEME

Internal Evaluation

20% of the total marks in each course are for internal evaluation. The marks secured for internal assessment only need to be sent to the university by the college concerned.

Components with the percentage of marks of Internal Evaluation of Theory Courses

Sl No.	Components	Marks (for courses with maximum marks 75)	Marks (for courses with maximum marks 100)
1	Test paper (40%) *	6	8
2	Assignment (20%)	3	4
3	Seminar (20%)	3	4
4	Classroom participation (attendance) (20%) *	3	4
	Total	**15**	**20**

***Split up of marks for Test paper**

Range of Marks in the test paper	Out of 8 (Maximum internal marks is 20)	Out of 6 (Maximum internal marks is 15)
Less than 35%	1	1
35%- 45%	2	2
45% - 55%	3	3
55% - 65%	4	4
65% -85%	6	5
85% -100%	8	6

*** Split up of marks for classroom participation**

Range of CRP	Out of 4 (Maximum Internal marks are 20)	Out of 3(Maximum internal marks are 15)
50% ≤CRP <75%	1	1
75% ≤CRP <85%	2	2
85 % and above	4	3

ExternalEvaluation

External evaluation carries 80% of marks. The external question papers may be of uniform pattern with 80/60 marks. The courses with 2/3 credits will have an external examination of 2 hours duration with 60 marks and courses with 4/5 credits will have an external examination of 2.5 hours duration with 80 marks.

PRACTICAL COURSE EVALUATION SCHEME

Internal evaluation

For practical courses - Record 60% and lab involvement 40% as far as internal is concerned. (if a fraction appears in internal marks, the nearest whole number is to be taken)

Components with the percentage of marks of Internal Evaluation of Practical Courses (as per CBCSS UG Regulations 2019)

Sl No.	Components	Marks (for core and complementary courses with maximum marks 100)
1	Record (60%)	12
2	Lab involvement (40%)	8
	Total	**20**

ExternalEvaluation

Practical examination will be conducted at the end of semesters IV and VI. Practical examination and viva-voce shall be conducted by one external examiner and one internal

examiner appointed by the university**. The practical exams shall be organized for two days (6 hrs./day) for each practical paper in batches (Maximum of 18 students/batch/day) based on the number of students for core and complementary courses with a maximum mark of 80.** Student, who appears for a practical examination, must submit a certified bonafide record duly attested by the teacher-in-charge and head of the Department for practical examinations.

Maximum marks for external evaluation are 80 for Biochemistry core and complementary course practicals.

For university practical examination, the question paper will have the following components: (a) Writing the procedure, (b) Qualitative analysis, (c) Quantitative estimation

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 conclusion
2. For quantitative experiments: a) Result of the reported value (minimum error), b) Calculation, presentation of the result (Graph), c) Procedure d) Skill
3. Performance in Viva-voce
4. By evaluating records

PROJECT

Project works will be carried out in the sixth semester. A group of students shall be given a combined project to minimize the workload on teachers. Each student should submit a copy of the project report duly attested by the supervising teacher and the Head of the Department at the time of evaluation. The evaluation of the project work shall be conducted at the end of the sixth semester, the next day to the practical examinations. Project /dissertation evaluation and Viva-voce shall be conducted by one external examiner and one internal examiner appointed by the university. **It includes a presentation and Viva-voce based on the report of Project work.**

EVALUATION SCHEME

The evaluation of the project shall be done under Mark System. The evaluation of the project will be done at two stages: Internal and external evaluation

a. Internal evaluation (20%) (supervising teachers will assess the project and award internal marks)

b. External evaluation (80%) (external examiner appointed by the University)

c. Marks secured for the project will be awarded to candidates, combining the internal and external marks

d. The internal to external components are to be taken in the ratio l.:4.

The assessment of different components may be taken as below.

Internal assessment of Project

Sl. No.	**Components**	**Internal Marks (20% of total)**
1	Originality	3
2	Methodology	3
3	Scheme/organization of the report	4.5
4	Viva - voce	4.5
	Total	**15**

External Evaluation of Project

Sl. No.	**Components**	**External Marks (80% of total)**
1	The relevance of the Topic, Statement of Objectives	12
2	Reference/ Bibliography, Presentation, quality of Analysis/ Use of Statistical Tools.	12
3	Findings and recommendations	18
4	Viva – Voce	18
	Total	**60**

Submission of the Project Report and the presence of the student for viva are compulsory for internal evaluation. No marks shall be awarded to a candidate if she/ he fails to submit the Project Report for external evaluation. The student should get a minimum P Grade in aggregate of External and Internal. There shall be no improvement chance for the Marks obtained in the Project Report. In the extent of a student failing to obtain a minimum of Pass Grade, the project work may be re-done and a new Internal mark may be submitted by the Parent Department. The external examination may be conducted along with the subsequent batch.

GRADING

After internal and external evaluation, marks are entered in the answer scripts. All other calculations, including grading, will be done by the university using the software.

For each course in the semester, letter grades and grade points are introduced in 10point Indirect Grading System. Each course is evaluated by assigning marks with a letter grade (O, A+, A, B+, B, C, P, F, I, Ab) to that course by the method of indirect grading. An aggregate of P grade (after external and internal put together) is required in each course for a pass and also for awarding a degree (A minimum of 20% marks in external evaluation is needed for a pass in a course. But no separate pass minimum is needed for internal evaluation).

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SYLLABUS

CORE COURSES

SEMESTER I

BCH1B01: INTRODUCTION TO BIOCHEMISTRY & CELL BIOLOGY

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

Course Outcomes (COs):

On completing the course, the student will be able to:

No.	Course outcome
CO1	Recognize Biochemistry as a discipline and identify its foundations.
CO2	Develop the basic knowledge of good laboratory practices.
CO3	Identify the types of molecular interactions, concepts on acids, bases and solutions, and the physical aspects of Biochemistry.
CO4	Explain the cell as the basic structural and functional unit of life.
CO5	Describe the structure and functions of each organelle and the transport of molecules across the cell.
CO6	Comprehend biochemical events involved in cellular communications, cell cycle and cell death.

UNIT I: General Introduction & Laboratory Practices (5 hrs)

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

UNIT II: Water, Acids, Bases & Buffer (10 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 Ka and pKa values, buffers and buffer action. Buffers in the 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 (10 hrs)

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. The general equation for dilute solutions, the influence of ionization & molecular size on osmotic pressure.

Meaning of true solution, colloidal solution, and coarse suspension. The 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 the cell (5 hrs)

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 (8 hrs)

Transport across the membranes: definition, simple diffusion, facilitated transport – symport, uniport & antiport, active transport (Na^+- K^+ ATPase). Ion channels, ionophores.

UNIT VI: Cell-Cell Interactions (8 hrs)

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

UNIT VII: Cell Cycle & Cell Death (8 hrs)

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

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

& necrosis.

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E.D.P. Robertis and De Robertis, Cell and Molecular Biology. Published by Lippincott Williams & Wilkins, 1981.

SEMESTER II

BCH2B02: BIOMOLECULES I

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

Carbohydrates, Amino acids, Lipids, Vitamins, and Minerals

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Define the structure, properties, classification, general reactions and roles of carbohydrates.
CO2	Describe the structure, functions, classification and acid-base properties of amino acids.
CO3	Explain the structure, properties, major classes and roles of lipids.
CO4	Enumerate the importance of vitamins and minerals in biological systems.

Unit I: Carbohydrates: General classification and monosaccharides (8 hrs)

Definition, sources and general classification of carbohydrates with structures.

Classification of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, hexoses, and heptoses (with special emphasis to important members). Linear and cyclic structure, Rule of the ring (Structures of glucose, galactose, mannose, ribose, and fructose).

Isomerism of carbohydrates: structural 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.

Basic reactions: Reactions and characteristics of aldehyde and keto group: Reduction, Oxidation, Reaction with strong acids (dehydration) and alkalies on sugars (tautomerization or enolization), reactions of sugars due to hydroxyl group, formation of esters, osazone formation.

Unit II: Carbohydrates: Sugar derivatives (2 hrs)

Sugar derivatives: sugar alcohols, sugar acids, amino sugars, deoxysugars, sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid and their relevance.

Unit III: Carbohydrates: Disaccharides (5 hrs)

Disaccharides: concept of reducing and non-reducing sugars, structure (Fischer and Haworth projections), occurrence, chemistry, and functions of sucrose, lactose, maltose, isomaltose, and cellobiose. Inversion of sucrose.

Unit IV: Carbohydrates: Polysaccharides (6 hrs)

Polysaccharides, Classification, Homopolysaccharides: occurrence, structure, chemistry, and functions of cellulose, starch, glycogen, chitin, and inulin (with an explanation to the ends of the linear polymer of sugars). Heteropolysaccharides: occurrence, types, composition, and function.

Unit V: Amino acids (15 hrs)

Definition of alpha-amino acids. Sources and structure of biologically relevant amino acids. Stereoisomerism: Optical properties of amino acids: L- and D-forms of amino acids.

Structure and classification of amino acids based on polarity (with name, structure and additional functional groups). Three letter and single letter abbreviations of amino acids. Essential and nonessential amino acids.

General reactions of amino acids- side chain, carboxyl, and the amino group

Zwitter ions and isoelectric pH. Ionization of amino acids. Titration curve of amino acid and its significance.

Amino acids derivatives: γ-aminobutyric acid (GABA), dopamine, histamine, thyroxine.

Nonprotein amino acids: Gramicidin, beta-alanine, D-alanine, and D-glutamic acid, ornithine, citrulline, cystine, homocysteine, S-adenosylmethionine.

Separation of the amino acids by ion-exchange column chromatography.

Unit VI: Lipids (12hrs)

Definition, sources, functions and major classes of storage and structural lipids. 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. Difference between fats and oils.

Chemical-based classification of fatty acids with examples- sources and structure. Physical and chemical properties of fatty acids. Saponification number, acid number, and iodine number and their application.

Structure of the following fatty acids - short-chain, medium-chain and long-chain fatty acids. Sources of each fatty acid and its relative size. Fatty acids present in coconut oil, groundnut oil, sunflower oil, and fish oil.

Essential and non-essential fatty acids with examples.

Steroids: Sources, Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol. Eicosanoids–definition & classes only.

Unit VI: Vitamins and Minerals (6 hrs)

Definition, classification- fat-soluble and water-soluble, sources, chemical nature (without structure), functions of vitamins and deficiency diseases.

Macrominerals (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.

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SEMESTER III

BCH3B03 BIOMOLECULES II

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

Peptides, Proteins, Nucleic acids, and Bioinformatics

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Define peptides and proteins.
CO2	Explain the hierarchy of protein architecture (primary, secondary, tertiary & quaternary structure) and distinguish features of globular & fibrous proteins.
CO3	Describe the diverse functions and classifications of proteins.
CO4	Comprehend the fundamentals of nucleic acid chemistry, function and classification.
CO5	Familiarize with the bioinformatics tools, data analysis and applications of bioinformatics.

Unit I Peptides and Proteins (24 hrs)

Peptides

Formation of the Peptide, hydrogen bonds, features of peptides- dihedral (torsion) angles- Phi and Psi.

Oligopeptides: Structure and functions of naturally occurring Oligopeptides-glutathione, oxytocin, vasopressin, and insulin.

Make polypeptides with 5 amino acids (Compulsory exercise).

Proteins

Basic ideas about the classification:

Classification based on solubility (simple proteins, albumins, globulins, prolamins, glutelins, protamines, albuminoids), classification based on composition (simple and conjugated proteins), classification based on function (catalytic proteins - enzymes, regulatory proteins - hormones, protective proteins – antibodies, storage proteins, transport proteins, structural proteins, secretory proteins, exotic proteins, toxic proteins), classification based on size and shape (globular proteins, fibrous proteins, and intermediate proteins), classification based on the location of the protein in the cell (membrane-bound proteins- translocase, soluble cytosol proteins, matrix proteins, lysosomal proteins).

Nature of protein molecule-why proteins are so sensitive to the environment?

Structural organization of protein

Primary structure of protein: definition, elucidation of primary structure- N-terminus identification- Sanger's method, using Dansyl chloride, Edman degradation (explain with different steps). C-terminal identification- enzymatic digestion, using Cyanogen bromide (CNBr).

Secondary structure: Definition, the structure of C terminal and N terminals of protein. Confirmation, types of secondary structures- alpha, beta, turn or bends, loops, helixes, parallel and antiparallel beta-pleated sheet. Alpha helix, Ramachandran’s plot, Sources and examples related to secondary structures-keratin, collagen. Outline the structure of collagen.

Tertiary structure: Definition, tertiary forces (ionic, hydrophobic interaction, van der Waals forces, and electrostatic bonds). Protein denaturation and renaturation (explain with Ribonuclease enzyme). Examples - structures of myoglobin and hemoglobin.

Quaternary structures of proteins. Definition, Protein with quaternary structure- example- human hemoglobin, DNA polymerase. Demonstration of the 3D structure of a protein with molecular visualization software (not compulsory).

Chemical reactions, precipitation reactions - salt and heavy metal precipitation of proteins. Colour reactions for proteins.

Unit II: Nucleic acids (20hrs)

Percentage chemical composition of chromosomes (% level protein, DNA and RNA)

Nucleic acids -types

Structural organization of nucleic acids:

Primary structure (Bases, sugars and phosphoric acid): Structure of common purine and pyrimidine bases, tautomeric forms of bases, Structure of sugar, and phosphoric acid, the structure of nucleosides and nucleotides (Ribonucleotides and Deoxynucleotides)-unusual bases in nucleic acids. cAMP structure. Primary structure of DNA and RNA.

Polynucleotide: Structure, a diagrammatic representation of DNA polynucleotide and RNA polynucleotide. Linkages in nucleoside and nucleotide: Phosphodiester bond (structure) and 5’ and 3’ ends of the polynucleotide (structure).

Secondary structure of nucleotides: Three-dimensional structure of nucleic acids- Physical and chemical properties of DNA, Chargaff's base pair rule, X-ray Diffraction studies, Double helical structure of DNA: basic ideas of Watson and Crick model. Hydrogen bonding: Watson and Crick base pair and Hoogsteen base pair.

A, B, and Z forms of DNA, physical properties of DNA (glycosidic bond- anti and syn conformation and endo-exo confirmation of sugars and confirmation of heterocyclic base).

Nucleic acids: DNA and RNA: hyperchromic effect, Tm-values, cot curves, and their significance.

Types of RNA (tRNA, rRNA, mRNA). Elementary study of the structures of these RNAs.

Sequencing of DNA: basic principles of the methods: Maxam–Gilbert (chemical sequencing) and Sanger dideoxy sequencing (chain-termination method)

Unit III: Introduction to bioinformatics (10 hrs)

A brief study on the introduction, importance, and applications of bioinformatics. Introduction to molecular visualizing tools - RasMol, RASWIN. Introduction to data mining and data analysis methods. Applications of sequence searching tools- BLAST, Clustal X. Elementary study of databanks- Genbank, EMBL, PDB (brief study).

Reference

1. D.L. Nelson and M. M. Cox. Lehninger Principles of Biochemistry: Worth Publishers, Madisons Avenue New York, USA.
2. Lubert Stryer, John L. Tymoczko, Jeremy Mark Berg. Biochemistry. 9th edition, W. H. Freeman and Company • New York, 2019.
3. Voet, Donald, and Judith G. Voet. Biochemistry. New York: J. Wiley & Sons, 1995.
4. A.C. Deb, Fundamentals of Biochemistry, 7th Edition, New Central Book Agency-Kolkata, 2001.
5. Debajyoti Das. Biochemistry, Academic Publishers, 1978.
6. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry Publishers: S. Chand & Co Ltd. New Delhi. 2008
7. U. Satyanarayana, U.Chakrapani.Biochemistry, Books and Allied (P) Ltd., Calcutta, Latest Edition, 2013.
8. T.K Atwood and D.J Parry. Introduction Bioinformatics, Smith Publisher. Pearson Education Pvt Ltd. 2002.
9. Dan E. Krane and Michael L Raymer, (2003). Fundamental concepts of bioinformatics, Benjamin Cummings
10. Jean-Michel Claverie and Cedric Notredame. Bioinformatics: A Beginner's Guide. Wiley Publishing, Inc.2003

BCH3B04 TECHNIQUES IN BIOCHEMISTRY

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Familiarize with various techniques used in biochemical separation and analysis.
CO2	Outline the principles and applications of chromatography techniques.
CO3	Comprehend the principles and applications of different electrophoresis and centrifugation techniques.
CO4	Explain the principles, procedures and applications of spectrophotometric techniques.
CO5	Recognize the instruments used for each technique.

CO6	Identify biochemical importance and applications of the techniques.

Unit I Cell disruption techniques (5 hrs)

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

Unit II Chromatography (7 hrs)

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

Unit III Electrophoresis (6 hrs)

The principle, procedure, and application of free flow, zone electrophoresis (Paper electrophoresis, membrane electrophoresis Gel electrophoresis, PAGE, SDS-PAGE and disc PAGE). Isoelectric focusing, high voltage electrophoresis, pulse-field electrophoresis, immune electrophoresis. 2D electrophoresis.

Unit IV Centrifugation (6 hrs)

Principle of sedimentation technique. Relationship with rpm and radius of rotation. RCF and centrifugal force (×g). Different types of centrifuge and rotors. The principle, procedure, and application of differential centrifugation, density gradient centrifugation, ultracentrifugation, rate zonal centrifugation, isopycnic centrifugation.

Unit V Colorimetry and spectrophotometry (6 hrs).

Laws of light absorption -Beer-Lamberts 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. Radioisotopic methods (6 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.

4. Cooper T.G. The Tools of Biochemistry. John Wiley and Sons Publication.
5. Upadhyay A, Upadhyay K and Nath. Biophysical chemistry. Principles and Techniques: N., Himalaya publishing house.
6. Cark Jr J. M. and Switzer R.L, Experimental Biochemistry. W.H. Freeman and company.
7. Chatwal. G and Anand.S. Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Mumbai, India.

BCH3B05 PRACTICAL I
(CARBOHYDRATES, LIPIDS, AMINO ACIDS, NUCLEIC ACIDS, AND TECHNIQUES)
TOTAL HOURS: 36, HOURS/WEEK: 2

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Prepare different types of solutions and buffers by correlating theoretical knowledge.
CO2	Perform analysis using the instruments in a biochemical laboratory.
CO3	Analyze biochemical samples qualitatively.
CO4	Identify various biomolecules in the samples using standard protocols.

Practicals

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 the 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
4. S. Sadasivam and A. Manickam, Biochemical Methods. New Age International Pvt Ltd Publishers. 2018.
5. Cooper T.G., The Tools of Biochemistry. 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. Upadhyay A, Upadhyay K and Nath N. Biophysical chemistry. Principles and Techniques. Himalaya publishing house.

10. Cark Jr J. M. and Switzer R.L. Experimental Biochemistry. W.H. Freeman and Company.

SEMESTER IV

BCH4B06 ENZYMOLOGY

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Define enzymes, their specificity and activity
CO2	Describe the classification, nomenclature and units of enzyme activity.
CO3	Explain the structure, functions and mechanisms of action of co-enzymes**.**
CO4	Summarize kinetics of enzyme-catalyzed reactions and their remarkable regulation.
CO5	Outline the methods for the identification and purification of enzymes from their natural sources.
CO6	Describe immobilization of enzymes and industrial use of enzymes.

Unit I Introduction and Classification of enzymes (8hrs)

Introduction to enzymes. History. Proteins as enzymes. Briefly mention 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 (8hrs)

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

Unit III Enzyme catalysis and Mechanism of enzyme action (6hrs)

Specificity of enzymes and types (with examples), Concept of the 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, the energy of activation.

Unit IV Enzyme kinetics (10hrs)

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. Km 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 (10hrs)

Enzyme inhibition: reversible and irreversible with examples. Reversible- competitive, non-competitive 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 the 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 the regulation of metabolic pathways (Brief study).

Unit VI Isolation, purification, and characterization of enzymes (6hrs)

General protocol: Solubilization, and extraction from the sample; fractional precipitation (salting out, pH, heat, organic solvents, etc.). Purification: by chromatography (exclusion, ion-exchange, adsorption, affinity); electrophoresis (PAGE); isoelectric focusing. Criteria of purity: immunological, ultracentrifugation, etc.

Unit VII Immobilization of enzymes (6hrs)

Different methods of immobilization of enzymes (brief mention only). Industrial and clinical uses of enzymes: detergent enzymes, as a food additive, and in other industrial applications (give examples: thermostable 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.
2. Palmer, T, and Bonner, P. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry Publisher: Horwood Publishing Limited.
3. Anusha Bhaskar, V. G. Vidhya, Enzyme Technology, MJP Publications.2009
4. Stryer, L. Biochemistr yPub.W.H. Freeman
5. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & Sons Inc. NewYork
6. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley publisher
7. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry by, Publishers: S. Chand & Co Ltd.2008

BCH4B07 INTERMEDIARY METABOLISM I

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Recognize the importance of metabolic pathways in living cells and methods adopted to trace them out.
CO2	Review the basics of metabolic pathways and metabolic integration.
CO3	Comprehend the anaerobic phase of carbohydrate metabolism.
CO4	Describe the events in the protein degradation process.

Unit I Introduction to metabolism (10 hrs)

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

Unit II Carbohydrates (22 hrs)

Anaerobic phase: Glycolytic pathway with structures, energetics, and regulation of Glycolysis. The fate of pyruvate under anaerobic conditions. Fermentation. Feeder pathways for glycolysis: Glycogen and starch degradation, Hydrolysis of dietary disaccharides and polysaccharides, Entry of other monosaccharides to the glycolytic pathway: galactose/ fructose metabolism. Gluconeogenesis: from pyruvate, from amino acids (without structure) and from propionyl CoA and its regulation. Reciprocal regulation of glycolysis and gluconeogenesis. HMP shunt and its significance. Cori cycle. Glycogenolysis and its regulation. Regulation of committed step in each pathway.

Unit III Protein degradation (4 hrs)

Proteasome mediated cellular protein degradation, ubiquitins and proteases.

References

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman and Company, N.Y., USA.

2. Stryer, L. BiochemistryPub.W.H. Freeman
3. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & Sons Inc. NewYork

4. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley publisher
5. J. L. Jain, Sunjay Jain and Nitin Jain. Fundamentals of Biochemistry by, Publishers: S. Chand & Co Ltd.2008
6. U. Satyanarayana, U. Chakrapani. Biochemistry. books and Allied (P) Ltd
7. Debajyothidas Das. Biochemistry, Academic Publishers, 1978

BCH3B05+ BCH4B08: PRACTICAL I

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

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Identify laboratory requirements, instruments and their uses.

CO2	Perform colorimetric analysis and verify the principles involved
CO3	Develop basic practical skills in quantitative estimation of biomolecules and their separation techniques.

Quantitative analyses

1. Verification of Beer's law (Use KMnO4, K2CrO4 or similar coloured solution for this experiment)

2. Experimental verification of the molar extinction coefficient of any known compound.

3. Estimation of sugars (by any two methods only)

4. Amino acid estimation by ninhydrin method

5. Protein estimation by Biuret method.

6. Protein estimation by Lowry et.al method.

7. Cholesterol estimation by Zak's method or any other convenient method.

8. Fractional precipitation of protein from crude tissue extracts (Avoid plant tissue with phenolics in it. May use pulses or animal tissues)

9. Separation of sugars and amino acids by paper chromatography

10. Separation of lipids and amino acids by thin-layer chromatography (TLC)

11. Separation of serum protein by agarose gel electrophoresis (Demonstration)

12. Dialysis using dialysis membrane

13. SDS- PAGE (Demonstration)

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
4. S. Sadasivam and A. Manickam, Biochemical Methods. New Age International Pvt Ltd Publishers. 2018.
5. Cooper T.G., The Tools of Biochemistry. 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. Upadhyay A, Upadhyay K and Nath N. Biophysical chemistry. Principles and Techniques. Himalaya publishing house.
10. 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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Illustrate plant cell structure, functions and metabolism.
CO2	Explain the biosynthesis, regulation, physiological and biochemical action of plant hormones.
CO3	Describe the basis of mineral metabolism in plants.
CO4	Describe the nitrogen fixation and assimilation process.
CO5	Classify plant secondary metabolites and state their physiological and biochemical actions with examples.

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

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

Unit II Mineral and other metabolisms (9 hrs)

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 (8 hrs)

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 hrs)

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. V. K. Jain, Fundamentals of Plant physiology, S. Chand publications,2000.

2. Biju Dharmapal, Plant Biochemistry: An Introduction, Alpha Science International Limited, 2016

3. Anderson, J. W., and Beardall, J. Molecular activities of plant cell: An Introduction to plant Biochemistry, Blackwell Science.

4. Bonner, J. and Varner, J. E. Plant Biochemistry, Academic Press, New York

5. Hopkins, W. G. and Norman. P.A. Hunger, Introduction to Plant physiology, 3rd edition

6. Pandey, S. N. and. Sinha, B.K. Plant Physiology, Vikas Publishing House Pvt. Ltd, 3rd edition, 1999.

7. Stumpf, P. K. and Conn, E. E (1980). The Biochemistry of Plants: A Comprehensive Treatise. Academic Press.

8. Taiz, L. and Zeiger E, Plant Physiology, 5th Ed. (2010), Sinauer Associates, Inc Publishers, Massachusetts

9. Verma, V. Plant physiology 7th Revised edition, Emkay Publications 2001.

10. H.D. Kumar and H.N. Singh. Plant Metabolism. Publisher: Macmillan 1980

11. K.G. Ramawat. Biotechnology: Secondary Metabolites, Science Publishers, 2000.

12. P. M. Dey and J. B. Harborne. Plant Biochemistry Publisher: Academic Press 1997

BCH5B10 HUMAN PHYSIOLOGY

TOTAL HOURS: 54, CREDITS: 3, HOURS/WEEK: 2

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Describe the homeostasis and organization of fluid compartments of the human body.
CO2	Outline the physiology of digestion and absorption.
CO3	Explain the physiological function of the respiratory system.
CO4	Describe the organization and physiology of blood and kidneys.
CO5	Illustrate the functions of organ systems, their coordination and specialized tissues.
CO6	Describe the hormonal control of various physiological functions of the human body.

Unit I Introduction to physiology (3 hrs)

Functional organization of the human body, extracellular and intracellular fluids, constituents and characteristics of extracellular fluid, homeostasis, an overview of coordination between major functional systems of the human body.

Unit II Digestion and absorption (5 hrs)

Functions of different gastrointestinal organs in digestion and absorption, secretion of digestive fluids and enzymes, activation of digestive enzymes, gastrointestinal hormones, epithelial transport of solutes, Digestion and absorption of carbohydrates, proteins, lipids, vitamins and minerals, composition, types, and function of bile, enterohepatic circulation.

Unit III Biochemistry of Blood: (7 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 haemoglobin, 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 (7 hrs)

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

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 (6 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, the role of creatine and creatine kinase.

Neurons- structure, mechanism of nerve impulse transmission, neurotransmitters, acetylcholine, 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.

Unit VI Endocrinology (8 hrs)

Organization of the endocrine system. Hormone secretion, transport, and clearance from blood, General mechanism of hormone action-Classification of hormones and hormone action- type I and type II hormones. Concept of second messengers- cAMP, DAG, IP3, G protein.

A brief study of chemistry, action and major physiological functions of hormones of Hypothalamus (vasopressin, oxytocin), Pituitary (growth hormone, corticotropic hormone, thyroid-stimulating hormone, gonadotropic hormone), Adrenal (epinephrine, glucocorticoids, mineralocorticoids), Thyroid (thyroxine, calcitonin), Parathyroid, Pancreas (insulin, glucagon) and Gonads (androgen, estrogen).

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. Gerald J Tortora, Bryan Derrickson, Principles of Anatomy and Physiology (Pub) John Wiley and Sons Inc
4. Chatterjee. Human physiology, Medical Allied Agency.
5. R.K. Murray, D. K. Granner, Peter A Mayer, Victor W Rodwell. Harper's Biochemistry, Lange Medical Publications, 1991.

BCH5B11 IMMUNOLOGY & MICROBIOLOGY

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Recognize the basics of immunology, types and components of the immune system.
CO2	Describe the basic mechanism and functional role of innate and adaptive immunity.
CO3	Explain the mechanisms involved in different types of hypersensitivity and diseases associated with immune function.
CO4	Summarize the role of vaccines.
CO5	Memorize microbial culture and sterilization techniques.

Unit I Overview of the immune system (10hrs)

Immunity, types of immunity: 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 (15 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 (12hrs)

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. Compliment deficiencies. Immunodeficiency diseases: Phagocytic, humoral and cell-mediated deficiencies.

UNIT IV Hypersensitivity and autoimmunity (15hrs)

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 devastative role. Autoimmune diseases- Definition & classification (organ-specific and systemic autoimmune diseases like HIV, systemic lupus erythematosus, Multiple sclerosis, Rheumatoid arthritis, scleroderma, Myasthenia gravies, 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 (15 hrs)

Definition and history of Microbiology: Leeuwenhoek and his microscope, Germ theory of disease- Koch's postulates. Basic understanding of the classification of Bacteria, Bacteriophages, Viruses, Algae, Fungi and Protozoa.

Microbial growth, growth rate, doubling time, exponential growth phase. Factors influencing growth- nutrition, carbon source, nitrogen source, temperature, pH, oxygen. Growth curve.

A brief study on Sterilization: Physical and Chemical methods - Dry and Moist Heat, Pasteurization, Radiation, Ultrasonication. Disinfection, Sanitization, Antiseptics, Sterilants, and Fumigation.

Preparation of culture media: Selective, Enrichment and Differential media. Requirements for carbon, N_2.

Microbial culture methods: Plating techniques (spread plate, streak plate and pour plate) and Isolation of pure colonies.

Staining: Simple staining, Negative staining and Gram staining.

Culture preservation techniques: Refrigeration, Deep freezing, Freezing under liquid Nitrogen and Lyophilization.

Definition of Antibiotics and mechanism of action of penicillin and chloramphenicol.

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. S C Rastogi, Elements of Immunology. Publisher: CBS Publishers&Distributors.2006

4. Ian R Tizard. Immunology: An Introduction, Publisher: Cengage Learning (Thompson) 2006

5. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

6. Lansing M. Prescott. Microbiology. IV edition, McGraw-Hill

7. Brooks GF, Carroll KC, Butel JS and Morse SA.(2007).Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

8. M.J. Pelzar, Jr. et al. Microbiology. McGraw Hill

BCH5B12 INTERMEDIARY METABOLISM II

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	State how oxidation is used as a mechanism of energy release from carbohydrates, lipids and amino acids.
CO2	Comprehend the aerobic phase of carbohydrate metabolism.
CO3	Describe the fatty acid oxidation and amino acid catabolism, the mechanism by which energy released is stored in high energy molecules and the basics of bioenergetics.
CO4	Explain how atmospheric carbon is fixed in plant cells by photosynthesis and photophosphorylation.

Unit II. Carbohydrates (10 hrs)

Aerobic phase: Production of acetyl CoA, reactions of the citric acid cycle with structures, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxylate pathway, coordinated regulation of glyoxylate and citric acid pathways.

Unit II. Bioenergetics (12 hrs)

Introduction, Thermodynamics (Brief study) and relevance in the biological system (Brief study). Free energy change. Difference between ΔG and ΔG^{o}. The requirement of free energy for cells, coupling reactions, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard free energy of ATP hydrolysis, other phosphorylated compounds and thioesters. ATP as universal energy currency in the biological system, Role of high energy phosphates in energy transfer-redox potential, biological oxidation.

Unit III Oxidative phosphorylation (13 hrs)

Structure of mitochondria. Electron transport chain - its organization (sequence of electron carriers: NADH ubiquinone dehydrogenase, Succinate dehydrogenase, cytochrome reductase, and cytochrome oxidase) and function. Peter Mitchell's chemiosmotic hypothesis (an outline). P/O ratio, Proton motive force. FoF1 ATP synthase, structure, oxidative phosphorylation and mechanism of ATP synthesis. Regulation of oxidative phosphorylation. Inhibitors and uncouplers. Transport of reducing potentials into mitochondria and metabolite transporters in mitochondria. A brief study on oxygen toxicity, free radical formation, ROS production, and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

Unit III Photosynthesis and Photophosphorylation (13hrs)

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

Unit II Fatty acid oxidation (12 hrs)

β- oxidation of fatty acids. β-oxidation of palmitic acid and its energy balance sheet. Regulation of fatty acid oxidation, ketone body metabolism, ketoacidosis.

Unit III Catabolism of amino acids (12hrs)

Transamination, oxidative deamination, reductive amination, non-oxidative deamination and decarboxylation of amino acids. Role of pyridoxal phosphate.

Metabolic fates of amino acids- glucogenic, ketogenic and gluco-ketogenic amino acids (structures not needed). Urea cycle. Details on committed steps in the cycle with structure.

References

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 6th Edition, W.H. Freeman and Company, N.Y.,USA.

2. Stryer, L. BiochemistryPub.W.H. Freeman

3. Voet, D. and. Voet, J. G, Biochemistry, 4th Edition, John Wiley & Sons Inc. NewYork

4. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley publisher

5. J. L. Jain, Sunjay Jain and Nitin Jain. Fundamentals of Biochemistry by, Publishers: S. Chand & Co Ltd.2008

6. U. Satyanarayana, U. Chakrapani. Biochemistry. books and Allied (P) Ltd

7. Debajyothidas Das. Biochemistry, Academic Publishers, 1978

BCH5B13 PRACTICAL II (CLINICAL AND ENZYMOLOGY)

TOTAL HOURS: 180 HOURS/WEEK: 10

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Perform clinical laboratory techniques such as haematology and estimations.
CO2	Demonstrate various enzymatic and nonenzymatic assays used for the diagnosis of defects in organ function and metabolic disorders.

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 ά ά 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 aminotransferase (ALT/SGPT)

c) Assay of serum aspartate aminotransferase (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. 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. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
6. Vasudevan, Practical textbook of Biochemistry for medical students, Jaypee Brothers Medical Publishers, 2013
7. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers 2013.
8. J. Ochei, Arundhati Kolhatkar. Medical Laboratory Science: Theory and Practice.

McGraw Hill Education.2000

9. Textbook of Biochemistry with clinical correlations. Thomas M. Devlin. Wiley Publishers.

10. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company

11. K. Park. Park's Textbook of Preventive and Social Medicine

SEMESTER VI

BCH6B14 INTERMEDIARY METABOLISM III

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Comprehend the biosynthetic pathways and regulation of various biomolecules such as carbohydrates, lipids and amino acids and their derivatives.
CO2	Explain nucleic acid biosynthesis and degradation and discuss above the regulation.

Unit I Carbohydrates (12 hrs)

Glycogenesis and details on regulatory mechanisms of glycogen metabolism.

Regulated synthesis of starch and sucrose. Synthesis of cell wall polysaccharides: plant cellulose and bacterial peptidoglycan.

Unit II Lipids (12hrs)

Fatty acid synthase complex, Biosynthesis of fatty acids and regulation, Fatty acid elongation.

Cholesterol biosynthesis (structure not needed), Derivatives from cholesterol and its significance. A brief account of the committed steps in the cholesterol biosynthesis pathway. Synthesis of steroid hormones from cholesterol (structure not needed).

Unit III Biosynthesis of amino acids (12 hrs)

A brief outline of the metabolism of aromatic amino acids, glycine, valine and methionine (structure not needed).

Derivatives from amino acids (the structure is not needed): Biosynthesis of creatine and creatinine, catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis.

Unit IV Metabolism of Purine and pyrimidine nucleotides (18hrs)

De novo synthesis of purine and pyrimidine nucleotides, regulation, salvage pathways (structure not required). Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides (structure not required).

Degradation and end products of purine and pyrimidine nucleotides (structure not required). Inhibitors of nucleotide metabolism. Details on committed steps in the metabolic pathway.

Reference

1. Voet, Donald, and Judith G. Voet. Biochemistry. New York: J. Wiley & Sons,1995.
2. D.L. Nelson and M. M. Cox. Lehninger Principles of Biochemistry: Worth Publishers, 41 Madisons Avenue New York, USA
3. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers
4. Lubert Stryer, Biochemistry, 4th edition, W.H. Freeman & Co, 1995
5. J. L. Jain, Sunjay Jain, and Nitin Jain. Fundamentals of Biochemistry Publishers: S. Chand & Co Ltd. New Delhi. 2008

6. U. Satyanarayana, U. Chakrapani. Biochemistry. books and Allied (P) Ltd
7. Debajyothidas Das. Biochemistry, Academic Publishers, 1978

BCH6B15 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Describe the genome organization, the concept of the central dogma, Chromosome structure and transposable elements.
CO2	Explain prokaryotic DNA replication, transcription, and translation processes.
CO3	Identify the basic processes involved in gene expression and its regulation.
CO4	Discuss the mutational changes in genetic material and how the systems repair them.
CO5	Enumerate the principles and techniques in genetic engineering.
CO6	Describe the fundamentals of genetics and common aberrations that occur in chromosomes.

Unit I Genome organization and transposons (10 hrs)

The central dogma of molecular biology. Identification of DNA as a genetic material: Experiments of Griffith, Avery, McLeod and McCarty, Hershey and Chase, Lederberg and Tatum. Chemical nature of the gene, the definition of a gene, 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 II Replication of DNA (12hrs)

DNA replication in prokaryotes. Theory and types of DNA replication. A detailed account of enzymology, chemistry, and events of DNA replication. Replication fork.

Difference between prokaryotic and eukaryotic replication.

Unit III Transcription (10 hrs)

Transcription in prokaryotes. Detailed theory, enzymology, chemistry, and events of transcription. Inhibitors of transcription.

Difference between prokaryotic and eukaryotic transcription. A brief mention of post-transcriptional processing.

Unit IV Translation and regulation of gene expression (12hrs)

Definition and salient features of Genetic code, triplet code, codon, and genetic code word chart and wobble hypothesis. Translation in prokaryotes: a detailed account of enzymology, chemistry, and events of protein synthesis. Inhibitors of protein synthesis.

Difference between prokaryotic and eukaryotic translation. A brief mention of the post-translational modifications.

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

Unit V Mutation and DNA repair (12 hrs)

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

DNA 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, the definition of carcinogenesis.

Unit VI Genetic Engineering (12 hrs)

Basic principles of recombinant DNA technology. Isolation of DNA, Enzymes involved in genetic engineering, Cutting of DNA by restriction endonucleases- staggered cut and blunt cut. Separation of DNA fragments by agarose gel electrophoresis. Vectors, Plasmids- PBR322, phage, cosmids, bacterial artificial chromosome (BAC), phage P, vector PACs (P1 artificial chromosomes), Yeast artificial chromosome (YAC) and human artificial chromosomes (brief study). Insertion of foreign DNA into vectors. Transfection of vectors into the host cell. Gene transfer techniques, separation techniques, and screening strategies. cDNA library. Polymerase chain reaction and its applications (Basic study). Basic study on Blotting techniques- Principle of Southern, Western and Northern blotting. DNA fingerprinting. Molecular markers – RFLP, RAPD, AFLP analysis (Brief study). Application of Genetic Engineering, Transgenic plants, Transgenic animals, Gene Therapy (basic study). Human genome project.

Unit VII Fundamentals of genetics (4hrs)

Mendel's laws of inheritance, Gene interactions (basics only): complete, incomplete and co-dominance, multiple alleles, linked genes.

Chromosomal aberrations: Structural and numerical: Deletion, Duplication, Inversion, Translocation, Aneuploidy, and Polyploidy (brief study)

References

1. Benjamin Lewin, Genes: Pearson education Inc. upper SiddleRiverNJ.
2. Gerald Karp. Cell and Molecular biology, John Wiley & Son Inc. NewYork
3. D. L. Nelson and M. M. Cox. Lehninger Principles of Biochemistry, Worth Publishers, 41 Madisons Avenue New York,USA
4. Benjamin A. Pierce. Genetics: A conceptual approach, WH Freemanpublications,2016

5. Watson, JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AAM, Molecular Biology of the Gene 1987. The Benjamin/Cummings publishing company.

6. Friefelder D. Molecular Biology, Narosa Publishing Home.1991.
7. D. Peter Snustard, Genetics, John Wiley and sons publications,2011
8. Peter J. Russel. iGenetics A molecular approach. Pearson Education India,2016
9. B.D Singh, Biotechnology, Expanding horizons. Kalyani publications,2015
10. Burton E. Tropp, Molecular Biology: Genes to protein, Laxmipublications,2012

11. David.T. Suzuki, Antony J.F. Griffiths, et al, An introduction to genetic analysis, WH Freeman & Co. Ltd.1996
12. T.A. Brown. Gene cloning and DNA analysis: An introduction. Fifth edition, Blackwell publishing.
13. S B Primrose. Molecular Biotechnology: Panima Publishing Corporation.
14. U Satyanarayana. Biotechnology. Books and Allied (p) Ltd.

15. Sambrook J, Fritsch EF and Maniatis T. Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.2001.

BCH6B16 CLINICAL & NUTRITIONAL ASPECTS OF BIOCHEMISTRY

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Describe the principles of clinical laboratory maintenance, clinical samples and their analysis.
CO2	Enumerate routine clinical assays, organ function tests and their clinical significance.
CO3	Describe the biochemical aspects of certain pathological conditions, especially those due to abnormal metabolism.
CO4	Comment on the role of diet in healthy living, food safety and hygiene.

Unit I Good clinical practices (6hrs)

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

Unit II Analysis of body fluids (20 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+, K+, Cl- 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 clinical significance.

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

Unit III Organ function tests (15 hrs)

Normal functions of the 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 the kidney, Renal function tests, Glomerular filtration rate, Renal threshold and clearance values for urea and creatinine, disorders of the 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, postprandial and random sugar, glycated hemoglobin, the significance of glucose tolerance test, hyperinsulinism and hypoglycemia, galactosemia, lactose intolerance, glycogen storage diseases, pentosuria, phenylketonuria, alkaptonuria, maple syrup urine, hyperlipidemia, atherosclerosis, sphingolipidosis. Disorders of purine and pyrimidine metabolism.

Unit V Nutrition: (13 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, the nutritional significance of proteins, fats, carbohydrates, fiber, vitamins, minerals, and trace elements. The nutritional profile of principal foods- Cereals, pulses, vegetables, fruits, nuts, oilseeds, 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, Foodborne diseases, Community nutrition program, Social aspects of nutrition - problems, ecology, social action.

References

1. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers,2006.
2. Harper's Biochemistry Ed. R.K. Murray, D.K. Granner, P.A. Mayes &V.W. Rodwell.
3. Human Nutrition and Dietetics. Davidson and Passmore. Churchill Livingstone; 8th edition (1986)
4. Shivaraja Shankara YM. Laboratory Manual for Practical Biochemistry, Jaypee Brothers Medical Publishers2013.
5. M Swaminathan. Advanced textbook on food & nutrition, Bapcco Publisher,2015
6. B. Srilakshmi. Nutritional science B. Srilakshmi, New Age International, 2006
7. B. Srilakshmi. Food Science, New Age International, 2003
8. Food and Nutrition. Don Ross, Oxford Book Company, Jaipur.

9. Thomas M. Devlin. Textbook of Biochemistry with clinical correlations. Wiley Publishers.

Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company

BCH5B13 & BCH6B17 PRACTICAL II (CLINICAL AND ENZYMOLOGY)

CREDITS: 5

*No practical hours in the sixth semester

BCH6B18 PRACTICAL III

(MOLECULAR BIOLOGY, IMMUNOLOGY AND NUTRITIONAL BIOCHEMISTRY)

TOTAL HOURS: 180, CREDITS: 4, HOURS/WEEK: 10

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Perform the basic techniques in molecular biology, immunology and nutritional biochemistry.
CO2	Isolate and estimate nucleic acids from biological samples.
CO3	Estimate nutrients from food samples.

Molecular Biology:

1. Isolation of nucleic acids, Electrophoretic separation of nucleic acids
2. Estimation of DNA by diphenylamine 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 the 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. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology Seventh edition, Cambridge University Press 2010
4. S. Sadasivam and A. Manickam, Biochemical Methods. New Age International Pvt Ltd Publishers. 2018.
5. Ramnik Sood. Textbook of Medical Laboratory Technology. Jaypee Brothers Medical Publishers, 2006.
6. Vasudevan, Practical textbook of Biochemistry for medical students, Jaypee Brothers Medical Publishers, 2013
7. J. Ochei, Arundhati Kolhatkar. Medical Laboratory Science: Theory and Practice. McGraw Hill Education.2000
8. Burtis & Ashwood W.B. Tietz Textbook of Clinical Chemistry. Saunders Company
9. K. Park. Park's Textbook of Preventive and Social Medicine

10. Sambrook J, Fritsch EF and Maniatis T. Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.2001.

BCH6B19 Project

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

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Describe basic concepts and tools of research methodology.
CO2	Collect relevant bibliographic material from different sources, organize it into a suitable form (Introduction, Backgrounds, material and methods, results, conclusion, Bibliography etc.) and make a written project report.
CO3	Present the project work.

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OPEN COURSES

BCH 5D01 ELEMENTARY BIOCHEMISTRY

CREDITS: 3 TOTAL HOURS: 54 HOURS PER WEEK: 3

Course outcomes (Cos)

On completing the course, the student will be able to

No.	Course outcome
CO1	Identify the basic concepts of Biochemistry
CO2	Provide preliminary knowledge on pH, buffers, major biomolecules, cell as the structural and functional unit of life, the concept of metabolism and applications of Biochemistry

UNIT I (4 hrs)

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

UNIT II (5 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 the 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 (7 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 (15 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. David L. Nelson and Michael M. Cox, Lehninger's Principles of Biochemistry - Worth W. H.Freeman andCo
2. JL Jain, Textbook of Biochemistry S. Chand and Co Ltd NewDelhi
3. U. Satyanarayana, U. Chakrapani. Biochemistry Books and allied (P)Ltd
4. Eric E Conn, Paul K Stumpf, George Bruening, Roy H John, Outlines of Biochemistry- Weily and sons NewYork

BCH 5D02 LIFESTYLE DISEASES

CREDITS: 3 TOTAL HOURS: 54 HOURS PER WEEK: 3

Course outcomes(Cos)

On completing the course, the student will be able to

No.	Course outcome

CO1	Identify major biomolecules present in the living system
CO2	Acquire preliminary knowledge on a healthy lifestyle and the characteristics, causes, risk factors diagnosis, prevention, and management of major lifestyle disorders.

UNIT I (4 hrs)

General awareness

Basic biochemistry (Biomolecules- carbohydrates, lipids, proteins, nucleic acids, vitamins, minerals – brief outline), Lifestyle, 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 (4 hrs)

Hypertension: Characteristics, Causes, Diagnosis, Prevention, and Management

UNIT-IV (4 hrs)

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

Unit V (6 hrs)

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 (4 hrs)

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

Unit VII (8 hrs)

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 VIII (8 hrs)

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 IX (8 hrs)

Liver disease: Function of the 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 aminotransferase, alanine aminotransferase, lactate dehydrogenase, treatment, and management.

References

1. Arthur C Guyton. Textbook of Medical Physiology, John E Hall Prism Saunders
2. U. Satyanarayana, U. Chakrapani, Biochemistry, books and Allied (P)Ltd
3. Gerald Karp. Cell and Molecular Biology John Wiley &Sons,

BCH 5D03 CLINICAL DIAGNOSIS OF COMMON DISEASES

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

Course outcomes (Cos)

On completing the course, the student will be able to

No.	Course outcome

CO1	Acquire basic knowledge on the causes, symptoms, organs affected, risk factors, diagnosis and management of major diseases

UNIT I (9 hrs)

Diabetes Mellitus: Hypoglycemia, hyperglycemia, a basic understanding of type 1 and type2 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, the role of hemoglobin A1c in diagnosis, diagnosis of diabetic ketoacidosis and retinopathy.

UNIT II (9 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 (9 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 (9 hrs)

Thyroid disorders: functions of the 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 (9 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 (9 hrs)

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 SaundersCo
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 ClinicalAspects.
5. Orla Hardiman & Colin P. Doherty. Neurodegenerative Disorders A Clinical Guide. Ed. Springer, New York.

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GENERAL COURSES

SEMESTER III

GENERAL COURSE I
A11.BIODIVERSITY – SCOPE AND RELEVANCE(THEORY)
TOTAL HOURS: 72, CREDITS: 4, HOURS/WEEK: 4

Unit I Defining Biodiversity (12 hrs)

The concept of biodiversity. Biodiversity crisis. Importance of biodiversity in daily life. Biodiversity and climate change. India as a mega biodiversity nation. Hot spots of biodiversity in India.

Unit II Components of Biodiversity. (12 hrs)

Genetic diversity, species diversity, and ecosystem diversity. Brief outlines of the magnitude of bacterial, fungal, protist, animal and plant diversity.

Unit III Loss of Biodiversity (12 hrs)

Factors causing loss of genetic- species- and ecosystem diversity. Processes responsible for species extinction. Threatened species and IUCN Red List categories. Loss of agrobiodiversity. Significance of wild relatives of cultivated plants and domesticated animals.

Unit IV Values and uses of biodiversity (12hrs)

Ethical and aesthetic values of biodiversity. Direct and indirect economic benefits of biodiversity. Bio-prospecting - micro-organisms and plants as a source of novel enzymes, antibiotics, antiviral agents, Immunosuppressive agents, and other therapeutic agents.

Unit V Inventorying and Monitoring of Biodiversity (12hrs)

The need for inventorying and monitoring of biodiversity. Methods of inventorying and monitoring of biodiversity and their limitations.

Unit VI Conservation of biodiversity (12hrs)

Conservation of genetic-, species- and ecosystem diversity. In situ and ex situ conservations: biosphere reserves, national parks, wild-life sanctuaries, gene banks, seed banks, botanical gardens, microbial culture collections.

Reference

1. Patent, D. H., Munnoz W. 1996. Biodiversity. Clarion Books.
2. Maiti, P. K., Maiti, P. 2011. Biodiversity: Perception, Peril and Preservation. Prentice Hall India.
3. Maclaurin, J. 2008. What is biodiversity? University of Chicago Press.
4. Krishnamurthy, K. V. 2003. Textbook of Biodiversity. SciencePublishers Inc.
5. Wilson E. O. 2010. The Diversity of Life. Harvard University Press.
6. Hosetti B.B., Ramkrishna, S. 2016. Biodiversity: Concepts and Conservation. Aavishkar Publishers.
7. Kumar A. 2011. Understanding Biodiversity. Discovery Publishing House.
8. Hendon, J. 2017. Textbook of Biodiversity. Syrawood Publishing House.
9. Adom, D. Umachandran, K., Ziarati, P., Sawicka, B., Sekyere, P. 2019. The Concept of Biodiversity and its Relevance to Mankind: A Short Review. Journal of Agriculture and Sustainability 12(2): 219-231.
10. Ehrlich, P.R., Ehrlich, A.H. 1992. The Value of Biodiversity. Stanford University Press.

GENERAL COURSE II:

A12. RESEARCH METHODOLOGY (THEORY)

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

Unit I (13hrs)

Topic selection - Planning research – defining objectives - Preparation of work plans. Identification of suitable methodology - Preparation of project proposal –Summer Schools – Training in research institutes

Unit II (14 hrs)

Collection of literature- News articles – Newsletters – Magazines – Books - Journals. Digital library and search of articles - Keywords and search - Internet – Google Scholar – PubMed –

Inflibnet – Medline – Agricola – Science direct -Open access Journals - virtual sources – other sources. Short communications –review articles

Unit III (15 hrs)

Collection of protocols and selection of suitable methods according to work plan. Observational and experimental research. Data analysis – Construction of tables – headings - footer - Tabulation – Presentation of results - Use of statistical software to analyze the results: SPSS.

Unit IV (15 hrs)

Thesis structure –Components - Writing Introduction – review of literature – Materials & Methods – Presentation of results – Discussion of Results based on literature – Arriving at conclusions – Preparation of Summary/abstract – Arrangement of Bibliography and how to quote reference in thesis - Appendix.

Unit V (15hrs)

Publishing of Articles in newspapers /newsletters - Selection of journals – ISSN Number – Peer-reviewed Journals – Science citation index – impact factor and importance. Manuscripts preparation for Journals – components – Plagiarism - Submission and Publication – reprints and pdf formats. Paper presentation in Conferences.

Reference

1. Anderson, Durston&Polle 1970: Thesis and assignment, writing. Wiley Eastern Limited.
2. Booth W. C. et al. 2016. The Craft of Research. University of Chicago Press.
3. Rajendrakumar C. 2008. Research Methodology. APH Publishing Corporation.
4. Kothari C. R. 2004. Research Methodology. New Age International Publishers.
5. Gurumani, N. 2006. Research Methodology for Biological Sciences. MJP. Publishers.
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SEMESTER IV

GENERAL COURSE III

A13. NATURAL RESOURCE MANAGEMENT (THEORY)

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

Unit I Introduction to natural resources (8hrs)

Definition of natural resources. Types of natural resources. Need for protecting natural resources

Unit II Sustainable utilization (8hrs)

Concept of sustainable utilization. Economic, ecological and socio-cultural approaches.

Unit III Land (8hrs)

Agricultural, pastoral, horticultural and silvicultural land utilization. Soil degradation and soil management.

Unit IV Water (8 hrs)

Freshwater (rivers, lakes, groundwater); Marine; Estuarine; Wetlands; Threats and management strategies.

Unit V Biological Resources (8 hrs)

Biodiversity-definition and types; Significance; Threats; Management strategies. Bioprospecting. National Biodiversity Action Plan.

Unit VI Forests (8 hrs)

Definition. Types of forests. Forest cover and its significance (with special reference to India); Major and minor forest products; Forest depletion. Forest Management.

Unit VII Energy (8 hrs)

Renewable and non-renewable sources of energy.

Unit VIII Contemporary practices in natural resource management (8 hrs)

Environmental Impact Assessment, Remote Sensing, Geographic Information System, Participatory Resource Appraisal. Ecological footprint with emphasis on carbon footprint. Resource Accounting. Waste management.

Unit IX National and international efforts in natural resource management and conservation (8 hrs)

Reference

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2. Singh, J. S., Singh, S.P. and Gupta, S. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
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7. Camp, W. G., Heath-Camp, B. 2016. Managing Our Natural Resources. Cengage Learning Pte. Ltd
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10. Deal, K. H. 2011. Wildlife and Natural Resource Management. Delmar Cengage Learning.

GENERAL COURSE IV

A14. INTELLECTUAL PROPERTY RIGHTS (THEORY)

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

Unit I Overview of intellectual property (4 hrs)

Introduction and the need for intellectual property rights (IPR). IPR in India - Genesis and Development. Some important examples of IPR.

Unit II Patents (10 hrs)

Macro-economic impact of the patent system. Patent and kind of inventions protected by a patent. Patent document. How to protect your inventions? Granting of patent. Rights of a patent. How extensive is patent protection? Why protect inventions by patents? Searching a patent. Drafting of a patent. Filing of a patent.

Unit III Copyright (10 hrs)

What is copyright? What is covered by copyright? How long does copyright last? Why protects copyright? Related rights: What are related rights? Distinction between related rights and copyright. Rights covered by copyright.

Unit IV Trademarks (14 hrs)

Definition of trademark. Rights of the trademark. Kinds of signs that can be used as trademarks. Types of the trademark. The function that a trademark performs. How is a trademark protected? How is a trademark registered? How long is a registered trademark protected for? How extensive is trademark protection? What are well-known marks and how are they protected? Domain name and how does it relate to trademarks?

Unit V Geographical Indications (4 hrs)

What is a geographical indication? How is a geographical indication protected? Why protect geographical indications?

Unit VI Industrial Designs (10 hrs)

What is industrial design? How can industrial designs be protected? What kind of protection is provided by industrial designs? How long does the protection last? Why protect industrial designs?

Unit VII Biotechnology and IPR (20 hrs)

The rationale for Intellectual Property Protection in biotechnology. Concept of Novelty in Biotechnological Inventions. Concept of Inventive Step in Biotechnological Inventions. Microorganisms as Biotechnological Inventions. Patenting biological inventions. Patenting microorganisms. Patenting other biological processes and products. Protection of new varieties of plants. Justification for Protection. Biotechnology and International Treaties such as Convention on Biological Diversity and TRIPs.

Reference

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2. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew.1985. Biotechnology Applications and Research, Technomic Publishing Co., Inc.
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13. N. S. Sreenivasalu. 2007. Intellectual Property Rights. Neha Publishers & Distributors.
14. Pal P. 2008.Intellectual Property Rights in India: General Issues and Implications. Regal Publications

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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 the ionic product of water.
2. Differentiate between isotonic, hypertonic and hypotonic solutions.
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 the 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 the biological system.
14. Derive Henderson - Hasselbalch equation and its applications.
15. Write about biological Buffer systems.

16. Explain the fluid mosaic model of the plasma membrane.

17. Explain the different components of ECM.

18. Write notes on cell-cell interactions.

19. Write short notes on cell signalling.

Section C

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

20. Explain the cell cycle with different phases of cell division.

21. Explain different molecular interactions in a biological system.

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BCH2B02 BIOMOLECULES I

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 an example with structure.

3. Explain the reaction of glucose with a) mild oxidants and b) strong oxidants

4. Explain the features of a glycosidic bond.

5. Write notes on the amphoteric property of amino acids with an example.

6. Draw the structure of tyrosine.

7. Write the structure of α D Galactose.

8. Write notes on Vitamin B5 deficiency.

9. What are trace elements?

10. Define mutarotation.

11. Define the Iodine 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 any two reducing disaccharides.

14. Write the structure and functions of phospholipids.

15. Give a brief account of the ionization of amino acids and their importance.

16. Explain fatty acids present in coconut oil.

17. Describe the classification of polysaccharides.

18. Explain the stereoisomerism of carbohydrates.

19. Give a brief account of Vitamin A.

Section C

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

20. Write an essay on water-soluble vitamins.

21. Describe in detail the classification of carbohydrates.

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BCH3B03 BIOMOLECULES II

Time: 2 hrs **Marks 60**

Section A

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

1. Define peptides and the formation of the peptide.

2. What are Torsion angles?

3. Explain the Biuret reaction.

4. Which are the pyrimidine bases present in RNA?

5. Explain Chargaff's base pair rule.

6. Draw the structure and formation of a phosphodiester bond.

7. Write the structure of AMP.

8. Write notes on molecular visualizing tools.

9. Differentiate between fibrous and globular proteins.

10. Define Tm Value.

11. Differentiate DNA and RNA.

12. Explain the classification of protein based on solubility

Section B

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

13. Explain basic principles of the Sanger dideoxy sequencing method

14. Write notes on applications of sequence searching tools such as BLAST, Clustal X.

15. Describe two reactions to identify the N terminal amino acids of a protein.

16. Explain the structure of tRNA.

17. Describe the denaturation and renaturation of proteins.

18. What is the cot curve? Write its significance.

19. Give a brief account on Genbank, EMBL, and PDB.

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 detail the classification of RNA and its structures.

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BCH3BO4 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 lyophilization
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 the 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 the centrifugation technique?
11. What are the applications of SDS-PAGE?
12. Write a note on different types of rotors used in the 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 traces 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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BCH3B06 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 km value.

4. What is the turnover number (kcat) of an enzyme?

5. What is binding energy?

6. Draw the structure of biotini.

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 the multienzyme complex.

Section B

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

13. Explain the Induced fit model of the enzyme.

14. Enumerate the different methods of enzyme immobilization.

15. Explain the allosteric type of regulation of the enzyme.

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

17. Describe in detail two nicotinamide coenzymes.

18. Explain in detail the 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 the IUPAC classification of the enzyme.

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

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BCH4B07 INTERMEDIARY METABOLISM I

Time: 2 hrs **Marks 60**

Section A

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

1. Name the rate-limiting step in glycolysis. Why is hexokinase is not a rate-limiting enzyme in glycolysis?

2. Define anabolism and catabolism?

3. Write down the formation of Glucose-1-phosphate from glycogen.

4. Define Gluconeogenesis.

5. Explain briefly different types of metabolic reactions

6. Write a note on alcoholic fermentation.

7. Give a brief account of the use of isotopes for metabolic studies.

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 the feeder pathways for glycolysis?

12. What is glycogenolysis and its site of action?

Section B

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

13. Explain the Cori cycle.

14. Explain the HMP shunt and its importance.

15. Briefly explain the fate of pyruvate in anaerobic glycolysis.

16. Explain gluconeogenesis from propionyl CoA.

17. Describe the galactose metabolism.

18. What is the role of ubiquitiin in protein degradation?

19. Describe the hormone-mediated regulation of glycogen metabolism

Section C

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

20. Write an essay on proteasome-mediated cellular protein degradation

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

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

Section B

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

13. Explain the structure and function of the cell wall
14. What you know about central vacuole
15. Outline the role of micronutrients in plants
16. Give a detailed note on plant growth regulators

17. Explain the role of ethylene in fruit ripening

18. Discuss 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 a 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 meant by homeostasis

2. Mention the difference between ECF and ICF

3. What is the physiological significance of lipids

4. Name hormones produced by the adrenal cortex

5. How pepsinogen is activated

6. What is mean by bile salt

7. What is the function of glucagon

8. What is mean by differentiation of RBC

9. What is mean by pulmonary volume

10. Explain the Bohr effect

11. What is a sarcomerei

12. What is the composition of urine

Section B

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

13. Describe the functions of insulin and growth hormone

14. What are the composition aind function of bile

15. Briefly explain the epithelial transport of glucose

16. Explain the structure and function of hemoglobin

17. Briefly explain the structure of the 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 a neuron and give a 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 2 marks (Ceiling 25 marks)

1. What is the prezone phenomenon in antigen-antibody reactions?

2. Write a brief note on the live vaccine.

3. Define enrichment media

4. Brief the function of an 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 a brief note on requirements for carbon and N2 for microbial growth.

11. Define Antibiotics.

12. How are cytokines classified?

13. What is the difference between magnification and resolution of a microscope?

14. What are TH cells

15. Where do B cells originate?

Section B

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

16. Discuss the clonal selection of lymphocytes

17. Give a brief outline of Western Blotting

18. Briefly explain hematopoiesis

19. Explain the steps involved in Gram staining.

20. What are monoclonal antibodies? How are they produced

21. Write a 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 INTERMEDIARY METABOLISM II

Time: 2 hrs and 30 min. **Marks 80**

Section A

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

1. What are anaplerotic reactions?

2. Define P:O ratio.

3. What are high energy compounds?

4. Write down the functions of plant pigments.

5. What are free radicals and briefly explain different types

6. How pyruvate is converted to acetyl CoA?

7. What are uncouplers?

8. Write notes on oxygen toxicity

9. Explain the role of pyridoxal phosphate in amino acid metabolism

10. Write a brief note on Fo F1 ATP synthase.

11. Define antioxidants with two examples.

12. Discuss the amphibolic role of the citric acid cycle

13. Why ATP is considered a universal currency in the biological system?

14. Define photorespiration

15. Explain transamination reaction with example

Section B

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

16. Discuss different steps of the urea cycle

17. Give a brief outline of the imetabolic fate of glucogenic amino acids

18. Briefly explain the glyoxylate pathway

19. Write down three inhibitors of oxidative phosphorylation and their action.

20. What are ketone bodies? How are they metabolized?

21. Write a short note on Calvin cycle

22. Explain different transport iof reducing potentials into mitochondria.

23. What is the role played by carnitine in mitochondrial oxidation of long-chain fatty acids??

Section C

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

24. Write an essay on the mitochondrial electron transport chain.

25. Discuss the reactions of the TCA cycle and give an account of its energetics.

26. Explain the light-independent reactions of photosynthesis.

27. Explain the β-oxidation of palmitic acid and its energy balance sheet.

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BCH6B14 INTERMEDIARY METABOLISM III

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 synthesis of starch
3. What is glycogenesis
4. Explain the role of creatine
5. Name two inhibitors of purine nucleotide biosynthesis
6. Which compounds contribute nitrogen atoms to purine and pyrimidines biosynthesis
7. What is gout ?i
8. Mention the role of nucleoside phosphorylase
9. Name two neurotransmitters from amino acids
10. Explain the peptidoglycan biosynthesis
11. Name two steroid hormones from cholesterol.
12. What is dopamine

SECTION B

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

13. What are the different derivatives formed from cholesterol and briefly explain its significance?
14. Outline fatty acid synthase complex
15. Explain porphyrin biosynthesis
16. Explain the elongation of fatty acids

17. What is mean by salvage pathway of nucleotide biosynthesis

18. Explain purine catabolism and its disorders

19. Explain the synthesis of sucrose

SECTION C

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

20. Explain the biosynthesis of purine nucleotides.

21. Explain the regulatory mechanisms of glycogen metabolism.

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BCH6B15 MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Time: 2 hrs and 30 min. **Marks 80**

Section A

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

1. What is the role of the rho factor in transcription

2. What are the vectors?

3. What is a topoisomerase

4. Give a short note on reverse transcriptase.

5. Give a short note on Okazaki fragments

6. What are restriction endonucleases?

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. Write a short note on RFLP technique

15. What is the law of segregation?

Section B

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

16. Briefly explain post-translational modifications.

17. Write notes on DNA fingerprinting

18. Write a note on the 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. Write notes on PCR technique

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. 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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BCH6B16 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 alkaptonuria

2. Give the normal serum concentration of urea, creatinine and Uric acid.

3. Give three examples of myocardial infarction markers.

4. What is the role of vitamin A in the 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 the 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 patience and give significance

15. Comment on the significance of monitoring fasting and postprandial blood sugar in a diabetic patient

Section B

Answer any 7 questions. Each question carries 5 marks (7×5=35 marks)

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 the 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 10 marks (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 the 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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MODEL QUESTION PAPERS FOR GENERAL PAPERS

A12. GENERAL COURSE II RESEARCH METHODOLOGY (THEORY)

Time: 2 hrs and 30 min. **Marks 80**

Section A

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

1. What is the role of keywords in a research paper?

2. What is meant by a protocol?

3. What is meant by the trial and error method?

4. What is Google Scholar?

5. Define plagiarism

6. What is meant by the impact factor of journals?

7. What is meant by the Science Citation Index

8. What are the basics of data collection?

9. What is SPSS? Explain its uses in research.

10. What is ISSN Number?

11. Define the term thesis?

12. What are open-access journals?

13. Explain the role of bibliography in a thesis

14. What is meant by data analysis?

15. What is meant by peer-reviewed journals?

Section B

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

16. Which are the different components of a thesis?

17. Differentiate between a research article and a monograph.

18. What is the significance of the review of literature in research?

19. Briefly explain the significance of INFLIBNET.

20. Discuss summer school and training research institutes in India

21. Explain the basics of manuscript writing for a journal.

22. Differentiate between observational and experimental research.

23. What is a predatory journal?

Section C

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

24. Explain the different steps in the preparation of a manuscript for publishing in a journal.

25. Explain the significance of planning in research.

26. What is a research project proposal? What are the different components of a project proposal?

27. What are the main steps of research and analysis of results?

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SCHEME& SYLLABUS

COMPLEMENTARY COURSE

BIOCHEMISTRYi

Scheme for B.Sc. Biochemistry Complementary Course (CBCSS)- 2020 Admission Onwards

Semester	Course code	Course title	Hours/ week	Credits	Total credits	Scheme of Evaluation (in marks)		
						Internal (20%)	External (80%)	Total
I	BCH1C01	Biochemistry I	2	2	2	15	60	75
	BCH1C05	Biochemistry Practical I*	2	-		-	-	-
II	BCH2C02	Biochemistry II	2	2	2	15	60	75
	BCH1C05	Biochemistry Practical II*	2	-		-	-	-
III	BCH3C03	Biochemistry III	3	3	3	15	60	75
	BCH1C05	Biochemistry Practical III*	2			-	-	-
IV	BCH4C04	Biochemistry IV	3	3	3	15	60	75
	BCH1C05	Biochemistry Practical IV	2	2	2	20	80	100

*No practical examinations. The practical examination will be only in the fourth semester.

Total credits for the complementary courses: 12

Total marks for the complementary course: 400

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 = 80

(b) Maximum marks for internal evaluation = 20

(c) Total marks for the practical examination = 100

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

(a) Attendance = 5

(b) Records =10

(c) Lab involvement = 5

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 conclusion

2. For Quantitative Experiments

a) Result of the reported value (minimum error)

b) The calculation, presentation of the result (Graph)

c) Procedure

d) Skill

SEMESTER I

BCH1C01 BIOCHEMISTRY I

Credit: 2 Total hours of instruction: 36. Hours/week: 2.

Course Outcomes:

On completing the course, the student will be able to:

No.	Course outcome
CO1	Recognize Biochemistry as a discipline and understand the basic concepts of biochemical evolution
CO2	Understand the isomerism of carbohydrates and conceptualize monosaccharides, disaccharides and polysaccharides
CO3	Illustrate the features of amino acids and proteins and analyze structural levels of organizations of proteins and their reactions
CO4	Explain the structure of RNA and DNA
CO5	Describe the structure, properties, major classes and roles of lipids.

Unit 1: (8 hrs)

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

Unit 2: (8 hrs)

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 β 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: (10 hrs)

Amino acids and proteins. structure of 20 amino acids occurring in proteins; Color reactions of amino acids. Zwitterions and isoelectric pH; peptide bond; the 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 sulfate, heavy metal ions). Denaturation and renaturation of proteins

Unit 4:(5 hrs)

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

Unit 5:(5 hrs)

Lipids - Structure and Classification of lipids - simple lipids (fats and oils), compound lipids (phospholipids, sphingolipids) 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)

No.	Course outcome
CO1	Identify laboratory requirements, instruments and their uses.
CO2	Perform colorimetric analysis and verify the principles involved
CO3	Analyze biochemical samples qualitatively.

CO4	Identify various biomolecules in the samples using standard protocols.

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: 2 Total hours of instruction: 36. Hours/week: 2

Course Outcomes (COs):

On completing the course, the student will be able to:

No.	Course outcome
CO1	Identify the types of molecular interactions, concepts on acids, bases and solutions, and the physical aspects of Biochemistry.
CO2	Describe the transport of molecules across the cell.
CO3	Explain plasma proteins, coagulation of blood and maintenance of pH of the blood
CO4	Outline the principles and applications of chromatography techniques.

CO5	Comprehend different types of electrophoretic techniques.
CO6	Define absorption photometry and explain its application

Unit 1:(10 hrs)

Water - universal solvent. Dissociation of water - the concept of pH and pOH; Henderson - Hassel Balch equation, buffers - buffer and buffer action; titration curves of strong and weak acids and bases, the meaning of Ka and pKa values. methods of measurement of pH using pH meter, indicator solutions. Basic ideas about hydrogen bonds and weak interactions.

Unit 2: (8 hrs)

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

Unit 3. (5 hrs)

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

Unit 4: (7 hrs)

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

Unit 5. (3 hrs)

Electrophoretic techniques - SDS - PAGE, native PAGE, immunoelectrophoresis

Unit 6: (3 hrs)

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

BCH1C05 BIOCHEMISTRY PRACTICAL II (2 hours per week)

No.	Course outcome
CO1	Understand the preparation of solutions.

CO2	Perform colorimetric analysis and verify the principles involved
CO3	Develop basic practical skills in quantitative estimation of biomolecules and their separation techniques.

1. Weighing, Preparation of solutions, standard solutions, interconversion 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.

Course Outcomes (COs):

On completing the course, the student will be able to:

No.	Course outcome
CO1	Learn the basics of enzymology along with conceptualizing Km and LB Plot and illustrating the types of enzyme inhibition
CO2	Familiarize the process of ATP formation and review glycolysis, glycogen

	metabolism, gluconeogenesis and HMP pathway.
CO3	Understand the mechanisms of TCA cycle and the mechanism of oxidative phosphorylation
CO4	Outline photophosphorylation and analyse calvin cycle and glyoxylate cycle.

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 the velocity of enzyme-catalyzed reactions, Michaelis Menten equation, Km 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 a double reciprocal plot. Allosteric regulation of enzyme action with an example. Activation of the zymogen.

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

Unit II. Anaerobic Metabolism of Carbohydrates (15hrs)

Introduction to metaboilism. Digestion of carbohydrates and absorption. Reactions of glycolytic sequences with the names of enzymes and intermediates (without structures). The 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 the 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, the principle of a reversible reaction. Uncouplers and inhibitors of the 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 (C2, C3, and C4 pathways), Krans anatomy; glyoxylate cycle, significance.

BCH1C05 BIOCHEMISTRY PRACTICAL III (2 hours per week)

No.	Course outcome
CO1	Perform colorimetric assays
CO2	Estimate biomolecules quantitatively and illustrate their clinical implications.

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

Course Outcomes (COs):

On completing the course, the student will be able to:

No.	Course outcome
CO1	Explain β-oxidation and conceptualize cytoplasmic systems of fatty acid biosynthesis
CO2	Analyze decarboxylation, deamination, and transamination of amino acids and illustrate the Metabolism of ammonia.
CO3	Conceptualize central dogma of molecular biology
CO4	Outline classification, mechanism of action and physiological function of hormones.

Unit I. Metabolism of Lipids (12hrs)

Outline study of lipid digestion and absorption. Outline study of the β-oxidation scheme. ATP yield in β-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 amino acids (without molecular mechanisms). Urea cycle. Cori cycle.

nit III. Biochemical basis of inheritance. (20hrs)

The 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 – the role of the 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. Textbook of Biochemistry. Pub.The Macmillan Company, Collier-Macmillan Ltd., London

2. H.D. Kumar and H.N. Singh.Plant Metabolism. Pub. Affiliated East-West Press Pvt. Ltd. NewDelhi

3. D.L. Nelson and M.M. Cox.Lehninger, Principles of Biochemistry: Worth Publishers

4. Gerald Karp.Cell and Molecular Biology. John Wiley &Sons,

5. U. Satyanarayana, U. Chakrapani.Biochemistry, Books and allied (P)Ltd.

6. LubertStryer, Biochemistry, 4th edition, W.H. Freeman & Co,1995.

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

No.	Course outcome
CO1	Perform colorimetric assays
CO2	Perform quantitative estimation of biomolecules and their clinical implications.

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. Plummer Mu, David T. Plummer. Introduction to Practical Biochemistry TataMcGraw Hill publishing company

2. Cooper, T.G.The Tools of Biochemistry, John Wiley & Sons, NewYork.

3. K.E. Van Holde, Kensal.Principles of Physical Biochemistry, Pearson EducationInc

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iMODEL QUESTION PAPER

BIOCHEMISTRY I- BCH1C01

Time: Two Hours **Maximum**

Marks:60

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 fatty acid is

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

4is an example of 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 a 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) An 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 a suitable diagram.

19. (a) Name the carbohydrate transported in the 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 the 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. **(5 x 4 = 20 marks)**

Section D Answer any 1 question. It carries 10 marks.

23. What is isomerism? What are the different types of isomerism exhibited by biomolecules? Explain with suitable examples

24. Describe the structural organization of proteins. **(10 x 1 = 10 marks)**

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BIOCHEMISTRY II -BCH2C02

Time: Two Hours **Maximum Marks:60**

Section A Answer all the questions. Each question carries 1mark

1. The term “pH” is related to

a. concentration of salt b. Concentration of hydrogen ion

c. Concentration of metal ion d. Concentration of the solution

2. A condensation reaction is associated with the formation of

a. Ester b. Water c. Salt d.CO2

3. The term partition coefficient is related to

a. TLC b. Gel filtration c. RIA d. PAGE

4 When blood passes through capillaries, the fluid part oozes out forming_____

5. When the rate of the forward reaction equals that of backward reaction, the system is said to be in ----------

6. Name a plasma protein present in the 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 do 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 a 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 **(5 x 4 = 20 marks)**

Section D Answer any 1 question. It carries 10 marks.

23. Describe the principle of chromatography? Write on any five popular chromatographic techniques

24. What is the composition of blood? Write on the various methods by which the pH of blood is maintained **(10 x 1 = 10 marks)**

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BCH3C03BIOCHEMISTRY III

Time: Two Hours **Maximum Marks:60**

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

1. The enzyme is more efficient in catalysis when Km value is

a. Low b. High c. Zero d. Infinity

2. In the presence of a fixed concentration of a competitive inhibitor, an increase in the concentration of the substrate

a. Reverses the inhibitory action b. Increases Km c. The inhibitory effect remains unaffected

d. Decreases Vmax

3 groups of enzymes are involved in the joining of two molecules involving energy

a. oxidoreductases b. ligases c. hydrolases d. lyases

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_2 released during respiration is formed

6. The chemiosmotic hypothesis was proposed by----------

7. How many CO_2 molecules are released when three molecules of Glucose are converted into 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 = 9marks)**

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 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.

a. the area where lactic acid fermentation takes place

b. the place where succinate dehydrogenase is located

c. the molecule responsible for the formation of ATP

d. the area with the highest concentration of H^+ ions when the mitochondrion is actively engaged in ATP synthesis.

19. Explain with the help of a suitable example, how is C4 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 the fixation of CO_2 in C3plants.

22. Explain the reactions of the 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.

a. Draw Lineweaver Burk Plot. (3marks)

b. Why is this plot advantageous over MM plot? Explain using a suitable diagram (3)

c. How is Lineweaver Burk Plot useful in the study of enzyme inhibition? Explain using suitable diagrams. (4marks)

24.

a. How many ATP are produced from one molecule of glucose by complete aerobic respiration in prokaryotes? Explain (4marks)

b. What happens to pyruvate in the absence of oxygen? Explain (4marks)

c. Explain link reaction (2marks) **(10 x 1 = 10 marks)**

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BIOCHEMISTRY IV-BCH4C04

Time: Two Hours **Maximum Marks:60**

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

1. ATP yield during the β 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 reactions are carried out by. ----------

(a) Aminotransferases (b) Amino acid carboxylase (c) Amino acid 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 β -oxidation of fatty acids

8 Enzyme 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 = 9marks)**

Section B Answer any 7questions. 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 the 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 the 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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