



Dr. Ambedkar Veedhi, Central College Campus
Bengaluru-560001

Scheme and Syllabus

for I and II Semesters

**B.Sc. (Hons.) degree in Biochemistry
&
Discipline specific open elective
Course (CBCS) under NEP 2020**

(With effect from 2021-22)

**Department of Biochemistry,
Central College Campus
Bengaluru -560 001**

October, 2021



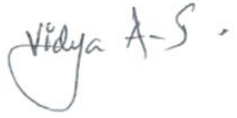



**Department of Biochemistry,
Central College Campus, Bangalore -560001**

**Proceedings of the Meeting of Board of Studies in Biochemistry (UG),
held on Tuesday the 28th September, 2021 in the chambers of the Chairman,
Dept. of Biochemistry, Central College Campus, Bangalore -560001**

The meeting started with the Chairman welcoming the members to the meeting. The Charmin placed before the board, draft syllabus proposed by the syllabus committee constituted by the Karnataka State Higher Education Council and the panel of examiners for the ensuing semesters and proposed Board of Examiners in Biochemistry (UG) for 2021-2022 examinations. The proposed syllabus and scheme was discussed in length and the board approved the same with minor additions and deletions. Further, on verification of list of examiners, the board approved the panel of examiners and the BOE in Biochemistry (UG) for the 2021-2022. 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,
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001 | Member | 
28/09/2021 |
| 6. Ms. Malini . M.R
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member |  |
| 7. Dr. Rajeev Ramachandra Kolagi
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001. | Member |  |
| 8. Dr. Kamala, A.
Dept. of Biochemistry,
MLA College for women
Malleswaram 18 th Cross
Bangalore-560004 | Member |  |
| 9. Mrs. Ramya Kumari B.S
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member |  |
| 10. Mrs. Madhukala. K.L.
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091 | Member | 
28/9/21 |
| 11. Dr. Bhagyalakshmi
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | 
28/9/21 |
| 12. Mrs. Savitha, K.R.
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | Absent |

B.Sc. BIOCHEMISTRY (Honors)

Preamble

As one of the basic science disciplines which lead to biotechnological advancement, Biochemistry is a branch of science that explores the chemical processes within and related to living organisms. It focuses on processes at cellular and molecular level. A trained biochemist employs chemical knowledge and bio-analytical skills, in order to unravel biological problems pertaining to physiological processes, diseases related to their malfunctions, diagnostics, prevention, therapy and prognostics. Considering far-reaching advances in modern biology in 21st century, it is imperative to incorporate emerging concepts of biochemistry in academic curriculum. The proposed pattern is designed for multi-faceted development of students, giving the freedom to choose a combination of courses of study from Biochemistry as well as from the allied disciplines. While 14 discipline Specific Courses with 70 credits (12 with practical components for 61 credits and 3 without practical for 9 credits), three discipline specific Electives (9 credits) provide fundamental and advanced courses in Biochemistry, two vocational courses for 6 credits, research project in VIII semester provides much needed orientation and exposure to experimental research. With the Biochemistry major, the candidate can choose a minor from other disciplines such as Botany, Zoology, Environmental science, physics, Electronics, Mathematic, and other allied disciplines for 34 credits, depending on the subject's expertise available in the respective College, University or Institutions.

Further, 24 credit courses shall be from ability enhancement courses (during first two years), and 4 credits shall be from compulsory environmental studies and Constitution of India. Skill enhancement courses for 8 credits earned over first six semesters include Digital fluency, Artificial intelligence, and Cyber security, and Professional communication. Value based courses of Physical education and health and wellness for 12 credits provide opportunities for personality development.

The curricular framework approved by the Karnataka State Higher Education Council and Govt. of Karnataka as part of National Education Policy (NEP-2020) programme shall thus provide understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biochemistry equipping students with requisite knowledge, skill and personality.

Programme Learning Outcomes

Broad outcomes that a student with B.Sc. (Honours) programme in Biochemistry should be able to demonstrate may involve academic, personal, behavioural as well as entrepreneurial and social competencies as follows;

- demonstrate an experiential learning and critical thinking of the structure and function of both prokaryotic and eukaryotic cells (including the molecular basis and role of sub-cellular compartmentalization)
- demonstrate an understanding of the principles, and have practical experience of, a wide range of biochemical techniques (e.g. basic molecular biology, cell biology and microbiology methods, spectrophotometry, the use of standards for quantification, enzyme kinetics; macromolecular purification, chromatography electrophoresis, etc.) and data analysis and competent interpretation.
- ability to use skills in specific areas related to biochemistry such as industrial production, technology development, clinical, health, agriculture, community development, etc.
- curiosity and ability to formulate biochemistry related problems and using appropriate concepts and methods to solve them.
- demonstrate skills to publish research findings, and awareness of IP rights, and scientific publication ethics and problems of plagiarism articulation of ideas, scientific writing and authentic reporting, effective presentation skills.
- having conversational competence including communication and effective interaction with others, listening, speaking, and observational skills.
- collaboration, cooperation and realizing the power of groups and community, ability to work in a group, community.
- ability to grasp ideas and to turn ideas into action related to biochemical mechanisms and processes related to industries, industrial production, health and agriculture, etc.
- creativity, innovation and risk-taking ability, and social skills to build great teams.

Graduate Attributes for B.Sc. (Honors) in Biochemistry

Graduates with strong academic knowledge, discipline-specific and generic skills complemented with social responsibility are greatest asset of the country. The curriculum framework under NEP for Biochemistry graduates aims to build the following attributes;

Disciplinary Knowledge:

- Ability to comprehend fundamental concepts of biology, chemistry and apply basic principles of chemistry to biological systems.
- Ability to relate various interrelated physiological and metabolic events.
- Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts
- Ability to think laterally and in an integrating manner and develop interdisciplinary approach
- Good experimental and quantitative skills and awareness of laboratory safety
- A general awareness of current developments at the forefront in biochemistry and allied subjects.
- Awareness of resources, and their conservation.

Communication Skills

- Ability to speak and write clearly in English and local language
- Ability to listen to and follow scientific viewpoints and engage with them.
- Ability to understand and articulate with clarity and critical thinking one's position.

Critical Thinking

- Ability to conceptualize critical readings of scientific texts in order to comprehend.
- Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions.

Problem Solving

- Ability to make careful observation of the situation, and apply lateral thinking and analytical skills.

Analytical Reasoning

- Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments.
- Ability to use scientific evidences and experimental approach to substantiate one's argument in one's reading of scientific texts.

Research Skills

- Ability to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers.
- Ability to plan and write a research paper.

Teamwork and Time Management

- Ability to participate constructively in class room discussions.
- Ability to contribute to group work.
- Ability to meet a deadline.

Scientific Reasoning:

- Ability to analyse texts, evaluating ideas and scientific strategies.
- Ability to formulate logical and convincing arguments.

Reflective Thinking:

- Ability to locate oneself and see the influence of location; regional, national, global on critical thinking.

Self-Directing Learning

- Ability to work independently in terms of organizing laboratory, and critically analysing research literature.

Digital Literacy

- Ability to use digital sources, and apply various platforms to convey and explain concepts of biochemistry.

Multicultural Competence

- Ability to engage with and understand cultures of various nations and respect and transcend differences.

Moral and Ethical Values

- Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.

- Ability to read values inherited in society and criticism *vis-a-vis* the environment, religion and spirituality, as also structures of power.

Leadership Readiness

- Ability to lead group discussions, to formulate questions related to scientific and social issues.

Life-long Learning

- Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day-to-day business.

Model Program Structures for the Under-Graduate Programs in Universities and Colleges in Karnataka
Bachelor of Arts (Basic/ Hons.)/ Bachelor of Science (Basic/Hons.)/Bachelor of Commerce (Basic/Hons.)/
Bachelor of Business Administration (Basic/Hons.)/Bachelor of Social Works (Basic/Hons.)/Bachelor of Computer Applications (Basic/Hons.) etc.

The Government of India has notified NEP-2020 on July 29, 2020 based on Dr.Kasturirangan Committee's Report. The objective is to bridge the gap between the current system of education and what is required in the 21st century. It is to have Holistic and Multidisciplinary Under-Graduate Education to produce employable graduates with integrated personality.

The Government of Karnataka had constituted a Task to suggest an Implementation Framework for NEP-2020. It had also constituted two sub-committees, one on Curriculum Reforms in Higher Education and the other on Governance and Regulations.

The Task Force has suggested NEP-2020 Implementation Framework for Karnataka. The State Government has accepted the action plan and taken steps to implement NEP-2020, as per the Implementation Roadmap suggested by the Task Force.

The Sub-committee on Curriculum Reforms in Higher Education had suggested a Draft Curriculum Framework for Undergraduate Programs in various disciplines. The State Govt. had also constituted Faculty-wise Committees to consider this draft framework to formulate program structures in their faculties. These Committees have submitted their reports. The latter were considered in the meetings of all the Vice Chancellors. The following Model Program Structures were designed for various Under-Graduate Programs in Arts, Science, Commerce and Management. The Subject Committees constituted to design and draft the curriculum in their subjects have to follow these Model Program Structures. The Terminology used in these Program Structures are.

Discipline Core (DSC) refers to Core Courses/Papers in a Core Discipline/Subject

Discipline Elective (DSE) refers to Elective Courses/Papers in the Core Subject or Discipline.

Open Elective (OE) refers to Elective Courses/Papers in a non-core Subject across all disciplines.

Program Structures also contain Ability Enhancement Compulsory Courses (AECC), Languages, Skill Enhancement Courses (SEC) (Both skills and value based). Pedagogy involves L+T+P model. Generally subjects with practical involve L+P, while the subjects without practical involve L+T model. The numbers in parentheses indicate credits allotted to various courses/papers as per definitions of Choice Based Credit System (CBCS). Generally 1 hour of Lecture or 2 hours of practical per week in a semester is assigned one credit. Generally core subject theory courses/papers will have 3 or 4 credits, while practical are assigned 2 or 3 credits.

Job opportunities in Biochemistry Core Course

Exit After one year: *CERTIFICATE COURSE*

<i>Knowledge</i>	<i>Skill Acquired</i>	<i>Employability</i>
<p>Fundamental properties of elements, atoms, acids and bases, metals, non-metals, alloys and composites. Biological significance of elements. Understanding of chemical bonding, Physical properties of molecules, chemistry of toxic chemicals. Chemical kinetics, Colligative properties, Properties of matter and electro chemistry, fundamentals and applications of nuclear and radio chemistry.</p> <p>Classification, structure, reactivity and biological significance of major organic compounds.</p> <p>A general scientific spirit of inquiry</p>	<p><i>Numerical calculations, data generation and analysis, including the application of data transformations. laboratory, safety and precautions, proficiency in preparation of laboratory reagents, use of glassware, Demonstration of basic oxidation and reduction reactions, primary and secondary standards. Handling basic instruments.</i></p> <p><i>Communication interpersonal and leadership skills, and ability enhancements complementing the core biochemistry, Entrepreneurship</i></p>	<p>Small and medium size chemistry/pharma based laboratories; as Jr. laboratory assistant assisting chemists/scientists. QC assistants in Laboratories dealing with QC service.</p> <p>Toiletries, chemicals, perfumery, oil industries, distilleries/ textiles/ pollution control units</p> <p>Entrepreneurship</p>

Exit after two year: *Diploma COURSE*

<p>Basic chemistry of natural compounds, alkaloids, terpenes, heterocyclic compounds, drugs, stereochemistry, biological relevance of these compounds, outlines of Photochemistry and environmental chemistry. History of Biochemistry,</p> <p>Comprehensive knowledge and hand-on training in laboratory techniques of biochemistry. Analytical instrumentation and methodology</p>	<p><i>Acquaintance with analytical techniques that will permit them to study the biological system. Demonstrating skills of fractionating organic compounds.</i></p> <p><i>Hands on experience of handling instruments and analysis of data.</i></p> <p><i>Improving personality traits, team work, organizing abilities. Communication skills</i></p>	<p>Assistants in Health care/paramedical laboratories. Supervision and maintenance of laboratories. QC assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Marketing</p> <p>Entrepreneurial opportunities, Material safety data sheet maintenance, curation of chemical/drug stores, chemical store keeping</p>
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Exit after three years: *B.Sc. degree*

<i>Knowledge</i>	<i>Skill Acquired</i>	<i>Employability</i>
<p>Comprehensive knowledge of biomolecules: higher order structures of proteins, nucleic acids and their functions. Bioenergetics, metabolism, enzyme kinetics, basic molecular biology, industrial microbiology, Immunology recombinant DNA technology. Understanding interrelated physiological and metabolic events.</p> <p>Overall knowledge of avenues for research and higher academic achievements in the field of biochemistry and allied subjects.</p>	<p><i>Basic skills in clinical laboratory techniques, Immunology and molecular biological experimental skills. Demonstrate the overall ability to independently design experiment and analyse data. Basic statistical handling of data.</i></p> <p><i>Oral and written skills to convey scientific experimental results. Ability to understand research findings and disseminate to common public. Teaching skills</i></p>	<p>Scientific assistants in biotech based industries. Chemical/pharma/animal feeds/scientific data mining, / Forensic science labs. Blood Banks, Public health support staff, Clinical research, Drug discovery R&D, Medical coding, medical transcription, Medical content writing Teaching at secondary school level</p>
B.Sc. (Hons.)		
<p>Introduction to advanced concepts in Biochemistry; Molecular Biology, Recombinant DNA technology, Clinical Biochemistry/ Plant Biochemistry, Immunology, Nutrition and Dietetics, Biochemical Pharmacology, Research methodology, Bioinformatics skills, data analysis, Pharmacogenomics, Introduction to Intellectual property rights.</p> <p>A strong theoretical and practical knowledge of clinical and molecular setting, core research exposure.</p>	<p><i>Skills to isolate, identify and quantify biomolecules. Conducting independent research as part of project work. Hands-on training in modern techniques of Molecular biology. Recombinant DNA techniques, Computational skills, Prism, graph pad, Excel, Scientific writing skills: general articles, research reviews, Debating on scientific inventions and social implications.</i></p>	<p>Research staff in modern biology laboratories, Industries, Research Institutions. Clinical Biochemist, Forensic science technician, Biomedical scientist, Nutrition Dept. Pharma and Clinical research industries, R&D divisions of Pharma industries, Vaccine industry. Medical coding, Bioinformatics, Medical content writing, Patent examiner, Toxicological asst. Medical Science Liaison officer,</p>

***IIA. Model Program Structures for the Under-Graduate Programs in Universities and Colleges in Karnataka
Bachelor of Arts (Basic/ Hons.)/ Bachelor of Science (Basic/Hons.) insubjects with practical, with one major and one minor
(Biochemistry major with suitable minor)***

Sem.	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Elective (DSE) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Compulsory Courses (AECC), Languages (Credits) (L+T+P)	Skill Enhancement Courses (SEC)			Total Credits
				Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)		
I	Biochem.1(4+2) Discipline B1(4+2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	SEC-1: Digital Fluency (2)(1+0+2)	Physical Education -Yoga (1)(0+0+2)	Health & Wellness (1) (0+0+2)	25
II	Biochem.2(4+2) Discipline B2(4+2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Environmental Studies (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
Exit option with Certificate (50 credits)							
III	Biochem.3(4+2) Discipline B3(4+2)	OE-3 (3)	L1-3(3), L2-3(3)(4 hrs each)	SEC-2: Artificial Inte- lligence(2)(1+0+2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
IV	Biochem.4(4+2) Discipline B4(4+2)	OE-4 (3)	L1-4(3), L2-4(3)(4 hrs each)	Constitution of India (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
Exit option with Diploma (100 credits) OR Choose any one of the core subjects as Major and the other as Minor							
V	Biochem.5(3+2) Biochem.6(3+2) Discipline B5(3+2)	Vocational-1 (3)		SEC-3: SEC such as Cyber Security(2) (1+0+2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	22
VI	Biochem.7(3+2) Biochem.8(3+2) Discipline B6(3+2)	Vocational-2 (3) Internship (2)		SEC-4: Professional Communication (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	24
Exit option with Bachelor of Arts, B.A./ Bachelor of Science, B.Sc. Basic Degree (with a minimum of 146credits) or continue studies with the Major							
VII	Biochem.9(3+2) Biochem.10 (3+2) Biochem.11(3)	Biochem. E-1(3) Biochem. E-2(3) Res. Methodology (3)					22
VIII	Biochem.12(3+2) Biochem.13(3) Biochem.14(3)	Biochem. E-3(3) Research Project (6)*					20
Award of Bachelor of Arts Honours, B.A. (Hons.)/ Bachelor of Science Honours, B.Sc. (Hons) degree in a discipline (with a minimum of 188 credits)							

**In lieu of the research Project, two additional elective papers/ Internship may be offered.*

***II-C. Model Program Structures for the Under-Graduate Programs in Universities and Colleges in Karnataka
Bachelor of Arts (Basic/Hons.)/ Bachelor of Science (Basic/Hons.) with one core subject with practical and the other without
practical***

Sem.	Discipline Core (DSC) (Credits) (L+T+P)	Discipline Elective (DSI) / Open Elective (OE) (Credits) (L+T+P)	Ability Enhancement Courses (AECC), Languages (Credits) (L+T+P)	Skill Enhancement Courses (SEC)			Total credits
				Skill based (Credits) (L+T+P)	Value based (Credits) (L+T+P)		
I	Discipline A1(4+2) Discipline B1(3), B2(3)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	SEC-1: Digital Fluency (2)(1+0+2)	Physical Education - Yoga (1)(0+0+2)	Health & Wellness (1) (0+0+2)	25
II	Discipline A2(4+2) Discipline B3(3), B4(3)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Environmental Studies (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
Exit option with Certificate (50 credits)							
III	Discipline A3(4+2) Discipline B5(3), B6(3)	OE-3 (3)	L1-3(3), L2-3(3)(4 hrs. each)	SEC-2: Artificial Inte- lligence(2)(1+0+2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
IV	Discipline A4(4+2) Discipline B7(3), B8(3)	OE-4 (3)	L1-4(3), L2-4(3)(4 hrs. each)	Constitution of India (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	25
Exit option with Diploma (100 credits)/ Choose any one Discipline as Major, the other as the Minor							
V	Discipline A5(3+2), Discipline A6(3+2) Discipline B9(3)	Discipline A, E-1(3) Vocational-1 (3)		SEC-3: SEC such as Cyber Security(2)(1+0+2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	23
VI	Discipline A7(3+2), Discipline A8(3+2) Discipline B10(3)	Discipline A, E-2(3) Vocational-2 (3)		SEC-4: Professional Communication (2)	Physical Education - Sports (1)(0+0+2)	NCC/NSS/R&R(S&G)/ Cultural (1) (0+0+2)	23
Exit option with Bachelor of Arts, B.A. /Bachelor of Science, B. Sc. Basic Degree (with a minimum of 146 credits) or continue studies with the Major							
VII	Discipline A9(3+2), Discipline A10(3+2) Discipline A11(3)	Discipline A, E-3(3) Internship (2) Res. Methodology (3)					21
VIII	Discipline A12(3+2), Discipline A13(3), Discipline A14(3)	Discipline A, E-4(3) Research Project (6)*					20
Award of Bachelor of Arts Honours, B.A. (Hons) /Bachelor of Science Honours, B.Sc. (Hons) degree in a discipline (with a minimum of 187 credits)							

**In lieu of the research Project, two additional elective papers/ Internship may be offered.*

Semester	1 (First)
Course title	Chemical foundation of Biochemistry -1
Course credits:	4
Total contact hours:	56
Duration of end semester assessment	02h
Formative assessment marks	40
Summative assessment marks	60

Course learning Outcome:

- Understanding of Biochemistry as a discipline and milestone discoveries in life sciences that led to establishment of Biochemistry as separate discipline.
- Fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms.
- Understanding of the concepts of mole, mole fraction, molarity, etc. and to apply them in preparations of solutions of desired strengths.
- Revisit to fundamentals of chemical bonds, electronic configuration, theories of bond formation.
- Unique property of water as a universal solvent and its importance in biological system.
- Understanding of fundamentals of physical phenomena associated with Adsorption, Viscosity, Distribution law, Osmotic pressure, etc. and their importance in living organisms.
- Understanding of concepts of acids, bases, indicators, pKa values, etc. Acquiring numerical skills

UNIT-1: Introduction to Biochemistry

14hrs

Origin of life, Miller's experiment, types of organisms, prokaryotes, eukaryotes, unicellular multicellular, compartmentalization of functions in lower and higher organisms, and common physiological events of organisms (RQ), chemical composition of living organisms, subcellular organelles: Structure, function and interrelationship.

SI units, Mass, volume, temperature, amount, length and time, an overview of the metric system, atomic weight, molecular weight, equivalent weight, basicity of acids, acidity of bases, Avogadro's number, molarity, normality, molality, Dalton concept, mole concept, concentration, mole to molar conversion, oxidation number and its significance, density and specific gravity, their significances.

UNIT-2: Atomic structure and chemical bonds

14 hrs

Structure of an atom, electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f sub shells, K, L, M, N, O, P, and Q shells. Illustration of Pauli's exclusion principle, Aufbau principle, and Hund's rule, electron configuration: up to atomic number 20, octet rule. Formation and properties of non-covalent and covalent bonds,

hydrogen bonds, ionic bonds, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. Sigma, pi and co-ordinate bonds, back bonding, corresponding energy associated, outline of theories of bonding: Valence bond theory, Molecular orbital theory and crystal field theory.

UNIT-3: Buffers and colligative properties

14hrs

Acids, bases, Arrhenius concept, Lowry and Bronsted concepts, Lewis concept. Buffers, composition, pH, pH scale, Henderson-Hasselbalch equation, titration curve of H_3PO_4 , pK value, isoelectric pH, ionization of HCl , CH_3COOH , NH_4OH , H_2SO_4 . Colligative properties and anomalous colligative properties of solutions, structure of water based on VSEPR theory, ionic product of water, special properties of water, buffers in animal system. Solutions and types, ionizable solutes, non-ionizable solutes, vapor pressure and its application in distillation, Van't Hoff law – Boyle's and Charles' law, Rault's law of Relative lowering of vapour pressure (RLVP), boiling point, freezing point, de-icing, osmosis and osmotic pressure determination by Berkeley and Hardley's method, reverse osmosis.

UNIT-4: Electrochemistry and redox reactions

14 hrs

Scope of electrochemistry, electrochemical cells, Daniel cell, galvanic cell, electrode potential and its measurement, electrolysis, types of electrolytes, primary and secondary batteries, electrodes, half-cell reaction, standard electrodes. Laws of thermodynamics, entropy and enthalpy, their relation, Gibb's energy, free energy change, ions, Redox reactions, types, Stock's notations, change in oxidation number and combination. Endergonic and exergonic reactions with examples, their importance in biological systems, redox potential, application of redox potential, energy linked to redox reactions, reduction of oxygen, oxidation and reduction of iron in hemoglobin, biologically active forms of zinc, calcium, nickel, molybdenum, selenium, and cobalt, NAD^+/NADH , $\text{NADP}^+/\text{NADPH}$, FAD/FADH_2 , FMN/FMNH_2 .

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Pedagogy: Lectures/problem solving/ assessments/group discussions/industrial visits

Formative Assessment	
Assessment occasion	Weightage in marks
Continuous evaluation and class test	20
Seminars/Class work	10
Assignments/Discussions	10
Total	40

Semester-I: Practical-I

Semester	1 (First)
Course title	Volumetric Analysis, Practical -1
Course credits:	2
Total contact hours:	4 hrs/week
Duration of end semester assessment	03h
Formative assessment marks	25
Summative assessment marks	25

Course Outcome: The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also, it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Understanding Good laboratory practices in a chemistry/biochemistry laboratory.
- Learn safety and precautionary measures for working in a laboratory.
- Develop skill and proficiency in preparation of laboratory reagents.
- Use of handling of glass wares, minor equipment for conducting experiments.
- Develop skills to prepare standard chemical solutions and secondary standards.
- Demonstration of basic oxidation and reduction reactions.

Experiments:

1. Calibration of volumetric glassware's (Burette, pipette, standard flasks).
2. Concept of molarity, molality and normality. Calculation and preparation of molar solutions (Problems to be given for exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions
3. Preparation of standard Sodium carbonate solution, standardization of HCl (Methyl orange) and estimation of NaOH in the given solution. (Methyl orange or phenolphthalein).
4. Preparation of standard Oxalic acid. Standardization of NaOH and estimation of H_2SO_4 in the given solution (phenolphthalein).
5. Preparation of standard Oxalic acid. Standardization of $KMnO_4$ and estimation of H_2O_2 in the given solution.
6. Preparation of standard $K_2Cr_2O_7$. Standardization of $Na_2S_2O_3$ and estimation of $CuSO_4$ in the given solution.
7. Preparation of $ZnSO_4$. Standardization of EDTA and estimation of total hardness of water using Eriochrome black-T indicator.
8. Preparation of standard potassium biphthalate. Standardization of NaOH and estimation of HCl in the given solution. (Phenolphthalein).
9. Estimation of sulphuric acid and oxalic acid in a mixture using standard sodium hydroxide solution and standard potassium permanganate solution.
10. Preparation of standard Potassium dichromate and estimation of ferrous/ferric mixture using diphenylamine indicator (Demonstration).

11. Preparation of standard oxalic acid solution. Standardization of NaOH solution and estimation of acidity in vinegar.
12. Preparation of standard potassium biphthalate solution, standardization of sodium hydroxide solution and estimation of alkalinity of antacids.
13. Preparation of standard Oxalic acid solution. Standardization of KMnO_4 solution and estimation of calcium in milk.
14. Preparation of buffers; phosphate, bicarbonate and acetate buffers
15. Construction of Daniell Cell and measurement of emf.

REFERENCES

1. Vogel's Qualitative Inorganic Analysis, 2012, Svehla, G. Pearson Education,.
2. Quantitative Chemical Analysis, 2009, Mendham, J. Vogel's Pearson,.
3. Practical Chemistry, O. P. Pandey, D. N. Bajpai, and S. Giri, S. Chand and Co. Ltd.
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press).
11. Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
12. Quantitative chemical analysis S. Sahay (S. Chand & Co.).
13. Practical Chemistry, O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
14. College Practical Chemistry, V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
15. Practical Physical Chemistry- B. Viswanathan, P S Raghavan, MV Learning Publication.

Pedagogy: *Lab work/ problem solving/ assessments/group discussions/industrial visits*

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

Second Semester

Course Title	Chemical foundation of biochemistry -2
Course credits	04
Total contact hours	56
Duration of End semester Assessment	02
Formative Assessment Marks	40
Summative assessment Marks	60

Course Outcome:

- These topics will enable students to understand the fundamentals of chemical processes in biological systems
- Appreciation of the roles of metals, non-metals, transition metals and coordination compounds in biological systems.

Course Outcomes/Program	1	2	3	4	5	6	7	8	9	10	11	12
Outcomes												
Aptitude	X	X										
Critical thinking	X	X										
Subject clarity	X	X										
Analytical Skills	X	X										

Course content

UNIT-1: Chemical kinetics and colloids

14 Hours

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 $a \neq b$), 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.

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.

UNIT-2: Nomenclature of Organic Compounds:**14 Hours**

Classification, naming- IUPAC nomenclature, compounds containing one, two functional groups with chains, homologous series. Stereochemistry, geometrical and structural isomerism, conformation and free rotation. Optical isomerism, symmetry of elements, plane polarized light and optical purity, calculations. Nomenclature of enantiomers, epimers, racemic mixture, resolution. Fischer and Newmann projection formulae, molecule with one and two chiral and achiral centers, spirines. Priority rules; E and Z (CIP rules), R and S, D and L notations, absolute (r and s) and relative (d and l) configuration. Role of stereochemistry in biological systems.

UNIT-3: Organometallic Compounds**14 Hours**

Metal atom linked organic compounds. Preparation of Grignard reagents and structure, limitations, protonolysis and reactions. Organolithium compounds, preparation and reactions. Organozinc compounds. Organoboranes its mechanisms. Ferrocenes. Organomercury compounds: Methods of preparation and applications, reactions—mercuration of aromatic compounds, solvomercuration, oxymercuration- demercuration. Organosilicon compounds: Methods of preparations and applications, general reactions of trialkyl silyl halides with ethers, esters, carbamides, epoxides and acetals.

Porphyrins and Metal ions: Role of metal ions in biological systems, Fe, Cu, Zn, structure and functions of porphyrins, metalloporphyrins and iron-sulphur clusters with suitable examples and their role in biological systems.

UNIT-4: Inorganic Chemistry**14 Hours**

Nomenclature of inorganic molecules and coordination compounds, formula. IUPAC nomenclature. Central metal ion, ligand, coordination number, sphere, complex ion, oxidation number of central atoms, homoleptic and heteroleptic complexes. Isomerism in complexes, structural, ionization, solvate (hydrate), linkage and coordination, Stereoisomerism, geometrical, optical isomerism with simple inorganic complexes. Applications of qualitative/ quantitative analysis, photographic, metallurgy, medicine, catalysis and biosystems.

Chemical toxicity: Introduction, poisons, lead, mercury, aluminium, arsenic, corrosives, cyanide, irritants, phosphorus, CO₂, SO₂, SO₃, NO₂, halides and acid fumes, poisoning; sources, signs and symptoms. Free radicals: introduction, definition, generation and scavenger systems.

REFERENCES

1. Physical Chemistry, 2006, Peter Atkins. 8th edition, W.H. Freeman and Company
2. Inorganic Chemistry: 2006, Principles of structure and Reactivity, Huheey JE, Keiter EA, Keiter RL, Pearson Education India
3. Stereochemistry: Conformation and Mechanism, 2009, Kalsi PS, New Age International Publications
4. Introduction to Stereochemistry, 2012, Kurt Mislow, Dover Publications
5. A text book of Organic Chemistry, 2016, Raj K Bansal, 6th edition, New Age International Publications
6. Advanced Inorganic Chemistry, 1999, Cotton et.al, 6th edition, A Wiley-Bengaluru City University, Biochemistry syllabus for B.Sc. degree under NEP-2020

International

7. Principles of physical Chemistry, Puri, Sharma and Pathania.
8. Physical Chemistry, R.L. Madan, G.D. Tuli. S. Chand and Co.
9. A Text Book of Physical Chemistry, K.L. Kapoor, Vol.2. McMillan Publisher, India Ltd.
10. Advanced Organic Chemistry, Bahl and Bahl.
11. Principles of organometallic Chemistry, 1991, P. Powell, 2nd Edition, ELBS.
12. Inorganic Chemistry, 1983, 3rd Edition, J.E. Huheey, Harper International.
13. Organic Chemistry, Claden J., Greeves, N., Warren, S. 2012, Oxford University Press.
14. Inorganic Chemistry, 1987, R.W. Hay, Ellis Harwood.
15. Bioinorganic Chemistry, 2002, R.M. Roat-Malone, John-Wiley.
16. Basic Organometallic chemistry, 2nd Edition, B.D. Gupta and A.J Elias.

Pedagogy: Lab work/ problem solving/ assessments/group discussions/industrial visits

Formative Assessment	
Assessment occasion	Weightage in marks
Continuous assessment/Class test	20
Seminars/class work	10
Assignment/open discussion	10
Total	40

Practical-2

Course title	Qualitative and quantitative analysis
Course credits	02
Total contact hours	4 Hours/Week
Duration of end semester assessment	03
Formative assessment marks	25
Summative assessment marks	25

Course Outcome: The Course Objective is to provide experimental practice of quantitative and qualitative analysis. Also, it provides training in physical chemistry laboratory techniques. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

Experiments:

1. *Systematic Semi-micro qualitative Analysis of Inorganic salt Mixtures*

(a) Systematic semi micro qualitative analysis of two acid and two basic radicals in the given inorganicsalt mixture. The constituent ions in the mixture to be restricted to the following (Any four binary mixtures shall be given)

Anions: HCO_3^- , CO_3^{2-} , Cl^- , Br^- , NO_3^- , BO_3^{3-} , SO_4^{2-} , and PO_4^{3-}

Cations: Pb^{2+} , Al^{3+} , Fe^{2+} , Fe^{3+} , Mn^{2+} , Zn^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Mg^{2+} , K^+ , Na^+ and NH^+ .

(b) Qualitative analysis of NPK fertilizers

- Determination of density and viscosity of the given liquid using specific gravity bottle and Ostwald's viscometer.
- Determination of density and surface tension of the given liquid using specific gravity bottle and stalagmometer.
- Determination of molecular weight of non-volatile solute by Walker-Lumsden method.
- Determination of rate constant of decomposition of H_2O_2 using KMnO_4 by volumetric analysis method using ferric chloride as catalyst.
- Determination of distribution coefficient of benzoic acid between water and benzene or iodine between water and carbontetra chloride Separation of Two Components from given Binary Mixture of Organic Compounds Qualitatively. (Types of binary mixtures-Solid-Solid, Solid-Liquid, Liquid-Liquid)
- Verification of Beer's Law.
 - Estimation of unknown concentration of a biomolecule by using colorimeter
 - Determination of molar extinction coefficient
- Calibration of pH meter and determination of pH of aerated soft drinks.

REFERENCES

1. Vogel's Qualitative Inorganic Analysis, 2012, Svehla, G. Pearson Education,.
2. Quantitative Chemical Analysis, 2009, Mendham, J. Vogel's Pearson,.
3. Practical Chemistry, O. P. Pandey, D. N. Bajpai, and S. Giri, S. Chand and Co. Ltd.
4. Principles of Practical Chemistry, M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.
6. Experiments in Physical Chemistry R.C. Das and B. Behra, Tata Mc Graw Hill
7. Advanced Practical Physical Chemistry J.B.Yadav, Goel Publishing House
8. Advanced Experimental Chemistry. Vol-I J.N.Gurtu and R Kapoor, S.Chand and Co.
9. Practical Chemistry K.K. Sharma, D. S. Sharma (Vikas Publication).
10. General Chemistry experiment – Anil J Elias (University press).
11. Vogel textbook of quantitative chemical analysis G.H. Jeffery, J. Basset.
12. Quantitative chemical analysis S. Sahay (S. Chand & Co.).
13. Practical Chemistry, O P Pandey, D N Bajpai, Dr S Giri. S. Chand Publication
14. College Practical Chemistry, V K Ahluwalia, Sunitha Dingra, Adarsh Gulati
15. Practical Physical Chemistry- B. Viswanathan, P S Raghavan, MV Learning Publication.

Pedagogy: *Lab work/ problem solving/ assessments/group discussions/industrial visits*

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

Biochemistry Open Elective for First Semester

Course title	<i>Biochemistry in Health and Disease</i>
Course credits	03
Total contact hours	42
Duration of end semester examination	02
Formative assessment marks	40
Summative assessment marks	60

Course Outcome: This open elective course offering to students of various streams gives knowledge about health and various terminologies used in health and disease conditions; Difference between communicable and non-communicable diseases; Health promotion and treatments for various diseases and disorders.

UNIT-1: Health and wellness:

14hours

WHO definition of health, Health and hygiene, General health care, Factors affecting health, Indices and evaluation of health, Disease patterns in developed and developing world; Classification of diseases-Endemic, Epidemic, Pandemic; Professional health hazards.

Disease conditions: Acute disease, chronic disease, Incurable disease, Terminal disease, Illness, disorders, Syndrome, Pre-disease.

Treatment: Psychotherapy, Medications, Surgery, Medical devices, and Self-care.

Dimensions of Health: Physical, Mental, Spiritual, Emotional, Environmental, and Philosophical.

UNIT-2 Diseases and disorders

14 hours

Communicable diseases: Tuberculosis, Cholera, Typhoid, Conjunctivitis.

Sexually transmitted diseases (STD): Information, statistics, and treatment guidelines for STD, Prevention: Syphilis, Gonorrhoea, AIDS.

Non-communicable diseases: Malnutrition Undernutrition, Overnutrition, Nutritional deficiencies; Anemia, Stroke, Rheumatic heart disease, Coronary heart disease, Cancer, blindness, accidents, mental illness, Iodine deficiency, Fluorosis, Epilepsy, Asthma.

Genetic disorders: Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Thalassemia, Sickle cell anemia.

Lifestyle disorders: Obesity, Liver cirrhosis, Diabetes mellitus, Hypertension (Causative agents, symptoms, diagnosis, treatment, prognosis, prevention)

UNIT-3 Health and awareness**14 hours**

Preventing drug abuse, Oral health promotion by tobacco control. Mental hygiene and mental health: Concepts of mental hygiene and mental health, Characteristics of mentally healthy person, Warning signs of poor mental health, Promotive mental health, strategies and services, Ego defense mechanisms and implications, Personal and social adjustments, Guidance and Counseling.

Infection control: Nature of infection, Chain of infection transmission, Defenses against infection transmission

REFERENCES

1. Modern Nutrition in Health and Disease, 2006, 10th Edition, Maurice E. Shils, Moshe Shike, A Catharine Ross.
2. Clinical Biochemistry and Metabolic Medicine, 2012, Eighth Edition, Martin Andrew Crook, CRC Press,
3. Nutrition and Health in Developing Countries, 2000, Editors: R. Semba and M.W. Bloem, Humana Press.

Pedagogy: Lectures/desk work/book chapter/problem solving/discussion/assignment

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

Biochemistry Open Elective for Second Semester

Course title	<i>Nutrition and Dietetics</i>
Course credits	03
Total contact hours	42
Duration of end semester examination	02
Formative assessment marks	40
Summative assessment marks	60

Course outcomes:

- Knowledge about energy requirements and the Recommended Dietary Allowances.
- understanding the functions and role of macronutrients, their requirements and the effect of deficiency and excess
- Understand the impact of various functional foods on our health
- To be able to apply basic nutrition knowledge in making foods choices and obtaining an adequate diet.
- Competence in connecting the role of various nutrients in maintaining health and learn to enhance traditional recipes.

UNIT-1 Basic concepts of Nutrition:

14 Hrs

Introduction, Basic principles of a balanced diet to provide energy and nutrients. Composition of foods and proximate analysis of foods. Calorific value of foods and Basal metabolism. Basal Metabolic Rate (BMR), Factors affecting BMR, Energy requirements for different physical activities, Specific dynamic action of food, Nutritive value of proteins. Energy requirements and recommended dietary allowance (RDA) for infants, children, and pregnant women. Protein calorie malnutrition.

UNIT-2 Macronutrients and Micronutrients

14 Hrs

Carbohydrates-Digestible and non-digestible, Dietary fibres, Essential fatty acids, lipoproteins and cholesterol. Essential amino acids, Fortification of foods, Protein requirement for different categories.

Vitamins: Sources, requirements, functions and deficiency symptoms of Vitamin-C, Thiamine, Riboflavin, Pyridoxine, Folic acid, VitaminB₁₂. Absorption of fat-soluble vitamins- A, D, E and K.

Micronutrients: Source, Daily requirement, functions and deficiency disease symptoms of Macrominerals (Ca, P, and Cl) and microminerals/trace elements (I, Fe, Zn and Se).

UNIT-3 Dietetics and Diet Therapy**14 Hrs**

Food pyramid: Diet planning and introduction to diet therapy. Nutritional requirements for different age groups, anemic child, expectant women, and lactating women. Diet planning for prevention and cure of nutritional deficiency disorders.

Diet therapy: Functional foods, Anthropometric measurements, dietary considerations during fever, malaria, and tuberculosis. Prevention and correction of obesity, underweight, and metabolic diseases by diet therapy. Dietary interventions to correct and/or manage the gastro-intestinal diseases (indigestion, peptic ulcer, constipation, diarrhoea, steatorrhoea, irritable bowel syndrome. Functional food-based diet therapy for diabetes, cardiovascular disease and cancer.

REFERENCES:

1. Clinical Dietetics and Nutrition, 2002, 4th Edition, Antia FP and Abraham P, Oxford University Press; ISBN-10: 9780195664157.
2. Oxford Handbook of Nutrition and Dietetics, 2011, Webster-Gandy J, Madden A and Holdsworth M. Oxford University Press, Print ISBN-13:9780199585823.
3. Krause's Food, Nutrition and Diet therapy, 2003, Mahan KL and Escott-Stump S., Elsevier, ISBN: 9780721697840.
4. Human Nutrition and Dietetics.1986, Passmore R. and Davidson S. Churchill Livingstone Publications, ISBN-10: 0443024863.
5. Rosemary Stanton's Complete Book of Food & Nutrition, 2007, Simon & Schuster Publishers, Australia, ISBN 10: 0731812999
6. Food Science and Nutrition, 2018, Roday S.Oxford University Press Publishers, ISBN: 9780199489084/0199489084.
7. Food Science, 2007, Srilakshmi S. New Age International (P) Limited Publishers, ISBN: 9788122420227/ 8122420222.

Pedagogy: Mooc/Lectures/book chapter/problem solving/assignment

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

Model question paper pattern for End semester Theory Examination

Time: 2 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 five* of the following; 5x4=20
- 2.
 - 3.
 - 4.
 - 5.
 - 6.
 - 7.

SECTION – C

- Answer *any three* of the following; 3x10=30
- 8.
 - 9.
 - 10.
 - 11.
- *Note: Section C shall include sub questions a and b either for 5+5 or 6+4*

Model question paper pattern for End semester Practical Examination

Time: 3 h

Max. Marks: 25

- | | |
|------------------------------------|----------|
| 1. Marks for procedure writing | 5 Marks |
| 2. Marks for Viva – Voce | 5 Marks |
| 3. Marks for performing experiment | 15 Marks |



**Dr. Ambedkar Veedhi, Central College Campus
Bengaluru-560001**

*Scheme and Syllabus
for*

**B.Sc. (Hons.) degree in Biochemistry
and
Discipline specific elective
Course (CBCS) under NEP 2020**

**for III and IV Semesters
(With effect from 2021-22)**

**Department of Biochemistry,
Central College Campus
Bengaluru -560 001**

September, 2022

Department of Biochemistry,
Central College Campus, Bangalore -560001

Proceedings of the Meeting of Board of Studies in Biochemistry (UG),
held on Tuesday the 3rd September, 2022 in the chambers of the Chairman,
Dept. of Biochemistry, Central College Campus, Bangalore -560001

The meeting started with the Chairman welcoming the members to the meeting. The Charmin placed before the board, draft syllabus for III and IV semester B.Sc. Biochemistry proposed by the syllabus committee constituted by the Karnataka State Higher Education Council and the panel of examiners for the ensuing semesters and proposed Board of Examiners in Biochemistry (UG) for 2022-2023 examinations. The proposed syllabus and scheme was discussed in length and the board approved the same with minor additions and deletions taking into account the wholesome nature of concepts to be introduced. The board approved the panel of examiners and the BOE in Biochemistry (UG) for the 2022-2023. The meeting concluded with the chairman thanking the members for their valuable inputs and cooperation.

Members Present

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

Signature

Chairman

R. Devaraj
3/9/2022

Member

S. Kantharaju
3/9/22



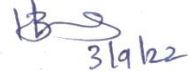
Member


Vidya A.S.
03/09/2022

Member

M. D'souza
03/09/2022

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- | | | |
|--|--------|---|
| 5. Dr. R. Nagesh Babu,
Dept. of Chemistry,
Maharani's Science College for women,
Palace Road, Bangalore-560001 | Member | ABSENT |
| 6. Ms. Malini . M.R
Dept. of Chemistry,
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | M.L. M.R 3/9/2022 |
| 7. Dr. Rajeev Ramachandra Kolagi
Dept. of Biochemistry,
Nrupathunga University
Bengaluru-560001. | Member | ABSENT |
| 8. Dr. Kamala, A.
Dept. of Biochemistry,
MLA College for women
Malleswaram 18 th Cross
Bangalore-560004 | Member | Kamala.A
3/9/22 |
| 9. Mrs. Ramya Kumari B.S
Dept. of Biochemistry
M.S Ramaiah College of Arts, Science & Commerce
Bangalore-54 | Member | 
03/09/22 |
| 10. Mrs. Madhukala. K.L.
Dept. of biochemistry
Acharya B School,
Magadi Road,
Bengaluru-560091 | Member | 
3/9/22 |
| 11. Dr. Bhagyalakshmi
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | 
3/9/22 |
| 12. Mrs. Savitha, K.R.
Dept. of biochemistry
University College of Science
Tumkur University
Tumkur-572101 | Member | ABSENT |


Dr. V.R. DEVARAJ, Ph.D.
Chairman
Dept. of Biochemistry
Bangaluru City University
Bangaluru - 560 001.

SEMESTER -III

Semester	III
Course title	Bio-organic chemistry
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:

These topics will enable students to understand the fundamentals of organic chemistry pertinent to their importance in understanding biochemical reactions.

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

UNIT-1: Reaction mechanisms and aliphatic hydrocarbons: 1

4 hrs

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Concept of inductive effect, mesomeric effect, resonance and hyperconjugation. Classification of organic reactions (substitution, addition, elimination and rearrangement), with two examples for each. Concepts reactive intermediates of the following – free radicals, carbocations and carbanions, carbenes, nucleophiles and electrophiles (Formation and Stability).

Hydrocarbons - Markownikoff's rule. Mechanism of addition of HCl to propene. Peroxide effect, Alkenes–Ozonolysis, oxidation. Alkynes–formation of acetylides and their importance. Dienes– types with examples. Conjugate dienes, 1, 3-butadiene – stability, mechanism of addition of HBr.

UNIT-2: Mechanism of Substitution, Elimination and Addition reactions

14 hrs

SN₁ and SN₂ reactions on tetrahedral carbon, energy profile diagrams, Stereochemistry, factors

affecting SN_1 and SN_2 reactions.

The Elimination reactions- E_1 , E_2 and E_{1cb} reaction, Zaitsev rule. Stereochemistry of E_1 & E_2 reactions, E_1 & E_2 elimination in cyclic compounds.

Addition reactions - Aldehydes and Ketones - nucleophilic addition of acetals & ketals. Addition of ammonia, primary amines and other ammonia derivatives. Conjugate addition – addition in alpha and beta unsaturated aldehydes and ketones, 1,2 and 1,4 addition.

Carbonyl compounds General properties. Keto-enol tautomerism. Mechanisms: addition of HCN to acetaldehyde, Claisen and aldol condensations. Quinones: *o*- and *p*-benzoquinones- structure and properties.

UNIT-3: Mechanism of electrophilic aromatic substitution reactions

14 hrs

Aromatic compounds- aromaticity, criteria for aromaticity, anti-aromatic and non-aromatic compounds with examples. Mechanism of electrophilic aromatic substitution reactions- halogenation, nitration, sulfonation, Friedel Crafts alkylation and Friedel Crafts acylation. Relative reactivity of substituted benzenes, polycyclic benzenoid hydrocarbons.

Role of coenzymes – definition of coenzymes, Structure and role of thiamine pyrophosphate in decarboxylation of α -keto acids, Biotin in carboxylation of important biochemical reactions of carbohydrate and lipid metabolism.

VitB₁₂-role in rearrangement reactions.

VitB₂- role in redox reactions with suitable examples.

UNIT-4: Bio-organic compounds

14 hrs

Alcohols: Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Tri hydric alcohols: glycerol – synthesis from propene, properties and uses.

Phenols: Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer– Tiemann and bromination reactions.

Hydroxy acids: Structure & properties: lactic acid, citric acid and isocitric acid. Dicarboxylic acid: maleic and fumaric acid. Keto acids: pyruvic, α -ketoglutaric, oxaloacetic acid.

Amines: Classification, properties, functional group– Basicity of amines, acylation. Reaction with HNO_2 & Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary amines.

Heterocyclic compounds: Definition, classification with examples, structure and biological importance of furan, pyrrole, thiophene, pyridine, pyran, thiazole, pyrimidine, purine, indole, imidazole. Aromaticity and basicity of pyrrole and pyridine.

Terpenes: Definition, Isoprene rule, classification, isolation. Structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols.

Steroids: Basic ring structure in steroids. Structure and biological importance of cholesterol, phytosterols, ergosterol, cortisol, β -estradiol, testosterone, and aldosterone. Bile acids (Mono, Di & Tri cholic acids).

Alkaloids: Definition, classification based on their structure and biological functions, Isolation of alkaloids, structure and physiological action of morphine, nicotine and atropine.

REFERENCES:

1. Text book of Organic Chemistry 22nd Edition S. Chand Publishers 2019.
2. Organic Chemistry, Vol. I. Fundamental principles. I.L.Finar.6th Edn. ELBS, 2002.
3. Organic Mechanisms, Peter Sykes, Longman, 1977.
4. Organic Chemistry R.T. Morrison and R.N. Boyd, 6th Edn. Prentice Hall, India, 2018.
5. Lehninger Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications, 2012.
6. Chemistry-An Introduction to General, Organic and Biological Chemistry,7th Edn. Karen C. Timberlake, Benjamin Cummings, 1999.
7. Reaction Mechanisms at a glance, M. Moloney (Ed.), Blackwell Science 2000.

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 – III; Practical-III

Course title	Bio-organic chemistry
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:

This course aims to familiarize students with the principles of organic chemistry and basic Qualitative analysis of organic compounds. Course Objective is to provide experimental practice of preparation of organic compounds and extraction of biologically important compounds.

Experiments:

I. Systematic Qualitative Analysis of organic compound (6 practicals)

- | | | |
|----------------|-----------------|----------------|
| 1.Urea | 2.Glucose | 3. Aniline |
| 4.BenzoicAcid | 5.Salicylicacid | 6.Benzaldehyde |
| 7.Acetophenone | 8.Chlorobenzene | 9.Nitrobenzene |

II. Preparation of the following organic compounds (2 practical's)

1. Acetylation: Preparation of acetyl salicylic acid from salicylic acid.
2. Oxidation: Preparation of benzoic acid from benzaldehyde.
3. Nitration: Preparation of *m*-dinitrobenzene from nitrobenzene.
4. Hydrolysis: Preparation of benzoic acid from ethyl benzoate.

III. Extractions:

1. Extraction of caffeine from tea leaves
2. Extraction of starch from potatoes
3. Extraction of casein from milk.

REFERENCES:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A.Chhikara 2009
2. Textbook of Practical Organic Chemistry Including Qualitative Organic Analysis by Arthur Israel Vogel, 2003
3. Comprehensive practical organic chemistry-Preparation and quantitative analysis, V.K. Ahluwalia and Renu Aggarwal, 2004.
4. Practical Hand Book of Systematic Organic Qualitative Analysis. Md. Rageeb Md. Usman, S. S. Patil, 2017.
5. Laboratory Manual of Inorganic & Organic Chemistry (Qualitative Analysis) Kalpa Mandal, Sonia Ratnani, 2020.

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

SEMESTER III; Open Elective –1

Course title	Biochemical Techniques
Course credits	03
Total contact hours	42 h/week
Duration of end semester assessment	2.30 h
Formative assessment marks	40
Summative assessment marks	60

Course Outcome:

- Develop competence in handling various chromatographic, electrophoretic and isotope techniques and apply them in isolating and characterizing different biological molecules

UNIT-1

14 hrs

Microscopy: Different types of microscopes– Principle and applications of light microscope. Electron microscopy– TEM, SEM, applications. Fluorescence and confocal microscopes used in fine structure studies.

Centrifugation Techniques: Introduction, basic principle and applications of sedimentation. Centrifuges and their use- small bench centrifuges, refrigerated centrifuges– large capacity and high speed, continuous flow centrifuges, ultracentrifuge- preparative and analytical and density gradient centrifuge.

UNIT– 2

14 hrs

Chromatography: Introduction, classification of chromatographic techniques. Principle and applications of paper chromatography, Thin layer chromatography (TLC), Column chromatography- Adsorption chromatography, Gel-permeation, Ion exchange chromatography, Affinity chromatography, Gas chromatography (GC), High performance/pressure liquid chromatography (HPLC).

Electrophoresis Techniques: Introduction, principle and applications of electrophoretic techniques- Paper electrophoresis, starch-gel electrophoresis, polyacrylamide gel electrophoresis (native and SDS), agarose gel electrophoresis, isoelectric focusing, isotachophoresis.

UNIT– 3**14 hrs**

Isotope Techniques: Introduction to isotopes; radioisotopes. Radioactive decay, Units of radioactivity, Measurement of radioactivity-GM counters, Scintillation counters, autoradiography. Applications of radioisotopes in the biological Sciences.

Spectroscopy: Introduction, Nature of electromagnetic radiations. Beer-Lamberts law. Principle and applications of spectroscopic techniques in biochemical investigation- UV-Vis spectroscopy, Colorimetry, Fluorescence spectroscopy, Infrared spectroscopy, Circular dichroism (CD) spectroscopy, Electron spin resonance (ESR), Atomic Absorption spectroscopy (AAS), Nuclear Magnetic resonance (NMR) spectroscopy and Mass spectroscopy.

REFERENCES:

1. Modern experimental Biochemistry: Rodney Boyer, 3rd Edn. Benjamin Cummings, 2000.
2. Practical Skills in Biomolecular Sciences: R Reed, D.Holmes, JWeyersand A.Jones 1998
3. Physical Biochemistry: David Frifielder 2nd Edition, 1983.
4. Biophysical chemistry Upadya and Upadya, 2016.
5. Introductory practical Biochemistry: SK Sawhney and Randhir Singh, 2001.

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 – III; Open Elective-2

Course title	Hormones; Biochemistry and function
Course credits	03
Total contact hours	42
Duration of end semester assessment	03
Formative assessment marks	40
Summative assessment marks	60

Course Outcome:

- Understand the function of hormones and their regulation.
- Know how hormonal systems act in an integrated manner to regulate overall body functions.
- Understand how failure of these normal physiologic functions and integrations are associated with some endocrine disorders.

UNIT–1: Signaling

14 hrs

Introduction to the concept of systems. Hormones– definition, classification (origin, chemical nature, location and mechanism of action) and intercellular communication. Chemical signaling-endocrine, paracrine, autocrine, and neuro-endocrine mechanisms. Mechanism of hormone action: synergism, antagonism, permissive effects. Physiological role of pituitary, pineal, thyroid and parathyroid hormones. Introduction to the hypothalamus as the true master gland with releasing hormones and inhibitory substances. Neuro-hypophysis and its secretions– ADH and oxytocin. Outline of feedback regulation of secretion of hormones. Overview on signal transduction pathways for steroidal and non-steroidal hormones (one example each).

UNIT– 2: Physiology of hormone action

14 hrs

Physiological role of pancreas, adrenal, and placenta. Introduction to Gastrointestinal hormones and neurotransmitters (Acetyl Choline, GABA, Serotonin). Mechanism of action, target tissues, and the physiological effects of gastrointestinal hormones. Structure and functions of sex hormones. Hormones during ovarian and uterine phases of menstrual cycle; placental hormones; role of hormones during parturition and lactation. Hormone receptors: receptors in the cell membrane and in the cell. Secondary and tertiary messengers (cAMP and Ca⁺²).

UNIT– 3

14 hrs

Clinical endocrinology-Blood, plasma, serum- Separation and storage. Methods of hormone estimation, assay systems, normal range of hormones in tissues and clinical conditions leading to abnormal levels with interpretations. Thyroid function test- Determination of T3, T4, and TSH. Infertility profile: Determination of LH, FSH, TSH, estrogen, progesterone, total testosterone, free testosterone. Major manifestations of disease of the endocrine pancreas, thyroid, hypothalamus and pituitary disease.

REFERENCES:

1. Norman AW, Litwack G (1997), Hormones, 2nd Edition, Elsevier Publications.
2. Bolander F (2004), Molecular Endocrinology, 3rd Edition, Elsevier Publications.
3. Rifai N (2007), Teitz Fundamentals of Clinical Chemistry, 6th Edition, Elsevier Publications.
4. Henry's Clinical Diagnosis and Management by Laboratory Methods (2011), 22nd Edition, Elsevier.
5. Vasudevan DM (2011), Text book of Medical Biochemistry, 6th Edition, Jaypee Publishers.
6. Chatterjea MN & Shinde R (2012), Text book of Medical Biochemistry, 8th Edition, Jaypee Publications.
7. Bishop ML, Fody EP, Schoeff LE (2013), Clinical Chemistry: Principles, Techniques, and Correlations, 7th Edition, Wiley Publications.
8. JN Singh (2017), Biochemistry General, Hormonal and Clinical-1st Edition, Atithi books Publishers.
9. Rifai N (2017), Teitz Text book of Clinical Chemistry and Molecular Diagnostics, 6th Edition, Saunders Publications.

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 –IV

Semester	IV
Course title	Analytical Biochemistry
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:

- Understanding the concept of Biochemical analyzing instruments both automated and semi automated.
- To learn about how to Care & Maintenance of Equipment & Chemicals.
- To learn normal ranges of biochemical components in our body.
- Clinically relevant biochemical analysis for deeper understanding of all biochemical components i.e., Proteins, Electrolytes, Hormones etc.
- Basic knowledge of clinical and forensic analytical methods and their principles.

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

UNIT-1: Biological sample preparation and fractionation

14hrs

Introduction and objectives of bioanalysis and extraction of molecules from tissues and cells. Sample preparation types of sample- live, postmortem extraction of macromolecules from tissues; fractionation - liquid-liquid, liquid-solid and precipitation methods.

Centrifugation- Introduction, principles of centrifugation, angular velocity, sedimentation, sedimentation coefficient, centrifugal field, relative centrifugal field. types of centrifugation- Preparative and analytical. Differential, density gradient and ultra-centrifugation. Basic instrumentation; types of rotors and their design. Laboratory centrifuge; operational instruction and applications. Analytical centrifuges-Optics; Application in sub-cellular fractionation. Care and maintenance of instrument.

UNIT-2: Chromatography

14 hrs

History of chromatography. General principle of chromatography. Classification based on stationary and mobile phase- Planar and column chromatography, based on types of mobile and/or liquid phase- adsorption and partition- Gas chromatography and liquid chromatography. Based on stationary phase- thin layer chromatography, Paper chromatography-Ascending, descending and circular, 2-D chromatography, Rf value.

Principles, methodologies and applications of adsorption-, partition-, ion-exchange-, gel-filtration- and affinity-chromatography. Advanced chromatography- working principle and applications of HPLC, FPLC, UPLC and GLC.

UNIT-3: Electrophoretic and radio-isotopic methods

14hrs

Electrophoresis- General principle of electrophoresis, velocity of a charged molecule in the applied electric field, relevance of Ohm's law in electrophoretic separations. Supporting media for electrophoresis; work of Tiselius, paper, cellulose acetate, agarose, poly acrylamide. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS-PAGE, 2-D electrophoresis. Identification of proteins post electrophoresis- dyes and in-gel biological activities. Applications of agarose gel, pulse field electrophoresis, capillary electrophoresis and isoelectric focusing. Principle and applications of immuno-electrophoresis.

Radioisotopic methods: Radioactivity-Types of radioactive decay, Properties of α , β , γ radiations. Group displacement law. Decay law- decay constant, Half-life period and average life of a radioactive element. Detection of radioactivity – GM counter and scintillation counters (only principal and working). Applications of radioisotopes– ^3H , ^{14}C , ^{131}I , ^{60}Co and ^{32}P . Biological effects of radiations. Radio labelling, safety measures in handling radio isotopes.

UNIT-4: Spectroscopy

14 hrs

Wave particle duality of light, electromagnetic spectrum. Beer's law and its limitations, determination of molar absorption coefficient of molecules. Principle, design and application of colorimeter and UV-Vis spectrophotometer. Working principle and application of flame photometer and fluorimeter. Principle and application of IR, Raman, ESR, NMR, AAS and Mass spectroscopy.

REFERENCES:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer, 2011.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie,(Eds)., Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D.C. Elliott, Oxford University Press, 2014.

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 – IV; Practical-IV

Course title	Analytical Biochemistry
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 Course Objective is to provide experimental practice of analytical techniques in Biochemistry. Upon successful completion, students should develop skills in handling instruments and understand its application in research work.

- Sourcing and handling biological samples. Develop skill and proficiency in basic techniques;
- Centrifugation,
- Chromatography,
- Electrophoresis and
- Spectroscopy.

Experiments:

1. Isolation of human lymphocytes using clinical centrifuge.
2. Determination of packed cell volume/hematocrit.
3. Separation of basic, acidic and aromatic amino acids by ascending/descending and circular paper chromatography.
4. Separation of plant pigments by gel-permeation chromatography.
5. Separation of lipids by thin layer chromatography.
6. Determination of void volume of a gel-filtration column.
7. Recording the absorption spectrum of riboflavin and determination of λ_{\max} .
8. Colorimetric estimation of glucose by DNS method.
9. Estimation of DNA by diphenylamine method.
10. Electrophoretic separation of plasma proteins.

REFERENCES:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan, Springer, 2011.
2. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie, (Ed.), Cambridge University Press, 2018.
3. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D.C. Elliott, Oxford University Press, 2014.

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

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

SEMESTER – IV; Open Elective-1
Biochemical Toxicology

Course title	Biochemical Toxicology
Course credits	03
Total contact hours	42
Duration of end semester assessment	2.3 h
Formative assessment marks	40
Summative assessment marks	60

Course Outcome:

This open elective course offered to various streams gives basic idea about biochemical basis of various effects of toxins/ pharmaceuticals and an outline of process involved in toxicity testing and drug dosing.

- Categorize the classes of toxicants/drugs and know specific examples
- State the routes of exposure to toxins/drugs;
- Explain the processes of absorption, metabolism and elimination of toxins/drugs; and
- Explain environmental and physiological factors that affect toxicant metabolism

UNIT–1 Fundamentals of Toxicology and Dose response 14 hrs

Scope of toxicology; why should we know about toxins/xenobiotics (drugs) and what makes a substance toxic? Grading toxicity, use of animal studies for toxicity, *in vitro* toxicity, organ toxicity (liver and kidney toxicity). Indicators of toxicity/drug effects; biomarkers. Concentration and site of action, dose response, effect of route of administration, ED₅₀, LD₅₀/TD₅₀. Hazard and risk assessment, risk management, acceptable daily intake (ADI) and tolerable daily intake (TDI).

UNIT– 2 Disposition of Toxins 14 hrs

Outline of ADME process - toxin/drug uptake, entry into cells and systemic circulation. Effect of size, shape, solubility, and charge on their uptake. Major sites of absorption – skin, intestine, and liver. Role of transporters and plasma proteins in distribution. Plasma levels of toxins/drugs, plasma half-life. Excretion-kidney, biliary excretion. Metabolism-types of metabolic changes of foreign compounds, biotransformation/detoxification reactions, phase-1 and, phase -2 reactions. Nature of phase-1 and phase-2 enzymes.

UNIT-3 Targets of toxic damages and Biochemical Mechanism of toxicity 14hrs

Damage caused by toxins/drugs on liver, kidney, gall bladder and lungs. Methods of identifying the damages. Mechanism of biochemical toxicity; chemical carcinogens- benzo[a]pyrene, tamoxifen.

Liver necrosis: carbon tetrachloride, valproic Acid, and iproniazid, Kidney damage: chloroform, antibiotics- gentamycin,

Lung damage: 4- Ipomeanol,

Neurotoxicity: isoniazid, parquet, primaquine, cyclophosphamide.

REFERENCES:

1. Biopharmaceuticals Biochemistry and Biotechnology 2nd Edn. Gary Walsh, John Wiley & Sons, Ltd, England, 2003.
2. Fundamentals of Experimental Pharmacology, Ghosh, M.N. 2nd Edition, Scientific Book Agency, Kolkatta, 1984.
3. Introduction to Biochemical Toxicology, 3rd Edn., Ernest Hodgson, Robert C. Smart; Wiley-Interscience; 2001.
4. Principles of Biochemical Toxicology, John A. Timbrell, 4th Edn. 2009, Taylor & Francis
5. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins, 2000.

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 – IV; Open Elective-2

Plant Biochemistry

Course title	Plant Biochemistry
Course credits	03
Total contact hours	42 h
Duration offend semester assessment	2.30 h
Formative assessment marks	40
Summative assessment marks	60

Outcomes:

- Understand the plant cell, photosynthesis, transporters and important primary metabolites.
- Illustrate plant growth regulators, plant's responses to various biotic and abiotic stresses.
- Explain about plant secondary metabolites and their functional importance.

UNIT-1

14 hrs

Plant cell- structure and molecular components: Cytoskeleton, an overview. Plant cell division, cell cycle. Outlines of energy production in plant cells, Carbon assimilation and nitrogen assimilation.

An overview of photosynthesis; C3, C4 plants and crassulacean acid metabolism (CAM); photorespiration; Phytochromes, cryptochromes and phototropins. Non-protein thiols and sulfur cycle.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of transporters in plant cell and organelle membranes; classification and importance of H⁺-ATPases. Ion channels- properties and significance; Aquaporins and water transport.

Important primary metabolites of plants: Properties, function and applications of cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.

UNIT-2

14 hrs

Plant growth regulators: Role of auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid and salicylic acid.

Plant responses to biotic stresses: Introduction; plant pathogens and diseases; plant defense systems-hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant biotic stress response to pathogens and insects.

Plant responses to abiotic stress- Salt stress, drought and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds. An overview of oxidative stress and oxidative damage – antioxidant enzymes and stress tolerance.

UNIT-3

14 hrs

Plant Secondary Metabolites

Introduction and definition. An overview of primary metabolism contribution to secondary metabolites biosynthesis. Classification of plant secondary metabolites.

Alkaloids: General characteristics and classification with examples. Contribution of amino acids for alkaloid biosynthesis. Isolation and purification of alkaloids. (S)-Senticuline-the chemical chameleon.

Phenolics: General characteristics and classification with examples- flavonoids and anthocyanins. Isolation and purification of phenolics.

Terpenoids: General characteristics and classification with examples. Isoprene rule. Isolation and purification of terpenoids.

Applications of secondary metabolites: in plants' defense; in insects' signalling, morphogenesis and defense. Physiologically active secondary metabolites in modern medicine and therapeutic compounds for human ailments.

REFERENCES:

1. Lehninger's Principles of Biochemistry-Nelson & Cox. CBS Publishers & Distributors, 2013.

2. Principles of Biochemistry-Moran, Horton, Scrimgeour, Perry. Pearson, 5th Edition , 2011.

3. Plant Biochemistry, P.M. Dey & J.B. Harborne. Hart Court Asia Pvt Ltd.,1997.
4. Plant Biochemistry and Molecular Biology; P.Lea & Richard C Leegood, John Wiley & Sons, 1999.
5. Introduction to Plant Biochemistry; Goodwin and Mercer, CBS Publisher and Distributors, 2005.
6. Biochemistry and Molecular Biology of Plants; Buchanan, Greussem and Jones, American Society of Plant Physiologists, 2000.
7. Natural Products from plants; Peter B. Kaufman, Lel and J. Cseke, Sara Warber, James A. Duke, HarryL. Briemann, CRC Press, Boca Raton, 1999.
8. Natural Products Targeting Clinically Relevant Enzymes. Paula B. Andrade, Patricia Valentao David M. Pereira. Wiley-VCH Verlag GmbH & Co., 2017.
9. Plant Cell Tissue and Organ Culture: Fundamental Methods; O.L. Gamborg & G.C. Phillips, Narosa Publishers, New Delhi , 1995.
10. Kant R. Sweet proteins; Potential replacement for artificial low calorie sweeteners. Nutrition J. 2005; 4:5 doi:10.1186/1475-2891-4-5.
11. MisakaT. Molecular mechanisms of the action of miraculin, a taste-modifying protein. Seminars Cell Develop Biol. 24:222-225, 2013.
12. Temussi PA. Natural sweet macromolecules: how sweet proteins work. Cell Molec Life Sci CMLS.63:1876-1888, 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

**B.Sc. III & IV 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

**B.Sc. III & IV SEMESTERS MODEL QUESTION PAPER
BIOCHEMISTRY OPEN ELECTIVE**

TIME: 2.30 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; 4 x5=20

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

SECTION – C

Answer any THREE Questions 3 x10 = 30

- 8.
- 9.
- 10.
- 11.
- 12.

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

INTERNAL ASSESMENT (as on 4thOctober meeting proceedings)

DISCIPLINE CORE	DISCIPLINE/OPEN ELECTIVE	PRACTICLAS
60+40 (IA)	60+40 (IA)	25+25 (IA)
Class Test -20	Class Test -20	Continuous evaluation & class test -15
Seminars/Classwork-10	Seminars/Classwork –10	Record/Viva-10
Assignment/Open discussion-10	Assignment/Open discussion-10	



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)**

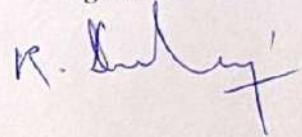

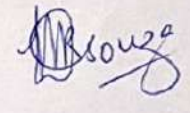
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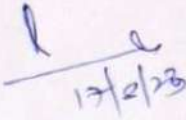
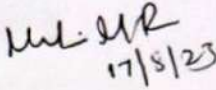

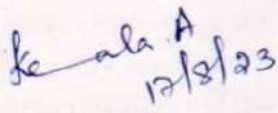
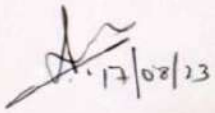

Department of Biochemistry,
Central College Campus, Bangalore -560001

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	

- | | | |
|--|--------|--|
| 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 (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, 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,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.

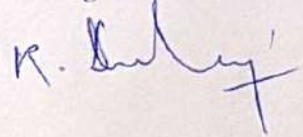

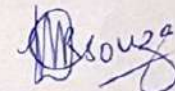
Note: Section C may include sub questions, a, and b

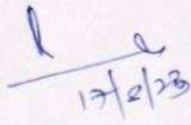
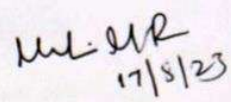
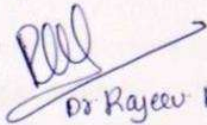
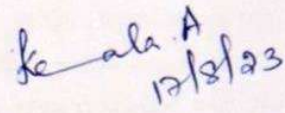
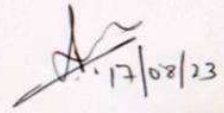

Department of Biochemistry,
Central College Campus, Bangalore -560001

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.
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| 9. Mrs. Ramya Kumari B.S
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| 10. Mrs. Madhukala.
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| 11. Dr. Bhagyalakshmi
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