



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)**

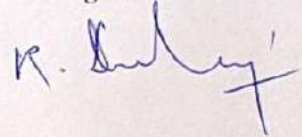

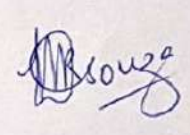
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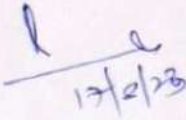
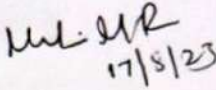

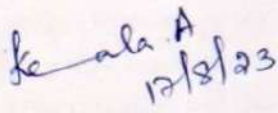
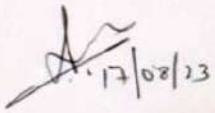
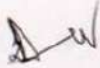
Department of Biochemistry,
Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG),
held on ~~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,
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001 | Member | 
17/2/23 |
| 6. Ms. Malini M.R
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | 
17/5/23 |
| 7. Dr. Rajeev Ramachandra Kolagi
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001. | Member | 
Dr. Rajeev R. Kolgi |
| 8. Dr. Kamala, A.
Dept. of Biochemistry,
MLA College for women
Malleswaram 18 th Cross
Bangalore-560004 | Member | 
Kamala A
17/8/23 |
| 9. Mrs. Ramya Kumari B.S
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | 
17/08/23 |
| 10. Mrs. Madhukala.
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091 | Member |  |
| 11. Dr. Bhagyalakshmi
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | Absent |
| 12. Mrs. Savitha, K.R.
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | Absent |

SEMESTER V-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 diastereoisomers. 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: Establishment of structures of Sucrose and Lactose, 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: Structure and importance of sphingomyelin.

Glycerosphingolipids: Composition and importance of gangliosides and cerebroside. 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 of the amino groups with HNO₂, LiAlH₄, Ninhydrin, Phenylisothiocyanate, Dansyl chloride, Fluorodinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionic properties. pK_a 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 amino acids, 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

14 hours

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 (T_m). 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. Chand publication 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, Lubert Stryer, 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	Qualitative analysis of 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's test, 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, acrolein test, Salkowski test, Lieberman-Burchard test.
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 of cell divisions. Student's knowledge with regard to the process of cell death and cell aging will enhance to its core.
- Physiology involves the study of how living systems function, from the molecular and cellular level to the system 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 the mechanism of action of enzymes. Learning kinetics of enzyme catalyzed reactions and enzyme inhibitions and regulatory process, Enzyme activity, Enzyme Units, Specific activity.

Course Outcomes	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 transport of gases & 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 model of skeletal muscle 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 – Glomerular filtration, tubular reabsorption and secretions. Role of kidney in acid-base balance. Regulation of kidney function.

Endocrine System: Brief outline of various endocrine glands and their secretions. Dynamic balance and regulation of hormonal secretions. Classification of hormones based on structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion.

UNIT-III

14 hours

Introduction to enzymes

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme, IUBMB classification of enzymes with examples. International Units of enzyme activity, specific activity.

Monomeric and oligomeric enzymes- Monomeric enzymes, multifunctional enzymes, oligomeric enzymes and multi- enzyme complexes, isoenzymes- lactate dehydrogenase.

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 V_{max} & K_m and their significance, K_{cat} 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 graphical representations using L-B plots, Evaluation of K_m and V_{max} in presence of inhibitor.

Irreversible inhibition- Suicide inhibition. Antibiotics as inhibitors- 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, 10th edition, Elsevier Health Sciences 2015
4. Sembulingam K & Prema Sembulingam, Essentials of medical physiology, 3rd edition, Jaypee Brothers, 2019.
5. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz and Graham T. Johnson, Cell Biology, 3rd edition, Elsevier 2017
6. Lodish, Berk, Kaiser, Krieger et. al, Molecular Cell Biology, 6th edition, 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 and demonstrate the principle and working of instruments 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 and determination of activity of amylase
 - b) Determination of specific activity of amylase
 - c) Determination of pH optimum of amylase.
 - d) Determination of K_m and V_{max} 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. Sembulingam and 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. A Handbook of practical Microbiology, 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-Experiments of 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 synthesis by 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 gene expression regulation.

UNIT- III

14 hours

Overview and Nature of Antigen and Antibody

Organs of the immune system: Anatomy and functions of lymphoid tissues. Haematopoiesis. Cellular components 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 influence immunogenicity, Classes of antigen, Epitopes, Haptens.

Antibody: Molecular Structure - general features, light and heavy chains, Hyper variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes.

UNIT- IV

14 hours

Innate and adaptive Immunity

Innate immunity: Anatomical and physiological barriers, Soluble factors, Inflammation-characteristics, initiation of the 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 and presentation: 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 germinal center 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 end of the course the students will be able to

- 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 and nucleotides 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
- Comprehend how the amino acid and nucleotide metabolism are integrated with 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 phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, Oxidative phosphorylation: Proton gradient generation, redox loop, Q-cycle, Proton pumping. The electron transport chain-

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 (De novo 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, glycolytic 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

Course Outcome:

- 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.
- Learning the structural level of Nucleic acids.

Experiments

1. Estimation of Blood 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, 3rd edition, 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

Course title	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

Course Outcome:

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.

Course Outcomes	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, David Plummer, 3rd edition, 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 Walker's 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 Age International Pvt Ltd, 2007.

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

Formative Assessment	
Assessment occasion	Weightage in marks
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Continuous evaluation and class test	15
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**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.

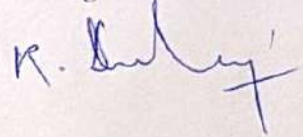

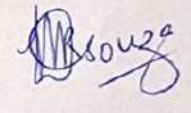
Note: Section C may include sub questions, a, and b

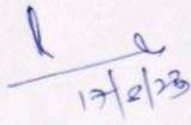
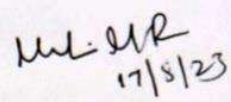
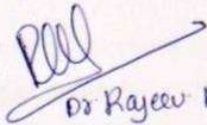
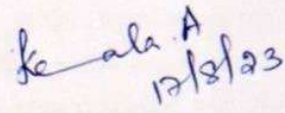
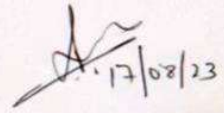

Department of Biochemistry,
Central College Campus, Bangalore -560001

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	

- | | | |
|--|--------|---|
| 5. Dr. R. Nagesh Babu,
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001 | Member | 
17/2/23 |
| 6. Ms. Malini M.R
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | 
17/5/23 |
| 7. Dr. Rajeev Ramachandra Kolagi
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001. | Member | 
Dr Rajeev R. Kolgi |
| 8. Dr. Kamala, A.
Dept. of Biochemistry,
MLA College for women
Malleswaram 18 th Cross
Bangalore-560004 | Member | 
17/8/23 |
| 9. Mrs. Ramya Kumari B.S
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | 
17/08/23 |
| 10. Mrs. Madhukala.
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091 | Member |  |
| 11. Dr. Bhagyalakshmi
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | Absent |
| 12. Mrs. Savitha, K.R.
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | Absent |