ಬೆಂಗಳೂರು ನಗರ ವಿಶ್ವವಿದ್ಯಾಲಯ
BENGALURU CITY UNIVERSITY
ಆಗು ಭೀ ಅಪೇಕ್ಷಾ
BE BOUNDLESS

Dr. Ambedkar Veedhi, Central College Campus
Bengaluru-560001

Scheme and Syllabus

For

Biochemistry

for B. Sc. Degree with three majors

As per SEP 2024

for I and II Semesters

(With effect from 2024-25)

Department of Biochemistry,
Central College Campus
Bengaluru -560 001

June, 2024

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BENGALURU CITY UNIVERSITY

Department of Biochemistry,
Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG), held on Wednesday, the 5th June, 2024 in the chambers of the Chairman, Dept. of Biochemistry, Central College Campus, Bangalore -560001

The meeting started with the Chairman welcoming the members and requesting the board to deliberate on the syllabus contents for B.Sc. Biochemistry UG course and propose the titles for all the six semester under SEP, and prepare the syllabus for the first two semesters. After a detailed discussion on the titles and contents, the board finalized the titles, and prepared the syllabi for I and II semester B.Sc. under the SEP scheme, effective from 2024-25. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

	Members Present		Signature
1.	Prof. V. R. Devaraj, Chairman, Dept. of Biochemistry, Bangalore University.	Chairman	
2	Dr. S. Kantharaju Dept. of Chemistry, SJRC College, Ananda Rao Circle Bangalore -560004	Member	
3.	Ms. Vidya, A.S. Dept. of Biochemistry, Seshadripuram College Yalahanka Bangalore -560064.	Member	
4.	Dr. (Mrs.) Myrene D'souza Dept. of Biochemistry, Mount Carmel College # 58, Palace Road, Bangalore – 560052	Member	

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5. Dr. R. Nagesh Babu, Member
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001

6. Ms. Malini. M.R Member
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

7. Dr. Rajeev Ramachandra Kolagi Member
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001.

8. Dr. Kamala, A. Member
Dept. of Biochemistry,
MLA College for women
Malleswaram 18th Cross
Bangalore-560004

9. Mrs. Ramya Kumari B.S Member
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

10. Mrs. Madhukala. K.L Member
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091

11. Dr. Bhagyalakshmi Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101

12. Mrs. Savitha, K.R. Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101

SCHEME OF EXAMINATION

Title of the paper	Contact h/week	Exam. hours	I A	Marks	Total Marks	Credits
First Semester						
Biochemistry-I: BCT-01 Chemical Foundations of Biochemistry	4	3	20	80	100	3
Biochemistry practical-IBCP-01 Experimental Biophysical Chemistry	3	3	10	40	50	2
Second Semester						
Biochemistry-II: BCT-02 Bioorganic Chemistry	4	3	20	80	100	3
Biochemistry practical-II: BCP-02 Experimental Bioorganic Chemistry	3	3	10	40	50	2
Third Semester						
Biochemistry-III: BCT-03 Biochemistry of Macromolecules	4	3	20	80	100	3
Biochemistry practical-III: BCP-03 Qualitative and Quantitative analysis of Macromolecules	3	3	10	40	50	2
Fourth Semester						
Biochemistry-IV: BCT-03 Physiology & Cell Biology	4	3	30	70	100	3
Biochemistry practical-IV: Clinical Biochemistry and physiology	3	3	10	40	50	2
Fifth Semester						
Biochemistry-V: BCT-05 Biochemical Techniques	4	3	20	80	100	3
Biochemistry practical-V Bio-analytical methods	3	3	10	40	50	2
Biochemistry-VI: BCT-06: Bioenergetics & Metabolism	4	3	20	80	100	3
*Biochemistry Elective-1:BCOE-1** *Microbiology & Immunology*	3	1.5	10	40	50	2
Sixth Semester						
Biochemistry-VII: BCT-07: Enzymology	4	3	20	80	100	3
Biochemistry practical-VI:BCP-06 Enzymology	3	3	10	40	50	2
Biochemistry-VIII: BCT-08: Molecular biology	4	3	20	80	100	3
*Biochemistry Elective-2: BCOE-2** *Membrane Biochemistry*	3	1.5	10	40	50	2

Theory question paper pattern:

Each theory question paper has ***three Sections***;

1. 20% of the marks seeking short answers;
   Student has answer 8 out of 10 questions of 2 marks each

2. 40% of marks seeking medium size answers:
   Student has to answer 8 out of 10 questions of 4 marks each.

3. 40% of question seeking comprehensive answers:
   Student has to answer 4 out of 5 questions of 8 marks each.
   These questions may include sub questions (5+3).

Internal Assessment: Tests: 10 Marks (two internal tests to be conducted and average is considered for assessment)

Scheme of Practical Examination:

Duration	3 hours
Max. Marks	40 Marks
Marks for practical record	5 Marks
Marks for Viva-Voce	5 Marks
Marks for performing major experiment	20 Marks
Marks for performing minor experiment	**10** Marks

Assessment in Practical Examination

Awarding marks for performance	
Deviation of experimental values:	
0-5%	100% of allotted marks
6-10%	80% of allotted marks
11-20%	60% of allotted marks
20% and above	50% of allotted marks

Practical Record:

Recording 8 or more different experiments	5 Marks
Recording 6-7 different experiments	4 Marks
Recording 4-5 different experiments	3 Marks
Recording 3 different experiments	2 Marks
Recording Less than 3 experiments	0 Marks

Syllabus for Biochemistry major for B.Sc. Degree program with three majors

SEMESTER – I

Course title	Chemical Foundations of Biochemistry
Course Code	BCT -01
Course credits	3
Total contact hours	56
Duration of ESA	3
Formative assessment marks	20
Summative assessment marks	80

Learning outcomes:

This course will enable students to understand basic physical principles of biological systems, measurements in biochemical study, nature of chemical bonds. Also, helps them appreciate the physical properties of molecules, colloids, and basics of chemical kinetics essential for biochemistry.

Course content:

UNIT-I **15 Hours**

1. **Overview of Biochemistry:** Origin of Biochemistry as a discipline. Definition, scope and significance of Biochemistry. Chemical composition of living organisms.
2. **Units and Measurements:** Avogadro's number, mole, mole fraction, molarity, equivalent weight, normality, molality, percentage. Graphical representation of data – types of graphs. Errors in quantitative analysis –types, sources and minimizations. Precision and accuracy. Significant figures and its computation (Problems to be worked out).
3. **Properties of water:** Molecular structure of water (VSEPR theory), physical properties of water, its effect on biomolecules. Effect of non-polar compounds on water.
4. **Physical properties of molecules:** Adsorption -Definition, Freundlich and Langmuir's adsorption isotherm. Applications of adsorption. Viscosity-Definition, Experimental method of measuring viscosity of liquids and solutions by Ostwald's viscometer. Surface tension – Definition and its measurement. Distribution law - Distribution law, partition coefficient. Applications of distribution law.

UNIT-II

13 Hours

1. **Colligative properties:** Osmotic pressure and its measurements by Berkely and Hartley's method. Laws of osmotic pressure. Hypo, hyper and isotonic solutions. Effects of osmotic pressure on living cells. Donnan membrane equilibrium.
2. **Ionic equilibria:** Lewis concept of acids and bases. Ionic product of water. pH scale, buffers, Henderson-HasselBalch equation, buffer capacity, preparation of acidic and basic buffer solutions. Theory of acid base indicators. Choice of indicators. pH titration curves and isoelectric pH of amino acids. Electrodes (Hydrogen Electrode & Calomel electrode), glass electrode. Conductometric titrations [Strong acid against strong base, weak acid (amino acid) against NaOH. Measurement of pKa of amino acid by using pH meter.

UNIT-III

14 Hours

3. **Chemical bonding:** Types of bonds & bond characteristics - Ionic, covalent, co-ordinate bonds. Atomic orbitals and molecular orbitals – Molecular Orbital Theory, LCAO, bonding and anti-bonding of molecular orbitals, sp, sp2, sp3 and sp3d2 hybridizations with suitable examples. Sigma and pi bonds with examples. Van der Waal's forces, ion-dipole, dipole – dipole interactions, London forces, hydrophobic interaction, hydrogen bonding. Effect of chemical forces on physical properties (Solubility, BP and MP).
4. **Co-ordination compounds:** Transition metals, properties (Colour, oxidation states, magnetic properties). Co-ordinate bond, double and complex salts – differences with examples. Postulates of Werner's theory. Types of ligands – uni, bi and polydentate with examples. Co- ordination number. Porphyrin nucleus and classification. Important metalloporphyrins occurring in nature-structure and their biological importance (Hb, cytochrome, chlorophyll, Vitamin B12). Bile pigments – Types, structure and chemical nature.

UNIT- IV **14 Hours**

5. **Chemical kinetics**: Introduction, Rate of reactions, rate law or rate equation, molecularity and order of a reaction with examples, velocity constant or rate constant and half-life period expressions for zero, first and second order reactions with derivations (a=b and a ≠b), rate constant of irreversible reaction, kinetics of reversible reaction (without derivation). Numerical problems. Effect of temperature, pressure and catalyst on rate of reaction, Arrhenius equation and Arrhenius interpretation of energy of activation. Transition state theory with brief explanation.
6. **Colloids**: true solutions, classification, peptisation, purification, ultrafiltration, Brownian movements, electric properties, coagulation, mutual, lyophilic sols, boiling, dialysis, electro- and persistent dialysis, addition of electrolytes, colloids in daily life and

applications. Emulsion, types, micelles with biomolecules and its biological applications.

Suggested Readings:

- Puri, Sharma, Pathania Text Book Of Physical Chemistry
- Puri, Sharma, Pathania Text Book Of Inorganic Chemistry
- A Guide To Organic Reaction Mechanism- P. Sykes
- General &Inorganic Chemistry-R.P.Sarkar
- Inorganic Chemistry-R.L.Dutta
- New Concise Inorganic Chemistry-J.D.Lee
- F. A. Cotton & G. Wilkinson. Basic Inorganic Chemistry, John Wiley (1998)
- Douglas, Mcdaniel And Alexander: Concepts And Models In Inorganic Chemistry, John Wiley, 3rd Edition (1994).
- James E. Huheey, Ellen Keiter And Richard Keiter : Inorganic Chemistry: Principles Of Structure And Reactivity, Pearson Public, 4th Edition (2013).
- Pattabhi. V. And Gautham.N. (2002) Biophysics. Narosa Publishing House, India.

Course title	**Experimental Biophysical Chemistry**
Course Code	BCP- 01
Course credits	2
Total contact hours	42
Duration of ESA	3
Formative assessment marks	10
Summative assessment marks	40

Learning outcomes:

In this practical course, students will be introduced to laboratory exercises which provide skills to apply biophysical/chemical principles to understand biological processes. Also, helps them appreciate the physical properties of molecules, colloids, and basics of chemical kinetics essential for biochemistry.

Practical content:

1. Calibration of volumetric glassware (Burette, pipette and volumetric flask).
2. Preparation of standard sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (Methyl orange or phenolphthalein).
3. Preparation of standard oxalic acid. Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).
4. Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.

5. Preparation of $ZnSO_4$. Standardization of EDTA and estimation of total hardness of water using eriochrome black-T indicator.
6. Preparation of standard potassium bipthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
7. Calibration of pH meter and Preparation of buffers - acetate and phosphate buffers.
8. Conductometric titration of strong acid against strong base.
9. Conductometric titration of weak acid (amino acid) against strong base.
10. Determination of rate constant of decomposition of H_2O_2 using $KMnO_4$ by volumetric analysis method.
11. Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
12. Determination of density and surface tension of the given liquid using specific gravity bottle and stalagmometer.

SEMESTER - II

Course title	BIO-ORGANIC CHEMISTRY
Course code	BCT-02
Course credits	03
Total contact hours	56
Duration of ESA	03
Formative assessment marks	20
Summative assessment marks	80

Learning outcomes:

This course helps the students to understand the significance of organic reactions and their relevance to biological systems. It help them gain a good understanding of aliphatic and aromatic compounds, nomenclature, reactivity of functional groups and the importance of stereoisomers in biological systems, and structure activity relationships in biomolecules.

Course Content:

UNIT-I **14 Hours**

1. **Introduction to organic chemistry**: Classification of organic compounds, unique characteristics, IUPAC nomenclature of organic compounds (including bi-functional) and biomolecules.
2. **Hydrocarbons**: Markownikoff and anti-Markownikoff addition. Addition of HBr to propene. Alkenes – Ozonolysis, oxidation. Dienes – types with examples, 1, 3 butadiene – Preparation, stability and mechanism of addition of HBr. Diels-Alder reaction. Conformational analysis of ethane.
3. **Reaction mechanisms:** Concept of inductive effect, resonance and hyperconjugation. Classification of organic reactions (substitution, addition, elimination and rearrangement), with two examples for each. Concepts of the following – carbanions, carbocations, free radicals, carbenes, nucleophiles and electrophiles (Formation and Stability).
4. **Alkyl halides and organometallic compounds:** SN^1, SN^2 and SN^i reactions, their mechanism with one example for each. Concept of elimination reactions (E^1, E^2 and E^1CB with an example). Organometallic compounds – definition and applications of organo lead, organo lithium, cis-platin.

UNIT-II **14 Hours**

5. **Arenes:** Structure of benzene – by Resonance and Molecular orbital theories.

Aromaticity (Huckel's rule). Mechanism of Nitration and Friedel- craft reaction. Electronic interpretation of the orientating influence of substituents in the electrophilic substitution of toluene, chlorobenzene, nitrobenzene and phenol. Resonance structures of naphthalene and anthracene.

6. **Stereochemistry:** Stereoisomerism, types, Fischer-projection formulae, chiral carbon atom, asymmetry and dissymmetry, chirality, conditions for optical isomerism ex: glyceraldehyde, lactic acid, tartaric acid, Nomenclature of enantiomers, diastereomers. D and L notation, R and S system, racemization and resolution (Biochemical, chemical and physical methods).Geometrical isomerism. E and Z notations.

UNIT-III

14 Hours

7. **Cycloalkanes:** Reactivity and relative stability. Bayer's strain theory. Sachse-Mohr theory. Boat and chair forms of cyclohexanes. Axial and equatorial bonds and their relation with biological activities of carbohydrates
8. **Alcohols:** Definition, classification, monohydric alcohols-distinguishing reactions for primary, secondary and tertiary alcohols. Dihydric alcohols: Glycol, preparation (any 2 methods) and uses. Trihydric alcohols: Glycerol, synthesis from propene, properties, (reaction with conc. H_2SO_4, HNO_3, Oxalic acid and HI). Phenols: Acidity of phenols, effect of substituent on acidity.
9. **Hydroxy acids and dicarboxylic acids:** Structure & properties of hydroxy acids: Lactic acid, citric acid and isocitric acid. Dicarboxylic acid: Maleic and fumaric acid. Ketoacids: Pyruvic, α-ketoglutaric, oxaloacetic acids.
10. **Carbonyl compounds:** General properties. Aldehydes and ketones. Keto-enol tautomerism, Mechanism: Claisen and aldol condensations. Quinones: Biologically important quinones.
11. **Amines:** Classification, properties, functional amino group – Basicity of amines, acylation. React with HNO_2 & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

UNIT-IV

14 Hours

12. **Heterocyclic compounds:** Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole, quinoline and isoquinoline. Basicity of pyrrole and pyridine.
13. **Terpenes:** Definition, isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.
14. **Steroids:** Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols and ergosterol. Bile acids [Mono, Di & Tri cholic acids].
15. **Alkaloids:** Definition, classification based on their structure and biological functions,

isolation, structure and biological action of morphine, nicotine & atropine. Chemical synthesis of nicotine and atropine.

16. **Drugs**: Classification of drugs; synthesis and uses of sulphanilamide and paracetamol. Antibiotics: Definition; types; sources; structures and antimicrobial spectrum of action of penicillin, chloroamphenicol, streptomycin and tetracyclines.

Suggested Readings:

- Arun Bahl and B. S. Bahl: *Advanced Organic Chemistry,* S. Chand. (2019)
- L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S. (2002)
- R. T. Morrison & R. N. Boyd: *Organic Chemistry*, Prentice Hall. (2011)
- Organic Chemistry (vol.1&2) – I. L. Finar
- Stereochemistry of Carbon Compounds- D. Nasipuri
- Basic Stereochemistry of Organic Compounds- S. Sengupta
- A Guide To Organic Reaction Mechanism- P. Sykes

Course title	**Experimental Bioorganic Chemistry**
Course code	**BCP-02**
Course credits	**02**
Total contact hours	**42**
Duration of ESA	**03**
Formative assessment marks	**10**
Summative assessment marks	**40**

Learning outcomes:

This laboratory course is aimed at imparting skills of identifying organic compounds, demonstrating reactivity of various functional groups, and synthesis of simple organic compounds of biological importance.

Practical content:

1. **Systematic qualitative analysis of the organic compounds:** Urea, glucose, benzamide, benzaldehyde, aniline, acetophenone, nitrobenzene, chlorobenzene, *p*-toluidine, benzoic acid, salicylic acid, resorcinol, and ethyl acetate.

2. **Organic preparations**: Aspirin from salicylic acid, benzoic acid from benzaldehyde, and meta-dinitrobenzene from nitrobenzene.

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM
(As per SEP)

Syllabus for Bio-Chemistry

2025-26

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BENGALURU CITY UNIVERSITY
ಅನಂತ ಕ್ಕೆ ಅವಕಾಶ
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Department of Biochemistry, Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG), held on Tuesday, the 13th May, 2025 in the chambers of the Chairman, Dept. of Biochemistry, Central College Campus, Bangalore -560001

The meeting started with the Chairman welcoming the members and requesting the board to deliberate on the syllabus contents for B.Sc. Biochemistry UG course 3rd and 4th semester under SEP,. After a detailed discussion on the contents, the board finalized the syllabus prepared by members for III and IV semester B.Sc. under the SEP scheme. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

	Members Present		Signature
1.	Prof. V. R. Devaraj, Chairman, Dept. of Biochemistry, Bangalore University.	Chairman	13/05/2025
2	Dr. Rajesh, J. Dept. of Biochemistry, Uvaraja's College, University of Mysore	Member	13/5/25
3.	Ms. Vidya, A.S. Dept. of Biochemistry, Seshadripuram College Yalahanka Bangalore -560064.	Member	
4.	Dr. (Mrs.) Shilini Purushothaman Dept. of Biochemistry, Mount Carmel College # 58, Palace Road, Bangalore – 560052	Member	13/5/25

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5. Dr. R. Nagesh Babu, Member
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001

6. Ms. Ramya Kumar, B.S. Member
Dept. of Biochemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

7. Srikanta A.S. Member
Dept. of Chemistry,
Vijaya College
Basavanagudi
Bangalore-560004

8. Dr. Jyothi, S.G. Member
Dept. of Chemistry
B.M.S. College of Women
Basavanagudi
Bengaluru-560004

9. Mr. [redacted]. Manohar, N. Member
Dept. of Biochemistry,
Seshadripuram College
Yalahanka
Bangalore -560064.

SCHEME OF EXAMINATION

Title of the paper	Contact h/week	Exam. hours	I A	Marks	Total Marks	Credits
Third Semester						
Biochemistry-III: BCT-03 Biochemistry of Macromolecules	4	3	20	80	100	3
Biochemistry practical-III: BCP-03 Qualitative and Quantitative analysis of Macromolecules	3	3	10	40	50	2
Biochemistry Elective-1:BCT E-1 Microbiology & Immunology*	2	1.5	10	40	50	2
Fourth Semester						
Biochemistry-IV: BCT-04 Physiology & Cell Biology	4	3	30	70	100	3
Biochemistry practical-IV: Clinical Biochemistry and physiology	3	3	10	40	50	2
Biochemistry Elective-2: BCT E-2 Membrane Biochemistry*	2	1.5	10	40	50	2
Compulsory Practical/Skill-1*	3		10	40	50	2
Fifth Semester						
Biochemistry-V: BCT-05 Biochemical Techniques	4	3	20	80	100	3
Biochemistry practical-V Bio-analytical methods	3	3	10	40	50	2
Biochemistry-VI: BCT-06: Bioenergetics & Metabolism	4	3	20	80	100	3
Compulsory Practical/skill-2*	3		10	40	50	2
Sixth Semester						
Biochemistry-VII: BCT-07: Enzymology	4	3	20	80	100	3
Biochemistry practical-VI:BCP-06 Enzymology	3	3	10	40	50	2
Biochemistry-VIII: BCT-08: Molecular biology	4	3	20	80	100	3
Compulsory Practical/skill-3*	3		10	40	50	2

**The compulsory skill may involve practical experience in an industry /Laboratory/ dissertation/ minor Project providing hands on experience* other than the regular practical of the course.

The student can opt for the skill related to any of the three majors in a semester; the skill requirement may be met with one skill course in all the three majors or all three skills related to any one of the majors to enhance the employability.

Scheme of skill/project/dissertation Examination:

Internal Assessment: 10 Marks

The assessment is based on the performance, punctuality and regular updates of the progress in the project/dissertation. An assigned supervisor will be authorized to assess. If carried out in an industrial set up, the personnel supervising the student shall be authorized to provide internal assessment marks.

End semester Examination: Max. Marks: 40

Report/Dissertation:	Max. Marks: 25
Viva-Voce:	Max. Marks: 15

Syllabus for Biochemistry major for B.Sc. Degree program with three majors under SEP

SEMESTER – III

Course title	Biochemistry of Macromolecules
Course Code	BCT -03
Course credits	3
Total contact hours	56 h
Duration of ESA	3 h
Formative assessment marks	20
Summative assessment marks	80

Learning outcomes:

The course introduces students to chemical nature and biological importance of biological macromolecules. It enables the students become conversant with the basic structures and properties of macromolecules and to understand the concepts of structure–activity relationships in Biochemistry.

UNIT– I CARBOHYDRATES **15 Hrs**

Monosaccharides: Definition, classification, occurrence, structure and functions of monosaccharides (glucose and fructose). General properties with reference to glucose, anomers, epimers, enantiomers and mutarotation. Elucidation of open chain and ring structure of glucose, conformation of glucose (structures only). Structure of galactose, mannose, ribose and fructose.

Disaccharides: Structure, occurrence, properties and biological importance of disaccharides (sucrose, and lactose).

Polysaccharides: Storage polysaccharides (starch, glycogen) with partial structure, Structural polysaccharides (cellulose, chitin). Structure, occurrence, and biological roles of heteropolyasaccharides (hyaluronic acid, heparin) and bacterial cell wall polysaccharides.

UNIT- II AMINO ACIDS AND PROTEINS **16 Hrs**

Amino acids: Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO2, LiAlH4, ninhydrin, phenyl isothiocyante, dansylchloride, flurodinitrobenzene. Zwitterionic properties. pKa values. Reaction of carboxyl group – hydrazine. Biological importance of D and L amino acids

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Peptides: Peptide bond, geometry and characteristics, Ramachandran Plot. Structure and biological importance of peptides; glutathione, valinomycin, Leu-enkaphalins and Endorphins. Synthetic peptides- polyglutamic acid, and polylysine.

Proteins: Definition, classification based on solubility, composition and functions. Introduction to structural organization; Primary, Secondary (alpha helix, beta pleated sheet and beta bends), tertiary (including factors stabilizing the structure) and quaternary structure eg. Hemoglobin and myoglobin. Denaturation and renaturation of proteins; Anfinsen's experiment.

UNIT– III LIPIDS **16 Hrs**

Structure, function and classification: Classification and biological role. Fatty acids– Nomenclature of saturated and unsaturated fatty acids. Physical properties of fatty acids. Sources of fats, invisible fat, essential fatty acids and their biological importance. Saponification, saponification value, iodine value, acid value and significance. Acylglycerols: Mono, di and triglycerols**.**

Phosphoglycerides: structure of lecithin (phosphatidyl choline), cephalins, phosphatidyl inositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides. Sphingolipids; Structure and importance of sphingomyelin. Glycerosphingolipids; Composition and importance of gangliosides and cerebrosides.

Eicosanoids: Types, structure of PGE2, PGI2, PGD2 and PGF2α. Biological roles of thromboxanes, leukotrienes and prostaglandins. Plasma lipoproteins; composition, types and functions, clinical significance.

UNIT– IV NUCLEIC ACIDS **9 Hrs**

Chemistry of nucleic acids: Composition of DNA. Nucleosides and nucleotides. Chargaff's rule. Watson and Crick model of DNA, physical and chemical properties of nucleic acids. RNA: Composition, types (mRNA, tRNA and rRNA), secondary structures of tRNA – clover leaf model. Denaturation and renaturation, melting of DNA (Tm). RNA – types - mRNA, tRNA, rRNA – structure and functions, secondary structure of tRNA – clover leaf model. Isolation of DNA and RNA (from biological sources). UV absorption, hypochromic and hyperchromic effects. Effect of alkali and acid on DNA. Chemical reactions of RNA and DNA.

References

1. Fundamentals of Biochemistry; Jain JL, Sunjay Jain and Nitin Jain, (2020), Updated edition. S. Chand Publishers, New Delhi.
2. Vasudevan DM. Biochemistry. 9th edn. (2018), Aypee Brothers Medical Publishers, New Delhi.
3. Fundamentals of Biochemistry, Ambika Shanmugam, 8th Edn. 2016, Wolters Kluwer India Pvt Ltd
4. Lehninger Principles of Biochemistry, D. Nelson and M. Cox 8th edn, (2021) Macmillan and Co.
5. Biochemistry R. Garrett and C. Grisham 6th Edn (2016) Brooks/Cole.
6. ISE Harper's Illustrated Biochemistry V. Rodwell, D. Bender, et al 31st Edn., (2018) McGraw Hill.
7. Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt 5th Edn, (2016) Wiley.

8. Biochemistry J. Berg L. Stryer et al 9th edn, (2019) W H Freeman.
9. Biochemistry-the chemical reactions of living cells, David E Metzler, 2nd Edn, Elsevier Academic Press.
10. Zubay's principles of Biochemistry, V. B Rastogi and K. R Aneja revised and enlarged edn (2016) Medtech.
11. Textbook of Biochemistry with Clinical Correlations, Thomas Devlin, 7th Edn, (2022), Wiley.

Semester-III; Biochemistry Practical -3: BCP-03

Course title	Qualitative and Quantitative analysis of Macromolecules Practical
Course Code	BCP -03
Course credits	2
Total contact hours	42 h
Duration of ESA	3 h
Formative assessment marks	10
Summative assessment marks	40

Learning outcomes:

The course introduces students to chemical basis of identification and quantification of biological macromolecules and their component. The emphasis will be on the skills essential to understand the chemistry of macromolecules and relate the chemical principles to biological properties.

List of Experiments

1. Qualitative analysis of carbohydrates: Molisch, Benedict's / Fehling's, picric acid, Barfoed's, Bial's, Seliwanoff's, osazone tests. Colour reactions of Glucose, fructose, lactose, maltose and sucrose.
2. Qualitative analysis of amino acids: Colour reactions of amino acids; tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine.
3. Qualitative analysis of proteins**:** Colour reactions of proteins– Biuret, xanthoproteic, Millon's. Precipitation reactions of proteins.
4. Qualitative analysis of lipids– solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
5. Qualitative tests for nucleic acids.
6. Determination of moisture content of foods.
7. Identification of adulterants in food.
8. Estimation of calcium in finger millet (ragi).
9. Estimation of iron in drumsticks.
10. Estimation of vitamin-C in lemon and gooseberries.
11. Estimation of amino acid by formal titration.
12. Determination of total sugars by anthrone method.

References

1. Biophysical Chemistry – Principles and Techniques by Upadhaya, Upadhaya and Nath, 2016 Himalaya Publishing House
2. Tools of Biochemistry by T. Cooper Wiley Publishers
3. Principles and techniques in biochemistry and molecular biology by Walker and Wilson 8th edition, Cambridge University Press
4. Biochemical Calculations by I. Segel 2nd edn (1971) Wiley Publishers

5. Analytical biochemistry, David J Holme, Hazel Peck, 3rd Edn. (1998) Prentice Hall.
6. Bioanalysis of Pharmaceuticals, Steen Honoré Hansen and Stig Pedersen-Bjergaard (2015), Wiley.
7. Biochemical Methods, S.Sadasivam and A.Mannickam, (1993) New Age International.
8. Biophysics, Pattabhi. V. and Gautham.N. (2002) Narosa Publishing House, India.
9. L. Finar: *Organic Chemistry* (Vol. I & II), E. L. B. S. (2002)

Semester-III; Biochemistry Elective: BCTE-01

Course title	**Microbiology & Immunology**
Course Code	**BCTDE-1**
Course credits	2
Total contact hours	28
Duration of ESA	1.5
Formative assessment marks	10
Summative assessment marks	40

Learning outcomes

The students will become conversant with structure, classification, characteristics of microorganisms, scientific basis of food spoilage and preservation techniques.
The student will gain an overview of immune system, including cells and organs. Learn the functions of antigens, immunoglobulins and importance of immune response.
Exposure to the types of hypersensitivity and importance of vaccines.

UNIT- I: Introduction **9 hours**

History and Scope of microbiology
Scope and Development of microbiology as a discipline. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Alexander Fleming.

Diversity of Microbial world
Differences between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (viruses, viroid) and cellular microorganisms (bacteria, algae, fungi, and protozoa).

Microscopy
Principle and application – light microscope, compound microscope, resolution power, electron microscope- SEM and TEM.

UNIT- II Bacteria and viruses **8 hours**

Bacteria
Morphology and general structure, gram positive and gram-negative organisms, nutritional requirements, and growth curve and characteristics of bacteria. Pure culture techniques, bacterial infections and AMR (antimicrobial resistance)

Viruses
General structure and characteristic features of plant, animal and bacteriophages. HIV- structure and route of transmission. TMV- structure, route of transmission and multiplication cycle. Bacteriophages- T- even, structure and replication cycle.

UNIT- III **3 hours**

Food, Dairy and Industrial microbiology
Food spoilage, food, preservation, fermented foods, probiotics and functional foods. Contamination of milk by microorganisms. Reactions occurring in milk, Pasteurization and sterilization. Industrial production of microbial products- antibiotics (penicillin), enzymes (amylase) and biofuel production.

UNIT- IV: **8 hours**

Immunology; *Organs and cells of the immune system*-Primary and secondary lymphoid organs.

Immunity- Definition, Types, Innate immunity - Mechanism of immune response anatomic, physiological, phagocytic and inflammatory barriers. Adaptive immunity- cell mediated and humoral immunity- Mechanism of immune response.

Immunoglobulins- Definition, Structures and functions: IgG, IgM & IgE. Monoclonal and polyclonal antibodies - production and applications.

Antigens – Definition, Chemical nature of antigens, hapten, antigenicity, immunogenicity, epitopes, paratopes, idiotopes, super antigens.

Antigen-antibody reactions - Agglutination, Precipitation, Neutralisation, Complement fixation and Opsonisation.

Hyper sensitivity reactions- Definition, types and examples, Type-I HS reaction and its mechanism

Immunological techniques: Principle and applications of Immunodiffusion; RIA and ELISA.

Vaccines- Definition, types, methods of preparation of live, attenuated vaccines, toxoids, adjuvants. Modern vaccines -recombinant, peptide and DNA vaccines.

References

1. Microbiology, Pelczer, Reid and Kreig Tata McGraw Hill (1996).
2. Microbiology; Lansing M. Prescot, Hartley and Klein, 6th Edn. McGraw- Hill (2005).
3. Basic and Practical Microbiology, Ronald L. Atlas (1986) McMillan Publication Co.
4. Biology of Microorganisms, Brock Prentice Hall (1996).
5. Roitt's Essential Immunology; Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt Peter J. Delves, 13th Edn., (2017)) John Wiley.
6. Kuby Immunology; Oven, Punt, Stranford, 8" Edn. (2018). W. H. Freeman
7. Lippincott Illustrated Reviews Immunology, Doan T, 3rd Edn., (Pb 2022), Wolters Kluwer (India) Pvt. Ltd.
8. Immunology at a Glance: J.H.L. Playfare [ed.] (1987), Blackwell Science.
9. Immunology; Jan Klein [Ed.], (1990), Blackwell Science.

SEMESTER –IV

Biochemistry -4: BCT-04

Course title	**Physiology & Cell Biology**
Course Code	BCT -04
Course credits	3
Total contact hours	56
Duration of ESA	3
Formative assessment marks	20
Summative assessment marks	80

Learning outcomes:

This course is expected to familiarize students with the structural and functional aspects of cell, the basic unit of life and its different organelles and their interrelationships. Students will be able to understand homeostatic and altered physiology of major systems such as; respiration, renal, nervous, muscular, and cardiovascular system.

UNIT- I **14 hours**

Introduction to Cell Biology: Historical aspects - cell theory, protoplasm theory and organizational theory. Broad classification of cell types: prokaryotic cell and eukaryotic cells and their characteristics; Ultra structure of cell: virus, microbial, plant and animal cells.

Structure and functions of cell: Bacterial cell wall and plant cell wall; Plasma membrane: composition. Intercellular junctions; anchoring junctions, tight junctions, desmosomes, hemidesmosomes.

Cell organelles: Structure and functions – Endoplasmic reticulum, Golgi apparatus, Lysosomes, Endosomes, Microbodies: Peroxisomes and Glyoxysomes. Mitochondria: structure. Chloroplast: structure. Vacuoles, Ribosomes, Centriole and Basal bodies.

UNIT- II **14 hours**

Cell division: Nucleus - Structure of nucleus, nuclear pore complex, internal organization of nucleus – chromosome, nuclear matrix, the nucleolus. Cell cycle – cell division (mitosis and meiosis), checkpoints in cell cycle.

Cytoskeleton: Structure, assembly and function of Microtubules: Dynamics, Axonemal and cytoplasmic microtubules. Microfilaments: Actin and Myosin. Intermediate Filaments: different classes and function.

Tissues and Extracellular matrix: Types and functions of epithelial tissue and connective tissues. ECM components – proteins, polysaccharides and adhesion proteins.

UNIT- III **12 hours**

Cardiovascular system: Histological structure of arteries, arterioles, capillaries & veins. Open and close systems. Blood pressure- systolic, diastolic, mean arterial & pulse pressure. Factors controlling blood pressure. Structure and functions of heart, pulmonary and systemic circulation. Cardiac cycle, Rhythmicity of heart, heart sounds, heart rate, factors affecting heart rate, cardiac output, ECG. Blood – composition – packed cell volumn (PCV) and hematocrit and plasma. Erythropoiesis, blood coagulation - outline of the extrinsic and intrinsic pathway. Cardiovascular diseases: Atherosclerosis, haemorrhage, heart attack and stroke.

Body fluids: Intracellular and extracellular compartments, water balance and its regulation, dehydration, oedema. Composition and function of CSF, Lymph, Blood brain barrier (BBB).

Digestive system: The anatomy of the human alimentary canal. Accessory glands of the digestive system, composition of digestive secretions. The biochemistry of digestion of carbohydrates, proteins and fats in various regions of the alimentary canal in humans. Absorption, and fates of ingested carbohydrates, protein and dietary lipids. Storage and detoxification

UNIT- IV **16 hours**

Respiratory system: Mechanism of respiration. Role of alveolar surfactants. Lung volume and capacity. Transport of gases in blood, Bohr's effect, O_2 and CO_2 dissociation curve. Exchange of gases at lung and tissues. Respiratory failure and artificial respiration. Respiratory acidosis and alkalosis. Hypoxia, asphyxia, dyspnoea, cyanosis, emphysema, acclimatization.

Excretory system: Renal circulation-anatomy, Structure and functions of nephron, glomerular filtration rate (GFR), tubular reabsorption. Passive and active tubular transport. Tubular secretion. Formation of urine - counter-current exchanger and counter multiplier mechanism. Role of kidney in osmoregulation. Regulation of renin-angiotensin system. Kidney failure. Renal stone formation. Dialysis.

Nervous system: Structure and types of neurons; other cells of Nervous system. Autonomic. Neurotransmitters – classification based on chemical nature, adrenergic and cholinergic neurotransmission Membrane potential, resting membrane potential and action potential; IPSP and EPSP. Mechanism of synaptic transmission (acetylcholine).

Muscular system: Ultrastructure of skeletal muscles. Sarcotubular system. Fast and slow muscles. Muscle proteins; contractile and non-contractile. Mechanism and regulation of skeletal muscle contraction and relaxation, neuromuscular junctions, Excitation-contraction coupling. Muscular dystrophies. Calmodulin and its regulatory role.

References

1. Harper's Illustrated Biochemistry, by R.K.Murray & others. Lange Medical Book, International Edition, Mc Graw Hill.
2. Text Book of Medical Physiology, by A.C. Guyton. W.B. Saunders Co.
3. Lehninger's Principles of Biochemistry. By D.L.Nelson and M.M. Cox, Worth Publishers Inc.
4. Cell Biology: A Short Course, 4th Edn, (2022) S R. Bolsover, A Townsend-Nicholson, G FitzHarris, E A. Shephard, J S. Hyams, Sandip Patel, Wiley.
5. Molecular Biology of the Cell, by B. Alberts and others, Garland.
6. Biochemistry, by L. Stryer, W.H. Freeman and Co.
7. Molecular Cell Biology, by H. Lodish; D. Baltimore & Others. Scientific American Book.
8. The Cell: A Molecular Approach, Geoffrey Cooper and Kenneth Adams R.E. 9th edn., (2022), Oxford University press.
9. Becker's World of the Cell, Jeff Hardin, Lewis Kleinsmith, 10th Edn., (2022), Pearson.
10. Karps Cell and Molecular Biology Concepts and Experiments, Asian Edition IWASA J. 9th Edn. (2022), Wiley.
11. Human Physiology; Vander Sherman & Luciano (2001), McGraw-Hill.
12. Molecular Cell Biology, Lodish et al., (2021) W H Freeman & Co.
13. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3rd Ed. Jhon Wiley and sons.
14. Lippincott Illustrated Reviews: Biochemistry, Emine Ercikan Abali, Susan D. Cline , David S. Franklin , Susan M. Viselli, 9th Edn., (2025) Wolters Kluwer.

Semester-IV; Biochemistry Practical -4: BCP-04

Course title	Clinical Biochemistry and physiology Practical
Course Code	BCP -04
Course credits	2
Total contact hours	42 h
Duration of ESA	3 h
Formative assessment marks	10
Summative assessment marks	40

Learning outcomes:

The course is expected to make the students conversant with basic clinical parameters, an idea about the clinical parameters and health status. Along with these, the student is skilled in handling biological samples for laboratory analysis and experience of clinical data generation and analysis.

List of Experiments

1. Determination of ABO blood grouping/Analysis of blood group
2. Determination of Blood clotting time
3. Enumeration of RBC and WBC count using Hemocytometer/ Hemocytometric analysis.
4. Separation of Serum and Plasma from Blood.
5. Estimation of hemoglobin content in blood Sahlin's acid hematin method.
6. Qualitative analysis of normal and abnormal constituents of urine.
7. Estimation of inorganic phosphate by modified Fiske-Subbarow method.
8. Estimation of blood sugar by O-Toluidine /Folin -Wu method.
9. Estimation of urea in blood by Fearson method.
10. Estimation of uric acid by phosphor-tungstic acid.
11. Estimation of serum creatinine by Jaffe's method.
12. Estimation of serum bilirubin by Malloy and Evelyn method.
14. Liver function tests-serum bilirubin test, bile pigment in urine, bromosulphalein test,
15. Determination of bile acids in serum, flocculation test, Bilirubin, SGOT, SGPT,
16. Lipid profile tests- Total cholesterol, Triglycerides in serum and Diabetic profile: Fasting blood sugar,
17. Estimation of serum proteins and determination of ratio of albumin and globulin.

References

1. Clinical Biochemistry: an illustrated color text, 6th edn., (2019) Murphy M J, Srivastava R and Deans K, Edinburgh, Elsevier.
2. Textbook of Biochemistry with Clinical Correlations, Devlin TM, (7th edn.) (2010), John Wiley & Sons,.

3. Textbook of Medical Biochemistry, 8th edn. (2012); Chatterjee M N, Rana Shinde, JPB.
4. Textbook Of Biochemistry For Medical Students, 9th edition, (2019) Vasudevan DM, Sreekumari S, Kannan Vaidyanathan, Jaypee Brothers Medical Publishers.
5. Essentials of Medical Physiology, K. Sembulingam and P.Sembulingam. Jaypee Brothers medical publishers, New Delhi., 2019
6. Text book of Medical Physiology-C, Guyton and John. E. Hall, Miamisburg, O H, U.S.A, 12th Edn., 2011.
7. Hawk's physiological chemistry. 14th Edn. (1966) Bernard L. Oser Ed) McGraw-Hill Book Co.
8. Varleys Practical Clinical Biochemistry Gowenlock A. H. 6th Edn, (2002), CBS.
9. Modern Analytical Chemistry 2.1, David Harvey, (2008), David Harvey.

Semester-IV; Biochemistry Elective-2: BCTE-2

Course title	**Membrane Biochemistry**
Course Code	**BCTE-2**
Course credits	2
Total contact hours	28
Duration of ESA	1.5
Formative assessment marks	10
Summative assessment marks	40

UNIT-I **7 hrs**

Introduction: Historical background, membrane models, Monolayer, planer bilayer and liposomes as model membrane systems. Fluid mosaic model with experimental proof. Salient features of bio-membrane, comparison with model membrane. Role of cholesterol and fatty acid composition in membrane fluidity. Supramolecular membrane structure.

Membrane asymmetry and its significance in membrane structure and function. Various techniques to determine asymmetry. Membrane domains- lipid rafts, composition and implications in health and disease.

UNIT-II **5 hrs**

Molecular assembly of biomembranes; Structures of membrane proteins, classification of membrane proteins- integral and peripheral. Membrane proteins and their role in normal/abnormal cell physiology. Interchange of proteins between membranes and their soluble environment. Membrane receptors and responses. Membrane biology of glycolipids in normal and neoplastic cells.

UNIT-III **4 hrs**

Structural dynamics: Structure and function of various biological membranes. Lipid-protein and protein-protein interactions, dynamics of lipid-protein interactions, driving forces. Molecular and patch-clamp approaches to the structure function relationship of voltage gated channels. Ion channels in cancer cells. Membrane rafts in normal and disease conditions.

UNIT-IV **6 hrs**

Membrane transport: Simple diffusion and facilitated diffusion. Passive transport - glucose transporter, anion transporter and porins. Primary active transporters - P type ATPases, V type ATPases. Secondary active transporters- lactose permease, Na^+-glucose symporter. ABC family of transporters- MDR, CFTR. Ion channels - voltage-gated ion channels (Na^+/K^+ voltage-gated channel). ligand gated ion channels (acetyl choline receptor), aquaporins, and bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

UNIT-V **6 hrs**

Cellular processes: Structure-function interplay of some typical membrane receptors like LDL, Ferritin etc. Membrane biology of receptor-mediated endocytosis. Role of cytoskeletal components in membrane structure/organization.

Liposome: Technology and its application in biotechnology. Preparation and characterization of liposomes. Covalent attachment of protein/ligand to liposome surface. Biophysical study of methods of liposome membrane. Liposome in biological systems and its application in Biotechnology such as targeted drug delivery.

References

1. The Cell: A Molecular Approach, Geoffrey Cooper and Kenneth Adams R.E. 9th edn., (2022), Oxford University press.
2. Becker's World of the Cell, Jeff Hardin, Lewis Kleinsmith, 10th Edn, (2022), Pearson.
3. Karps Cell and Molecular Biology Concepts and Experiments, Asian Edition IWASA J. 9th Edn. (2022), Wiley.
4. Molecular Cell Biology, Lodish et al., (2021) W H Freeman & Co.
5. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3rd Edn. Jhon Wiley and sons.
6. Molecular Biology of Membranes Structure and Function, H.R. Petty. 1993., Plenum Press, New York, USA and London.
7. Membrane Molecular Biology of Neoplastic Cells, D.F.H. Wallach. (1975). Elsevier Scientific Publishing Company.
8. Liposomes a Practical Approach, R.R.C. New. (1990). IRL Press, Oxford, New York.
9. Biochemistry of Lipids, lipoproteins and Membranes, 5th Edn, D.E. Vance and J.E. Vance, (2007) Elsevier.
10. Lipid Biochemistry, An Introduction, Michael I. Gurr, John L. Harwood and Keith N. Frayn, 5th Edn., (2002), Blackwell Science Ltd,

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)

Syllabus for Biochemistry
(V & VI Semester)

2023-24

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BENGALURU CITY UNIVERSITY

Department of Biochemistry, Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG), held on Thursday the 17th August, 2023 in the chambers of the Chairman, Dept. of Biochemistry, Central College Campus, Bangalore -560001

The meeting scheduled to discuss the V and VI semester B.Sc. Biochemistry course started with the Chairman welcoming the members. The Chairman placed before the board, draft syllabus for V and VI semester B.Sc. Biochemistry proposed by the syllabus committee constituted by the Karnataka State Higher Education Council and guidelines for preparing two major scheme. The proposed syllabus and scheme was discussed in length and the board approved the syllabus conforming to two major patterns. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

Members Present		**Signature**
1. Prof. V. R. Devaraj, Chairman, Dept. of Biochemistry, Bangalore University.	Chairman	
2 Dr. S. Kantharaju Dept. of Chemistry, SJRC College, Ananda Rao Circle Bangalore -560004	Member	Absent
3. Ms. Vidya, A.S. Dept. of Biochemistry, Seshadripuram College Yalahanka Bangalore -560064.	Member	
4. Dr. (Mrs.) Myrene D'souza Dept. of Biochemistry, Mount Carmel College # 58, Palace Road, Bangalore – 560052	Member	

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5. Dr. R. Nagesh Babu, Member
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001

6. Ms. Malini M.R Member
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

7. Dr. Rajeev Ramachandra Kolagi Member
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001.

8. Dr. Kamala, A. Member
Dept. of Biochemistry,
MLA College for women
Malleswaram 18th Cross
Bangalore-560004

9. Mrs. Ramya Kumari B.S Member
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

10. Mrs. Madhukala. Member
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091

11. Dr. Bhagyalakshmi Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101

12. Mrs. Savitha, K.R. Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101

SEMESTERV-V

Semester	**V**
Course title	**Biochemistry of macromolecules**
Course credits	**04**
Total contact hours	**56**
Duration of end semester assessment	**2.30 h**
Formative assessment marks	**40**
Summative assessment marks	**60**

Course Outcome:

The course provides fundamental insights on the types of macromolecules; and unique structural features, chemical properties and biological importance of each.

CourseOutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x	x								
Criticalthinking		x								x		x
Subjectclarity	x	x					x					x
AnalyticalSkill	x				x	x				x		

UNIT-I **14 hours**

Carbohydrates

Definition, empirical formulae, classification, biological importance.

Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation–phenylhydrazine, addition HCN. Interconversion of aldoses and ketoses by chemical method. Stereochemistry of monosaccharides, (+) and (-), D and L, epimers, anomers, and diastreoisomers. Elucidation of open chain structure and ring structure of glucose. Conformation of glucose (only structures), mutarotation. Structure of galactose, mannose, ribose and fructose. Structure and biological importance of deoxy sugars and sugar acids.

Disaccharides:EstablishmentofstructuresofSucroseandLactose,Biological Importance and structure of Isomaltose, Trehalose and Maltose.

Polysaccharides: Partial structure, occurrence and importance of Starch, Glycogen,Inulin, Cellulose, Chitin, and Pectin.

Glycosaminoglycans: Structure of amino sugars, neuraminic and muramic acid. Occurrence, importance and the structure of the repeating units of heparin, hyaluronic acid, teichoic acid and chondroitin sulphate. Bacterial cell wall polysaccharide, peptidoglycans.

UNIT-II: **14 hours**

Lipids

Classification and biological role, fatty acids – nomenclature of saturated and unsaturated fatty acids.

Acylglycerols: Mono-, di- and triacylglycerols. Saponification, saponification value, iodine value, acid value and significance. Rancidity– types.

Phosphoglycerides: Structure of lecithin (phosphatidyl choline), cephalins, phosphatidyl inositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.

Sphingolipids:Structureandimportanceofsphingomyelin.

Glycerosphingolipids: Composition and importance of gangliosides andcerebrosides. Prostaglandins: Types, structure of PGE2, PGI2, PGD2 and PGF2α. Biological roles of thromboxanes, leukotrienes and prostaglandins.

Plasma lipoproteins: Composition, types and functions – clinical significance.

UNIT-III **14 hours**

Amino acids and Proteins

Amino acids: Structure and classification of amino acids based on polarity. Reactions oftheaminogroupswithHNO_2,$LiAlH_4$.Ninhydrin,Phenylisothiocyante, Dansyl chloride, Fluoro-dinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionic properties. pKa values, D-& L- notation.

Peptides: Peptide bond, geometry and bond parameters, Ramachandran plot.Structure and biological importance of peptides; glutathione, Valinomycin. Synthetic peptides- polyglutamic acid, and polylysine.

Proteins: Classification of proteins based on solubility, structure and functions with examples. Forces that stabilize the structure of proteins. Primary structure of proteins, methods of determining N- and C- terminal aminoacids, sequencing by Edman's degradation method. Secondary structure–α-helix, β-sheet β-bend. Tertiary and quaternary structures-hemoglobin. Denaturation and renaturation of proteins; Anfinsen's experiment.

UNIT-IV **14hours**

Nucleic acids

Composition of DNA and RNA. Nucleosides and Nucleotides. Other functions of nucleotides– source of energy, component of coenzymes and secondary messengers.Chargaff's rule. Watson and Crick model of DNA. Forms of DNA and their interconversions. Nucleic acid chemistry-UV absorption, hypochromic and hyperchromic effects. Effect of alkali and acid on DNA, Chemical reactions of RNA and DNA.Melting of DNA (Tm).Types of RNA (snRNA, mRNA, tRNA and rRNA), Secondary structure of tRNA – clover leaf model.

REFERENCES

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W.Pratt, 4th Edition, John Wiley and Sons Inc, 2012.
2. Lehninger-Principles of Biochemistry; D L Nelson and MM Cox (Eds), 6th Edn. Macmillan Publications, 2012.
3. Biochemistry-the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press,
4. Fundamentals of Biochemistry, Jain, J.L,S.Chandpublication 6th Edition, 2005.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, Freeman & co., 7th Edition, 2010.
6. Harper's Illustrated Biochemistry, Victor Rodwell et. ,al, 31st edition,McGrawHill Education Lange ® 2018.
7. Biochemistry,10th edn., Jeremy M. Berg, John L. Tymoczko, LubertStryer, Gregory J. Gatto, Jr., mcmillan Education, 2023.

8. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1999), Wiley -Liss.
9. Principles of Biochemistry H. Robert Horton, Laurence A. Moran, K. Gray Scrimgeour, J. David Rawn, Pearson College, 2006.

PEDAGOGY: **Mooc/Deskwork/Book chapter/Problem solving/Assignment**

Formative Assessment	
Assessment occasion	**Weightage in marks**
Class test(2 class tests)	**20**
Seminars/class work	**10**
Assignment/open discussion	**10**
Total	**40**

SEMESTER – V; Practical-V

Course Title	**Qualitativeanalysisof Macromolecules**
Course credits	**02**
Total contact hours	**4 Hours/Week**
Duration of end semester assessment	**03 h**
Formative assessment marks	**25**
Summative assessment marks	**25**

Course Outcome

- The practical course will enable the students to learn the principles of reactions pertaining to different macromolecules. They will be able to qualitatively identify the presence of specific macromolecules or amino acids when provided with solution of a mixture of biomolecules.

EXPERIMENTS

1. **Carbohydrates:** monosaccharides (glucose, fructose, galactose) disaccharides(lactose, maltose, sucrose) and polysaccharides (starch, glycogen), ribose, deoxy ribose- Molisch Test, Iodine test, Benedict's test, Barfoed's test, Seliwanoff's test, Bial's test, DPA Test, Tollen'stest, Fehling's test, Picric Acid test, Osazone test.
2. **Proteins:** Biuret Test, Ninhydrin Test, Precipitation reactions of proteins- Precipitation by salts (half-saturation test), precipitation by organic solvents, precipitation by acidic reagents, precipitation by heavy metal ion, precipitation by heat; colour reactions of proteins (gelatin and albumin) and any five amino acids (tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine)- Xanthoproteic test, Millon's Test, Sakaguchi Test, Hopkins- Cole Test, Lead acetate test, Sullivan and McCarthy's Test, Isatin Test, Pauly's Diazo Test.
3. **Lipids:**solubility,acroleintest,Salkowskitest,Lieberman-Burchardtest.
4. **Nucleic acids:** diphenylamine test, orcinol test.

PEDAGOGY: Mooc/Deskwork/Book chapter/Problem solving/Assignment

Formative Assessment	
Assessment occasion	**Weightage in marks**
Continuous evaluation and class test	**15**
Record/ viva-voce	**10**
Total	**25**

REFERENCES

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
2. Biochemical Methods,S.Sadasivam,A.Manickam,3rd Edition, New Age International Pvt Ltd, 2007.
3. An Introduction to Practical Biochemistry, David Plummer,3rd edition, 2017.
4. Laboratory Manual in Biochemistry, J. Jayaraman,2011.

SEMESTER-V

Course credits	Human physiology and Enzymology
Course credits	**04**
Total contact hours	**56 h**
Duration of ESA	**2.30 h**
Formative assessment marks	**40**
Summative assessment marks	**60**

Course Outcome:

- Describe cell structure and functions, how cells form and divide, and how they differentiate and specialize.
- Students will be able to describe the cyclical events of cell division and types ofcell divisions. Student'sknowledge with regard to the process of cell death and cell aging will enhance to its core.
- Physiologyinvolvesthestudyofhowlivingsystems function, fromthe molecular and cellular level tothesystem level, and emphasizes an integrative approach to studying the biological functions of the human body.
- Enzymology topics will enable students to describe structure, functions and themechanism of action of enzymes. Learning kinetics of enzyme catalyzed reactionsand enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units,Specific activity.

CourseOutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking		x										
Subject clarity	x	x									x	
Analytical Skill	x				x	x						

UNIT-I **14 hours**

Basic body plan in humans & Location of organs.

Nervous System: Brief outline of nervous system, Neurons – types, structure of multipolar neuron, mechanism of nerve impulse transmission- along axon, across synapse. Resting membrane potential and Action potential. Neurotransmitters – Excitatory & Inhibitory with examples.

Respiratory system: Anatomy, structure and functions of lungs, mechanism of respiration(pulmonary ventilation), gas exchange mechanism, biochemical events in the transportofgases & factors affecting, role of lungs in acid-base balance. Bohr's effect. Hypoxia, emphysema.

Cardio-vascular system: Structure and functions of heart. Blood vessels–types, Overview & functions: Cardiac cycle, cardiac output, regulation of CVS, blood pressure, heart rate, ECG. Body fluids–blood (composition and functions of blood and plasma), Lymph and CSF. Blood clotting mechanism.

Muscular System: Types of muscles and their structure. Ultra-structure of skeletal muscle. Contractile & regulatory proteins of muscle. Sliding filament modelof skeletalmuscle contraction.

UNIT-II **14 hours**

Connective tissue: Types and functions of connective tissue.Structure and types of bone and cartilage. Long bone – Composition, structure, growth& remodeling, factors affecting.

Digestive System and GIT: Digestion, absorption & transport of carbohydrates, lipids and proteins. Role of various enzymes involved in digestive process. Microbiota of GIT and its significance.

Hepatic System: Structure of a liver lobule. Role of liver in metabolic, storage and detoxification.

Excretory System: Brief outline of excretory system, formation of urine – Glomerularfiltration, tubularreabsorption and secretions. Roleofkidneyinacid-base balance. Regulation of kidney function.

Endocrine System: Brief outline of various endocrine glands and their secretions. Dynamicbalance and regulation of hormonal secretions. Classification of hormones basedon structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulationoftheir secretion.

UNIT-III **14 hours**

Introduction to enzymes

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prostheticgroup, apoenzyme, holoenzyme, IUBMB classification of enzymes withexamples. International Units of enzyme activity, specific activity.

Monomeric and oligomeric enzymes- Monomeric enzymes, multifunctional enzymes,

oligomeric enzymes and multi- enzyme complexes, isoenzymes- lactatedehydrogenase.

Features of enzyme catalysis:

Catalysis, reaction rates and thermodynamics of reaction. Enzyme as catalyst. Activation energy and transition state theory, catalytic power and specificity of enzymes (concept of active site), Theories of enzyme catalysis- Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

UNIT- IV **14 hours**

Enzyme kinetics of single substrate reactions

Review of Law of Mass Action. Equilibrium constant, mono substrate reactions,relationship between initial velocity and substrate concentration,derivation of Michaelis-Menten equation. Lineweaver- Burk plot. Determination of Vmax & Km and their significance, Kcat and turnover number. Factors affecting the rate of reaction- enzyme concentration, substrate concentration, pH, temperature, inhibitors and activators (including metal ions).

Reversible inhibition- competitive, uncompetitive, non-competitive, mixed and substrate inhibition with graphicalrepresentations using L-B plots, Evaluation of Km and Vmax in presence of inhibitor.

Irreversible inhibition- Suicide inhibition. Antibiotics asinhibitors- penicillin.

REFERENCES

1. Chatterjee, C C, Human physiology, Medical allied Agency. New Delhi 2020.
2. Gerard J Tortora, Bryan H Derrickson. Principles of anatomy and physiology, 13th edition, John Wiley & Sons 2000.
3. Gyton and Hall,Textbook of Medical physiology, 10thedition,ElsevierHealth Sciences 2015
4. Sembulingam K& Prema Sembulingam, Essentials of medical physiology, 3rd edition, Jaypee Brothers, 2019.
5. ThomasD.Pollard, WilliamC.Earnshaw,Jennifer Lippincott-Schwartzand Graham T. Johnson, Cell Biology, 3rd edition, Elsevier 2017
6. Lodish, Berk, Kaiser,Krieger et. al, Molecular Cell Biology, 6thedition, 2010
7. Bruce Alberts, Hopkin, Johnson Morgan, Raff, Roberts, and Walter, Essential Cell Biology, 5th edition, W.W. Norton & Company, 2019
8. Palmer, Understanding enzymes, 4th edition, Prentice Hall/Ellis Horward, Landon 2000.
9. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2010

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
Assessment occasion	**Weightage in marks**
Class test (2 class test)	**20**
Seminars/Class work	**10**
Assignment/Open discussion	**10**
Total	**40**

SEMESTER-V; Practical -VI

Course title	Humanphysiologyand Enzymology Practical
Course credits	**02**
Contact hours	**4 h/week**
Duration of ESA	**03 h**
Formative assessment marks	**25**
Summative assessment marks	**25**

Course Outcome:

At completion of this course, it is expected that the students will be able to: Determining the blood grouping and other physiological parameters, Identification of microscopical features of various types of cells and tissues: Understand the anatomy & Physiology of various systems and learn the various cells anddemonstrate the principle and working ofinstruments used in cell biology.

EXPERIMENTS:

1. Determination of ABO blood grouping
2. Determination of Blood clotting time
3. Enumeration of RBC and WBC count using Hemocytometer
4. Separation of Serum and Plasma from Blood
5. Estimation of hemoglobin in content in blood
6. Study of pulmonary function test using spirometer
7. Salivary amylase/β- amylase
   a) Construction of Maltose/glucose calibration curve by DNS method anddetermination of activity of amylase
   b) Determination of specific activity of amylase
   c) Determination of pH optimum of amylase.
   d) Determination of Km and Vmax of amylase.
   e) Determination of optimum temperature of amylase.
   f) Effect of sodium chloride on amylase.
8. Determination of activity of yeast invertase.
9. Isolation of Urease and demonstration of its activity.

REFERENCES

1. Essentials of Medical Physiology, K. Sembulingamand P.Sembulingam. Jaypee Brothers medical publishers, New Delhi., 2019
2. Text book of Medical Physiology-C, Guyton and John.E.Hall, Miamisburg,OH, U.S.A, 12th edition 2011.
3. Text book of Practical Physiology, C.L. Ghai, Jaypee brother's Medical Publishers, New Delhi, 10th edition 2022.
4. AHandbookofpracticalMicrobiology, R. Saravanan , D. Dhachinamoorthi , CH. M M. Prasada Rao , 2019.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING/ASSIGNMENT

Formative Assessment	
Assessment Occasion	**Weightage in marks**
Record/Viva-Voce	**10**
Continuous Evaluation and Class Test	**15**
Total	**25**

SEMESTER-VI

Course title	Molecular Biology and Immunology
Course credits	**04**
Total contact hours	**56**
Duration of ESA	**2.5 h**
Formative assessment marks	**40**
Summative assessment marks	**60**
Course credits	**04**

Course Outcome:

These topics will enable students to understand the molecular mechanisms, via which genetic information is stored, expressed and transmitted among generations. Students will be able to define the concept of immunology and concepts of antigen and antibody, explain immune system cells,discuss active immunity, passive immunity and cellular immune mechanism.

CourseOutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude	x	x	x									
Critical thinking		x										
Subject clarity	x	x				x					X	X
Analytical Skill	x				x	x				X		

UNIT-I

DNA replication and Transcription **14 hours**

Introduction to Molecular Biology: Identification of DNA as genetic material-Experimentsof Griffith, Hershey and Chase: Overview of structure of DNA.Chromosomal organization in prokaryotes and Eukaryotes; Gene and gene concept: cistron, muton, recon and replicon. Central dogma of molecular biology and its modification.

Replication: Types of replication; Conservative, semi conservative and dispersive. Evidence for semi conservative replication- Meselson and Stahl experiment. Mechanism of semi conservative replication- Steps involved in replication, enzymes and proteins involved in replication. Properties of DNA polymerase I.
Outline of DNA replication in eukaryotes.

Transcription in prokaryotes: RNA polymerase, mechanism of initiation, organization of promoters and enhancers. Role of sigma factor. Termination (Rho -dependent and independent). Reverse transcription.

Overview of eukaryotic transcription: Eukaryotic RNA polymerases. Post transcriptional mRNA processing: capping, splicing and poly adenylation.

UNIT-II **14 hours**

Translation and Regulation of gene expression

Genetic code: Characteristics of genetic code, wobble hypothesis.
Translation: Mechanism of translation - amino acid activation, charging of tRNA, initiation, elongation, and termination; post-translational modification; Inhibition of protein synthesisby antibiotics.

Mutation: Concept of mutation, Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations, intercalating agents and UV-radiation. Point mutations - missense, nonsense and frame shift mutations.

Regulation of gene expression: General aspects of regulation, transcriptional regulation-inducible and repressible system. Operon concepts -lactose, tryptophan operons. Brief account of Eukaryotic geneexpression regulation.

UNIT- III **14 hours**

Overview and Nature of Antigen and Antibody
Organs of the immune system: Anatomy and functions of lymphoid tissues. Haematopoiesis. Cellularcomponents of the immune system - granulocytes- neutrophil, eosinophil, basophil and mast cell, Mononuclear cells- Lymphocytes, Monocytes, Macrophages,NK cells and Dendritic cells.

Antigen: Concept of antigenic determinants and immunogens, factors that influenceimmunogenicity, Classes of antigen, Epitopes, Haptens.

Antibody: Molecular Structure - general features, light and heavychains, Hyper variable and constant regions, Different isotypes and subtypes ofimmunoglobulins, Allotypes and idiotypes.

UNIT- IV **14 hours**

Innate and adaptive Immunity

Innate immunity: Anatomical and physiological barriers, Soluble factors, Inflammation-characteristics, initiation ofthe inflammatory response, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity.Cytokines, Complement system.

Adaptive immunity
MHC molecules: genes, different classes, structure and function. Antigen processing andpresentation: Endogenous and exogenous pathways.
Humoral Immunity –BCR, B-cell activation and maturation, generation of plasma cells and memory B cells.
Cell-mediated immunity:Structural organization of T cell-receptors, T-cell maturation and differentiation, Proliferation , B cell – T cell interaction, The germinalcenter reactions.

REFERENCES

1. Molecular Biology-David Friefelder, Narosa Publication-house Pvt.Ltd. New Delhi,2020
2. A Textbook of Biochemistry: Molecular and Clinical Aspects, S. Nagini. 2nd edition. Sci Tech Publ., Chennai, 2007
3. Owen, Judith A., Jenni Punt, and Sharon A. Stranford. Kuby immunology. New York: WH Freeman, 2013.
4. Delves, Peter J., Seamus J. Martin, Dennis R. Burton, and Ivan M. Roitt. &Roitt's Essential immunology. Vol. 20. John Wiley & Sons, 2011.

PEDAGOGY: MOOC/DESKWORK/BOOKCHAPTER/PROBLEMSOLVING /ASSIGNMENT

Formative Assessment	
Assessment occasion	**Weightage in marks**
Class test (2Classtests)	**20**
Seminars/Classwork	**10**
Assignment/Open discussion	**10**
Total	**40**

SEMESTER-VI

Course title	Bioenergetics and Metabolism
Course credits	**04**
Total contact hours	**56**
Duration of ESA	**2.5**
Formative assessment marks	**40**
Summative assessment marks	**60**

Course Outcome:

At the endofthecourse thestudentswillbe ableto

- Understand the concepts of metabolism, characteristics of metabolic pathways and strategies used to study these pathways.
  Gain a detailed knowledge of various catabolic and anabolic pathways and its regulation
- Systematically learn the breakdown and synthesis of amino acids andnucleotides in humans and recognize its relevance with respect to nutrition and human diseases
- Acknowledge the role of inhibitors of nucleotide metabolism which are potentially being used as chemotherapeutic drugs
- Comprehendhow theaminoacid andnucleotide metabolismareintegratedwith carbohydrate and lipid metabolism

Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude		x		x				x				
Critical thinking		x		x		x				x		
Subject clarity	x	x				x	x					x
Analytical Skill	x				x	x				x		

UNIT-I **14 hours**

Bioenergetics

Laws of thermodynamics, free energy change, equilibrium constant, energy charge, ATP cycle, phosphorylation potential, and phosphorylgroup transfers. Chemical basis of high standard energy of hydrolysis of ATP, Oxidative phosphorylation: Proton gradientgeneration,redoxloop,Q-cycle,Protonpumping.Theelectrontransportchain-

Peter Mitchell's Chemiosmotic hypothesis and Proton motive force. Fo-F1 ATP synthase – structure,and mechanism of ATP synthesis.

UNIT-II **14 hours**

Metabolism

Anabolism and catabolism, compartmentalization of metabolic pathways.

Metabolism of Carbohydrates: Reactions and energetics of glycolysis, entry of fructose, galactose, mannose and lactose into glycolytic pathway. Fates of pyruvate- conversion of pyruvate to lactate, alcohol and acetyl CoA. Cori's cycle.

Reactions and energetics of TCA cycle,amphibolic and integrating roles of TCA cycle. Anaplerotic reactions. Regulatory steps of glycolysis and TCA cycle, Gluconeogenesis and glycogenolysis. Pentose phosphate pathway and its significance.

Unit-III **14 hours**

Metabolism of Lipids

Introduction, hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, β-oxidation of saturated and unsaturated fatty acids, ATP yield from fatty acid oxidation. Biosynthesis of saturated and unsaturated fatty acids. Fatty Acid Synthase complex, Lipogenesis (Denovo synthesis of Fatty acid), Elongation of Fatty acid (Mitochondrial elongation). Biosynthesis of TAG, Phospholipids (Lecithin and Cephalin).Cholesterol metabolism.

Nucleic Acid metabolism: Degradation of nucleic acids, action of nucleases-DNase I and II, RNase and phosphodiesterases. Catabolism of purines and pyrimidines. Salvage pathways. De novo biosynthetic pathways of purine and pyrimidine nucleotides. Conversion of ribonucleotides to deoxyribonucleotides.

UNIT-IV **14 hours**

Metabolism of Amino acids

General mechanism of amino acid metabolism: Deamination- oxidative and non – oxidative deamination, transamination, decarboxylation (biologically important amines) and desulphuration. Catabolism of carbon skeleton of amino acids, glycogenic and ketogenic amino acids. Urea cycle and its significance. Synthesis and catabolism of alanine, serine and cysteine

REFERENCES

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, JohnWiley and Sons Inc, 2012.
2. Lehninger Principles of Biochemistry; DL Nelson and MM Cox (Eds), 6th Edn. Macmillan Publications, 2012.
3. Biochemistry-the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier, Academic Press,
4. Fundamentals of Biochemistry, Jain, J. L, S. Chand publication 6th Edition, 2005.
5. Biochemistry, Jeremy M. Berg, John L. Tymoczko, LubertStryer, Freeman and company, 7th Edition, 2010.
6. Harper's Illustrated Biochemistry,Victor W Rodwell,et.al, 31st edition, McGraw-Hill Education Lange, 2018.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING /ASSIGNMENT

Formative Assessment	
Assessment occasion	**Weightage in marks**
Class test (2class test)	**20**
Seminars/class work	**10**
Assignment/open discussion	**10**
Total	**40**

SEMESTER-VI; Practical-VII

Course title	Bioenergetics and Metabolism Practical
Course credits	02
Contact hours	4 Hours/Week
Duration of ESA	04
Formative assessment marks	25
Summative assessment marks	25

CourseOutcome:

- The practical course will enable the students to learn the estimation of blood substances which tell how well the organs/kidneys are functioning, and glucose, which indicates whether there is a normal amount of sugar in the blood. Blood urea nitrogen is a measure of how well the kidneys are working.
- LearningthestructurallevelsofNucleicacids.

Experiments

1. EstimationofBlood glucose
2. Estimation of protein
3. Estimation of inorganic phosphate
4. Assay of Digestive enzyme
5. Estimation of Urea
6. Estimation of Uric acid
7. Estimation of creatinine
8. Estimation of cholesterol
9. Estimation of vitamin C
10. Determination of A/G ratio

II : Report:

Visit to scientific/research institute–Tour report.

OR

Submission of assignment on recent trends in biochemistry

REFERENCES

1. Practical Biochemistry, Geetha Damodaran, Jaypee, 2011.
2. Biochemical Methods,S.Sadasivam,A.Manickam,3rd Edition, New Age International Pvt. Ltd, 2007.
3. An Introduction to Practical Biochemistry,David Plummer,3rdedition, 2017
4. Laboratory Manual in Biochemistry, J.Jayaraman, 2011.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING/ASSIGNMENT

FormativeAssessment	
Assessment occasion	**Weightage in marks**
Record/Viva voce	**10**
Continuous evaluation and class test	**15**
Total	**25**

SEMESTER-VI; Practical - VIII

Coursetitle	**Molecular Biology and Immunology Practical**
Course credits	**02**
Contact hours	**4 h/week**
Duration of ESA	**03 h**
Formative assessment marks	**25**
Summative assessment marks	**25**

CourseOutcome:

The practical course will enable the students to learn

- Identifying blood groups and types
- Competently perform serological diagnosis
- Analyze components of human sera by performing electrophoresis experiments.

CourseOutcomes	1	2	3	4	5	6	7	8	9	10	11	12
Aptitude		x		x								
Critical thinking		x				x						
Subject clarity	x	x				x	x		x	x	x	x
Analytical Skill	x				x	x				x		

EXPERIMENTS

Molecular biology

1. Isolation of DNA from banana/endosperm of coconut/ bacteria / any other source
2. Agarose gel electrophoresis of nucleic acids
3. Isolation of RNA from spinach leaves/any other source
4. DNA Purity check by UV spectrophotometer
5. Isolation of plasmid from E. *coli*
6. DNA analysis by Restriction endonucleases
7. Western blotting

Immunology

1. Hemagglutination inhibition test
2. WIDAL test
3. ELISA test/assay
4. Isolation of antibodies
5. Differential leucocyte count
6. Ouchterlony double diffusion
7. Radial immune diffusion test
8. Agglutination reactions

REFERENCES:

1. A Handbook of Practical and Clinical Immunology, G.P Talwar and S.K Gupta,2017.
2. Practical Immunology , Frank C Hey, Publisher: John Wiley and Sons Ltd, 2000.
3. An Introduction to Practical Biochemistry,DavidPlummer,3rdedition, 2017.
4. Laboratory Manual in Biochemistry, J.Jayaraman, 2011.
5. Molecular Biology: A Laboratory Manual by Ashwani Kumar S.K. Gakhar, Monika Miglani, 2019.
6. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology 8th edn. (Sae) by Hofmann, 1983.
7. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology by J.Saxena, M. Baunthiyal, I. Ravi, 2015.
8. Biochemical methods, S. Sadasivam, A. Manickam, 3rd Edition, New AgeInternational Pvt Ltd, 2007.

PEDAGOGY: MOOC/DESK WORK/BOOK CHAPTER/PROBLEM SOLVING/ASSIGNMENT

Formative Assessment	
Assessment occasion	**Weightage in marks**
Record/viva- voce	**10**
Continuous evaluation and class test	**15**
Total	**25**

B.Sc. V &VI SEMESTERS MODEL QUESTION PAPER
BIOCHEMISTRY

Time:2.5 h Max.marks:60

Note: all sections are compulsory

SECTION – A

1. Answer any FIVE of the following 5x2= 10

a.
b.
c.
d.
e.
f.
g.

SECTION –B

Answer any FOUR of the following; 4x5= 20

2.
3.
4.
5.
6.
7.

SECTION – C

Answer any THREE Questions 3 x 10 = 30

8.
9.
10.
11.
12.

Note*: Section C may include sub questions, a, and b*

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BENGALURU CITY UNIVERSITY

Department of Biochemistry, Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG), held on Thursday the 17th August, 2023 in the chambers of the Chairman, Dept. of Biochemistry, Central College Campus, Bangalore -560001

The meeting scheduled to discuss the V and VI semester B.Sc. Biochemistry course started with the Chairman welcoming the members. The Chairman placed before the board, draft syllabus for V and VI semester B.Sc. Biochemistry proposed by the syllabus committee constituted by the Karnataka State Higher Education Council and guidelines for preparing two major scheme. The proposed syllabus and scheme was discussed in length and the board approved the syllabus conforming to two major patterns. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

Members Present		**Signature**
1. Prof. V. R. Devaraj, Chairman, Dept. of Biochemistry, Bangalore University.	Chairman	
2 Dr. S. Kantharaju Dept. of Chemistry, SJRC College, Ananda Rao Circle Bangalore -560004	Member	Absent
3. Ms. Vidya, A.S. Dept. of Biochemistry, Seshadripuram College Yalahanka Bangalore -560064.	Member	
4. Dr. (Mrs.) Myrene D'souza Dept. of Biochemistry, Mount Carmel College # 58, Palace Road, Bangalore – 560052	Member	

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5. Dr. R. Nagesh Babu, Member
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001

6. Ms. Malini M.R Member
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54

7. Dr. Rajeev Ramachandra Kolagi Member
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001.

8. Dr. Kamala, A. Member
Dept. of Biochemistry,
MLA College for women
Malleswaram 18th Cross
Bangalore-560004

9. Mrs. Ramya Kumari B.S Member
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10. Mrs. Madhukala. Member
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Magadi Road,
Bengaluru-560091

11. Dr. Bhagyalakshmi Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101

12. Mrs. Savitha. K.R. Member
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101