St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC with 'A++' Grade – CGPA 3.67/4 (Cycle IV)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under the DBT-BUILDER Scheme, Govt. of India
College with 'STAR STATUS' conferred by DBT, Govt. of India
Recognised by UGC as 'College with Potential for Excellence'

Course structure and syllabus of

B.Sc. BIOCHEMISTRY (HONOUR'S)

NEP SCHEME-2021 0NWARDS

B.Sc. BIOCHEMISTRY (Basic/ Honours)

Preamble:

The learning outcomes are designed to help learners understand the objectives of studying B.Sc (Honour's) Biochemistry that is, to analyze, appreciate, understand the basic concepts of biomolecular processes and chemical reactions occurring in the living system. This course is fundamental to tackle many of the health related challenges facing society. Considering the rapid and far-reaching advances in biological sciences in 21st century, it is imperative to have curriculum incorporating these updated emerging concepts of biochemistry. The current pattern is designed to impart concept based learning with emphasis on hands-on training, skill development and research. Aimed at multi-faceted development of a student, the curriculum includes courses encompassing core courses, intra and inter discipline specific courses, skill and ability enhancement courses to impart in-depth knowledge in biochemistry complemented with varied subjects and skills. The course seeks to discover and nurture typical attributes of a competent science graduate such as; spirit of inquiry, critical thinking, problem solving, analytical reasoning, aptitude to research/industry and entrepreneurial instincts.

Programme Learning Outcome

The learning outcome-based curriculum is specific in terms of changes in cognitive and psychomotor behavior of students. Biochemistry Honour's course is intended to provide a broad framework enabling students to acquire a skill set that helps them understand and appreciate the field of biochemistry. The structure or design of this framework shall ensure a high standard of the Honour's degree in Biochemistry at national level. The programme specification is intended as a reference point for prospective students, current students, academic in delivering the programme and realizing its objectives. Keeping in pace with the developmental trends in Biochemistry and allied areas, it is expected that the students undertaking Biochemistry (Honour's) course become conversant with the essence of Biochemistry and exhibit certain levels of learning outcomes as proposed below

PROGRAMME OUTCOME (PO)

PO 1	To create interest in Biochemistry and appreciation for chemical basis of biological processes.
PO2	To inculcate the spirit of inquiry and value of systematic study of a discipline. Provides general understanding of the related disciplines with a holistic knowledge generation in biological sciences.
PO3	To provide an in-depth understanding of chemical reaction mechanisms in biological processes.
PO4	To provide a flavor of historical developments of enzymes and their applications in research, diagnostics and various industries.
PO5	Gain proficiency in basic laboratory techniques and be able to apply the scientific method to the processes of experimentation, hypothesis testing, data interpretation and logical conclusions.
PO6	Develop problem solving and analytical skills through case studies, researchpapers and hands-on-experience
PO7	To appreciate biochemical mechanistic basis of physiological processes, metabolism under normal and pathological conditions importance and levels of metabolic regulations.
PO8	To apply and effectively communicate scientific reasoning and data analysis in both written and oral forms. They will be able to communicate effectively with well-designed posters and slides in talks aimed at scientific audiences as well as the general public.
PO9	To bridge the knowledge and skill gap between academic out and industry requirements.
PO10	To give students experience in conducting independent, hypothesis-driven, biologicalresearch, project planning and management
PO 11	To provide skills to publish research findings, and awareness of IP rights, and scientific publication ethics and problems of plagiarism.
PO 12	To prepare competent human resource with better knowledge, hands-on-experience and scientific attitude, at national and global levels for careers in research and development, academia and Pharma-, biotech- and agro-, and food processing industries.

A meeting of the Board of Study in BIOCHEMISTRY (UG) was held on13-11-2021 at 9.30 am in Conference Room Aruppe block 408

Members present:

Internal Members:

1. Ms. Shameena.K.A. {Chairperson , Department of Biochemistry (UG) }
2. Ms. Valina Jenisha D'Almeida

External Members:

3. Vice Chancellor nominee – Dr Sarojini B.K, Professor and Chairperson, M.Sc Industrial Chemistry, Mangalore University, Mangalagangothri, Konaje- 574199
4. Subject Experts - Dr Cletus D' Souza, Adjunct Professor, Department of PG studies and Research in Biochemistry, St Aloysius College (Autonomous), Mangalore-575003
5. Ms. Usha B Rao, HOD, Biochemistry, Alva's College, Moodibidri-Karnataka.
6. Representative from industry-Dr Praveen M.K, Assistant Manager, Mol Bio Diagnostics private Ltd., Goa.
7. Student representative- Saumia Thomas Kampadukad , Reg no 192852.

Job opportunities in Biochemistry Core Course

Exit After ONE Year: CERTIFICATE COURSE

Knowledge	Skill Acquired	Employability
Fundamental and principles of Biochemistry, atoms, acids and bases, metals. Biological significance of elements. Understanding of chemical bonding, Physical properties of molecules, chemistry of toxic chemicals. Colligative properties, Properties of matter and electro chemistry, redox reactions. Organometallic compounds and its applications. A general scientific spirit of inquiry	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. Communication interpersonal and leadership skills, and ability enhancements complementing the core Biochemistry, Entrepreneurship	Small and medium size chemistry/ pharma based laboratories; as Jr. laboratory assistant assisting chemists/scientists. QC Assistants in Laboratories dealing with QC service. Toiletries, chemicals, perfumery, oil industries, distilleries/textiles/ pollution control units Entrepreneurship

Exit After **two** Year: **Diploma COURSE**

Knowledge	Skill Acquired	Employability
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,Comprehensive knowledge and hand-on training in laboratory techniques of biochemistry. Analytical instrumentationand methodology	Acquaintance with analytical techniques that will permit them to study the biological system. Demonstrating skills of fractionating organic compounds. Hands on experience of handling instruments and analysis of data. Improving personality traits, team work, organizing abilities. Communication skills	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 Entrepreneurial opportunities, Material safety datasheet maintenance, curationof chemical/drug stores, chemical storekeeping

Exit After **three** Years: **B.Sc. degree**

Knowledge	Skill Acquired	Employability
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. Overall knowledge of the avenues for research and higher academic achievements in the field of biochemistry and allied subjects.	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. Oral and written skills to convey scientific experimental results. Ability to understand research findings and disseminate to common public. Teaching skills	Scientific assistants in biotech based industries. Chemical /pharma/animal feeds/ scientific data mining, / Forensic science labs. Blood Banks, Public heath support staff, Clinical research, Drug discovery R&D, Medical coding, medical transcription, Medical content writing Teaching at secondary school level

After Four Years: **B.Sc. (Hons.)**

Knowledge	Skill Acquired	Employability
Introduction to advanced concepts in Biochemistry; Molecular Biology, Recombinant DNA technology, Clinical Biochemistry/ Plant Biochemistry, Immunology, Nutrition and Dietetics, Biochemical Pharmacology, Research methodology,Intellectual property rights, Bioinformatics skills, data analysis, Pharmacogenomics, Introduction to Intellectual property rights. A strong theoretical and practical knowledge of clinical and molecular setting, core research exposure.	Skills to isolate, identify and assay the biomolecules. Conducting independent research as part of project work. Hand on training in modern techniques in molecular biology. R-DNA techniques Computation skills, Prism, graph pad, Excel, Scientific writing skills: general articles, research reviews, Debating on scientific inventions and social implications.	Research staff, Clinica Biochemist Forensic science technician Biomedical scientist Nutrition Dept. Pharma industry Clinical research industries, R&D divisions of Pharma industries Vaccine industry. Medica coding Bioinformatics, Medica content writing, Patent examiner Toxicological asst. Medica Science Liaison officer Environmental science

Programme structure for the under-graduate programs in universities and colleges
[subjects with practicals]

SEMESTER – I								
Group	**Course Code**	**Title of the Course**	**Instruction Hours / week**	**Duration of Exam (Hours)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.1	Chemical Foundation Of Biochemistry - I	04	2.5	40	60	100	4
	G 510 DC 2.1P	Volumetric analysis & Estimations – Practical-1	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.1	Biochemistry of cells	03	02	25	25	50	2
SEMESTER – II								
Group	Course Code	Title of the Course	Instruction Hours / week	Duration of Exam (Hours)	Marks			Credits
					IA	Exam	Total	
Discipline Core Courses	G 510 DC 1.2	Chemical Foundation Of Biochemistry - II	04	2.5	40	60	100	4
	G 510 DC 2.2P	Qualitative and Quantitative Analysis – II	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.2	Proteins & Amino acids	03	02	25	25	50	2

SEMESTER – III								
Group	**Course Code**	**Title of the Course**	**Instruction Hours / week**	**Duration of Exam (Hours)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.3	Bio-organic Chemistry	04	2.5	40	60	100	4
	G 510 DC 2.3P	Bio-organic chemistry Practical-3	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.3	Biochemical techniques	03	02	25	25	50	2
SEMESTER – IV								
Group	Course Code	Title of the Course	Instruction Hours / week	Duration of Exam (Hours)	Marks			Credits
					IA	Exam	Total	
Discipline Core Courses	G 510 DC 1.4	Analytical Biochemistry	04	2.5	40	60	100	4
	G 510 DC 2.4P	Analytical Biochemistry Practical-4	04	03	25	25	50	2
Open Elective Courses	G 510 OE 1.4	Plant Biochemistry	03	02	25	25	50	2

SEMESTER – V								
Group	**Course Code**	**Title of the Course**	**Instruction Hours / week**	**Duration of Exam (Hours)**	**Marks**			**Credits**
					IA	**Exam**	**Total**	
Discipline Core Courses	G 510 DC 1.5	Human Physiology and Cell Biology	06	2.5	40	60	100	3
	G 510 DC 1.6	Biochemistry of Macromolecules	06	2.5	40	60	100	3
	G510 DC 2.5P G510 DC 2.6P	Practical 5& Practical 6	02 02	03	25	25	50	4
Vocational		Basics in Molecular Biology	03	2.5	40	60	100	3
SEMESTER – VI								
Group	Course Code	Title of the Course	Instruction Hours / week	Duration of Exam (Hours)	Marks			Credits
					IA	Exam	Total	
Discipline Core Courses	G 510 DC 1.7	Enzymology	06	2.5	40	60	100	3
	G 510 DC 1.8	Intermediary metabolism	03	2.5	40	60	100	3
	G 510 DC 2.7P G 510DC 2.8P	Practical 7 & Practical 8	02 02	03	25	25	50	4
Vocational			03	2.5	40	60	100	3

SEMESTER -I

COURSE TITLE : CHEMICAL FOUNDATION OF BIOCHEMISTRY	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 02 hours.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

This will inculcate confidence and clarity of mind in students to understand the chemistry of Biomolecules and Biological reactions.

UNIT-I

SCOPE OF BIOCHEMISTRY & UNITS OF MEASUREMENT:- **14 HOURS**

What is Biochemistry, brief historical overview, future and scope of Biochemistry, applications of Biochemistry, chemical composition of living organisms. 1hr.

Units of measurement: CGS and SI system, units of length, mass, time, temperature and amount (Mole), derived units, (velocity, density, specific gravity, frequency, power, force, pressure, and energy) SI prefixes (milli, micro, nano, pico, femto, kilo, mega, giga, tera)

3hr.

Atoms, atomicity, element, compound, molecules, isotopes, isotope notation, A-Z notation, isobars,Natural abundance, atomic weight, average mass, molecular weight..

4hr.

Avogadro`s number mole, mole concept, Dalton's concept, molarity, molality, percent composition of atoms. Concentration, molar solution, percent solution, ppm, equivalent weight, normality. 6 hr.

UNIT-II

ATOMIC STRUCTURE AND CHEMICAL BONDS:- **14 HOURS**

Structure of an atom, electrons and Quantum numbers, orbitals, shapes of orbitals, s, p, d, and f subshells, K, L, M, N, O, P, and Q shells. Illustration of Pauli`s exclusion principle, Aufbau principle, and Hund`s rule, electron configuration, octet rule. 6 hr.

Chemical bonding: formation of ionic bond, covalent bond (sigma and pi bonds), co-ordinate bond with examples. Hydrogen bonds, bonding in water molecule, Water as a fluid of life, special properties of water- (boiling point and melting point, surface tension, viscosity, high specific heat) bonding of water in ice and its significance. Weak forces of interaction, van der Waals interactions, London forces, dipole-dipole interactions, electrostatic interactions, and hydrophobic interactions. 8 hr.

UNIT-III

BUFFERS AND COLLIGATIVE PROPERTIES: - **14 HOURS**

Acids, bases, conjugated acids and bases. Arrhenius concept, Lewis concept, Lowry and Bronsted concepts.Strong and weak acids and bases. Strength of acids and bases. Ionic product of water, pH scale, Buffers, Henderson-Hasselbalch equation, buffers in blood-carbonic acid buffer. Titration curve of an amino acid. pK value, zwitterionic structure of aspartic acid isoelectric pH. 7hr.

Water as a solvent. Solutions and types-ionizable solutes, non- ionizable solutes (sugar & salt). Colligative properties and anomalous colligative properties of solutions, vapor pressure and its application in distillation, boiling point, freezing point, de-icing.

Osmotic pressure: Osmosis and osmotic pressure determination, reverse osmosis, isotonic, hypo and hypertonic solution and its effects on blood cells. Donnan membrane equilibrium. 7hr.

UNIT-IV

ELECTROCHEMISTRY AND REDOX REACTIONS:-

Electrochemistry: - electrochemical cells, electrode potential and its measurement, electrodes, half cell reaction,standard electrodes-glass electrode 4 hr.

Laws of thermodynamics-I, II and III law. Concept of entropy and enthalpy, their relation, Gibb`s energy, free energy change. Oxidation and reduction- oxidation number and its significance redox reactions, redox potential, application of redox potential. 6 hr.

Chemical Kinetics: Rate of a reaction, Molecularity and order of a reaction. First and second order reaction, Half life of a first order reaction, Energy of activation. 4 hr.

REFERENCES:

- dvanced Inorganic Chemistry: A comprehensive Text,1999, Cotton A and GeoffreyWilkinson, 6th edition , Wiley publication
- norganic Chemistry, 2014, Miessler GL , Paul Fischer PJ, and Tarr DA, 5th edition, PearsonPublication
- norganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication
- norganic Chemistry , 2015, Overton, Rourke , Weller , Armstrong and Hagerman ,Oxford Press
- hysical Chemistry: A molecular approach, 2019, Donald A, McQuarrie and Simon JD, Viva Books Publication.
- hysical chemistry 2019, Atkins P, Paula JD, Keeler J , 11th edition , Oxford press.

SEMESTER-1 PRACTICALS – 1

COURSE TITLE: VOLUMETRICANALYSIS & ESTIMATIONS – PRACTICALS-1	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 Hours/ Week	**DURATION OF ESA : 03 hrs**
Formative assessment marks: 25	**Summative assessment marks: 25**

Course Outcome:

This course aims to familiarize students with the principles of analytical chemistry and basic analytical techniques such as volumetric analysis. Course objective is to provide experimental practice of quantitative volumetric analysis. Upon successful completion students should be able to make solutions of various molar, normal concentrations and determine the amount of a substance in a given sample.

Experiments:

1. Concept of molarity, molality and normality. Calculation and preparation of molar solutions. (Problems to be given in exams). Calculation and preparation of normal solutions and percent solutions and dilute solutions.
2. Calibration of volumetric glassware's (Burette, pipette).
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 buffer.
5. Estimation of amino acid Glycine by formal titration method
6. Titration curve for an amino acid and determination of pKa value.
7. Preparation of Isotonic, hypotonic & hypertonic solution.
8. Effect of Isotonic, Hypotonic & hypertonic solutions on RBC.
9. Redox reactions
10. Dialysis & Reverse Dialysis

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, Dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.
4. Principles of Practical Chemistry- M. Viswanathan
5. Instrumental Methods of chemical Analysis B.K Sharma.

SEMESTER – II

COURSE TITLE : CHEMICAL FOUNDATION OF BIOCHEMISTRY -2	**COURSE CREDITS: 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA : 02 hrs**
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.

UNIT- I

CHEMICAL CATALYSIS:- **14 HOURS**

Homogeneous and Heterogeneous – Definition and examples. theories of catalysis, types- homogeneous, heterogeneous, Bio catalysis. Enzyme as catalyst. 4 hr.

Colloids: true solutions, classification of colloids (Examples: Fog, cloud, steam, smog, vehicle exhaust- PM, milk, jelly). 4 hr.

Protein as a colloidal solution. Ultra filtration, Brownian movements, electric properties, coagulation, salting in and salting out of protein. Emulsion, types, (Example Butter) micelles with lipids, emulsifiers. 6 hr.

UNIT- II

NOMENCLATURE OF ORGANIC COMPOUNDS: **14 HOURS**

Classification, naming- IUPAC nomenclature, compounds containing one and two functional groups. Stereochemistry, geometric isomerism-cis and trans (Example of fatty acids) 4 hr.

Structural Isomerism, conformation example glucose- enantiomers, epimer, anomer, mutarotation, chair and boat conformations. Optical isomerism, D and L plane polarized light and optical rotation d and l glucose. 5hr.

Nomenclature of racemic mixture, resolution. Fischer and Newmann projection formulae, molecule with one and two chiral and achiral centers. Priority rules; E and Z (CIP rules), R and S (alanine),D and L(Glucose) notations,. Role of stereochemistry in biological systems. 5 hr.

UNIT- III

INORGANIC CHEMISTRY: **14 HOURS**

Coordination compounds–simple, double and complex salts-definition, differences with examples, IUPAC nomenclature. Werner's theory, ligands- uni, bi, and polydentate. Coordination number. 5hr.

Trace metals in biological systems: selenium, molybdenum, cobalt. Toxicity of heavy metals:

Lead, mercury, cadmium, arsenic. Bulk elements in biological systems (Na, K, Ca, Mg, Fe, Co, Zn and I). Structural role of calcium, zinc in enzymes. 7hr.

Reactive oxygen, oxygen and nitrogen free radicals. 2hr.

UNIT- IV

ORGANOMETALLIC COMPOUNDS: **14 HOURS**

Metal atom linked organic compounds.

Para chloro mercury benzoate- structure, uses. Methyl mercury toxicity 2hr.

Porphyrins: definition, classification. Important metalloporphyrins occurring in nature; structure and their biological importance. 2hr.

(Hemoglobin, cytochrome, chlorophyll, myoglobin, vitamin B12 iron-sulphur clusters with suitable

Examples and their role in biological systems). 10hr.

REFERENCES:-

1. Physical Chemistry 2006, Peter Atkins. 8th edition, W.H. Freeman and Company

2. Inorganic Chemistry: Principles of structure and Reactivity, 2006, Huheey JE, Keiter EA, Keiter RL , Pearson Education India
3. A text book of Organic Chemistry 2016, Raj K Bansal, 6th edition, New Age International Publications
4. Advanced Inorganic Chemistry 1999, Cotton et al , 6th edition, A Wiley – International
5. Principles of physical Chemistry by Puri, Sharma and Pathania.
6. Physical Chemistry by R. L. Madan, G. D. Tuli. S. Chand and Co
7. Advanced Organic Chemistry by Bahl and Bahl

SEMESTER - II

PRACTICALS - 2

COURSE TITLE: QUALITATIVE AND QUANTITATVE ANALYSIS – PRACTICALS – 2	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 Hours/Week	**DURATION OF ESA : 03**
Formative assessment marks : 25	**Summative assessmentmarks : 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. Salting in and salting out of milk.
2. Estimation of calcium in Ragi
3. Estimation of Fe in Edible leaves
4. Reactive Oxygen species
5. Verification of Beer's Law. Estimation of unknown concentration of a biomolecule by using colorimeter
6. Partition Coefficient of Amino Acid (Phenylalanine/ Glycine) in n-octane: water system
7. Oxidation and reduction of cytochrome

8. Calibration of pH meter and determination of pH of aerated soft drinks.
9. Lab safety measures.

REFERENCES:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Dr. O. P. Pandey, D. N. Bajpai, dr. S. Giri, Practical Chemistry S. Chand and Co. Ltd.,
4. Principles of Practical Chemistry- M. Viswanathan

SEMESTER -I

OPEN ELECTIVE

COURSE TITLE	**BIOCHEMISTRY OF CELL**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**02hrs**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**50**

Course Outcome:

This open elective course offering to students of various streams gives knowledge about biomolecules in their cellular environment. Further, they will learn basic chemistry of amino acids, peptides, sugars, polysaccharides, nucleosides, nucleotides, nucleic acids, lipids, vitamins, coenzymes and metal ions.

UNIT - I

BIOMOLECULES IN THEIR CELLULAR ENVIRONMENT: 14 HOURS

The cellular basis of life. Cellular structures – prokaryotes and eukaryotes. Chemical principles in biomolecular structure. Major classes of biomolecules. Role of water.

Amino acids and peptides:

Structure of amino acids, classification of amino acids based on polarity, derivatives of amino acids and their biological role. Peptide bond, Properties of a peptide, biologically important peptides

UNIT - II

SUGARS AND POLYSACCHARIDES: 14 HOURS

Basic chemistry of sugars, optical activity. Disaccharides, trisaccharides and polysaccharides - their distribution and biological role.

Nucleosides, nucleotides and nucleic acids:

DNA structures and their importance, different types of RNA. Unusual DNA structures, other functions of nucleotides.

UNIT -III

LIPIDS: **14 HOURS**

Different classes of lipids and their distribution, storage lipids, structural lipids in membranes, lipids as signal molecules, cofactors and pigments.

Vitamins, coenzymes and metal ions:

Occurrence and nutritional role. Coenzymes and their role in metabolism. Role of metal ions in biological system and theirsignificance - heme, porphyrins and cyanocobalamin.

REFERENCES:

1. Lehninger- Principles of Biochemistry-DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).

SEMESTER-II

OPEN ELECTIVE

COURSE TITLE	**PROTEINS AND ENZYMES**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**42**
DURATION OF ESA	**02**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**50**

Course Outcome:

- Proteins: The course aims to introduce proteins and their importance to modern Biochemistry, highlighting their structural features and unique characteristics that help them participate in

every physiological process in life.

- Enzymes: The objective of this course is to integrate the practical aspects of enzymology with the kinetic theories to provide a mechanistic over view of enzyme activity and regulation in the cell.
- To prepare students to confidently and competently work with enzyme systems in both Academia and industry.

UNIT - I

Classification of amino acids based on structure, Zwitterion structure, Isoelectric point, pKa. Properties of peptide bonds. Classification of proteins based on structure and functions. Overview of Primary, Secondary, Tertiary and Quaternary structures of proteins. Structure of myoglobin and hemoglobin, Ramachandran plot, Helices, sheets and turns.

Determination of N-terminalamino acid (by DNFB and Edman method), and C- terminal amino acid (by thiohydantoin andwithcarboxypeptidaseenzyme). Overview on proteinfolding.

14 HOURS

UNIT – II

Introduction of Biocatalysts, Nomenclature and classification of enzymes, enzyme specificity, Active site and its models, fundamentals of enzyme assay. Enzyme Kinetics: Order of reactions, Michalis – Menten equation for Uni-Substrate reaction (derivation not necessary), significance of Km and Vmax. Enzyme inhibition: Over view on Reversible and irreversible inhibition Regulation of enzyme activity: Allosterism and cooperativity, feedback inhibition. Outline of Mechanism of enzyme action: Acid – base catalysis, covalent catalysis,. Mechanism of Chymotrypsin.Applications of enzymes.

14HOURS

UNIT – III

Separation and characterization of Proteins and enzymes: Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization, Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, Native and SDS – PAGE electrophoresis.

14 HOURS

REFERENCES

1. Lehninger Principles of Biochemistry, 6th Edition , David L Nelson, 2017
2. Fundamentals of Biochemistry, 4th Edition , Donald Voet and Judith Voet , 2015
3. Biochemistry Jeremy Berg , Lubert Stryer and John Tymoczko, Gregory Gatto, 2019
4. Protein Purification. Principles and Practice. Robert K Scopes, Springer, ISBN 978-1-4737-2333-5

SEMESTER -III

COURSE TITLE : BIO-ORGANIC CHEMISTRY	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 02 hours.**
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-I

REACTION MECHANISMS AND HYDROCARBONS **14 HOURS**

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Classification of organic reactions (substitution, addition, elimination, and re- arrangement), with two examples for each. Reactive intermediates-examples of free radicals, carbo cations and carbanions, free radicals, carbenes, nucleophiles and electrophiles 06 Hr.

Aromatic compounds - Aromaticity, criteria for aromaticity, anti-aromatic, and non-aromatic compounds with examples, POLYCYCLIC benzenoid hydrocarbons , their structure and role 03 Hr.

Biological occurrence -Structural formula and importance of Furan, Pyrrole, Thiopene, Pyridine, Pyran, Thiazole, Pyrimidine, Purine, Indole, Imidazole, Quinoline and Isoquinoline. 05 Hr.

UNIT -II

MECHANISM OF SUBSTITUTION, ELIMINATION, AND ADDITION REACTIONS 14 HOURS

Examples of Electrophilic substitution (nitration of Benzene), example of S_N1(from DNA synthesis) and S_N2 (S-Adenosyl Methionine methyl transferase) reactions , Stereochemistry (Retention of configuration and inversion of configuration).Addition and elimination reactions (Examples), 1,2 and 1,4 addition reactions. Addition of oxygen to C=C in fatty acids. 6 Hr.

Alcohols

Monohydric, Dihydric, Trihydric alcohols with examples. Primary, secondary and tertiary alcohols reactions: oxidation and reduction. Distinguishing test.

Function of phenols and phenolics (in plants) 3 Hr.

Amines

Classification, properties, Amino functional group - Basicity of amines acylation. Reaction with HNO_2 and Schiff's base formation. Distinguishing reactions of primary, secondary and tertiary -amines. 5 Hr.

UNIT -III

MECHANISM OF ELECTROPHILIC SUBSTITUTION REACTIONS 14 HOURS

Coenzymes- introduction, structure**,** Role of Coenzymes in reaction mechanism

Water soluble Vitamins- definition, sources, structures of thiamine, riboflavin, niacin, pyridoxine, biotin. The reaction of the coenzymes- thiamine pyrophosphate and its role in decarboxylation. Vit B_2 (FAD) role in redox reactions with suitable examples. Biotin its role in carboxylation reaction.

Mechanism of antioxidant activity of vitamin C and vitamin E

Antivitamins- sources and effects of avidin, Dicumarol & Antinutrition factors – Canavanin, Hypoglycin A

UNIT- IV

BIO-ORGANIC COMPOUNDS 14 HOURS

Introduction to Bioorganic chemistry

Terpenes: Definition, Isoprene rule, classification, isolation, structure and biological importance of menthol, camphor, farnesol, phytol, lanosterol, lycopene and dolichols. 4Hr.

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). 4Hr.

Alkaloids: Definition, classification based on their structure and biological functions, Isolation ofalkaloids, structure and physiological action of morphine, nicotine and atropine. 4Hr.

Food Adulteration

Natural toxicants (Lathyrus sativus) and adulterants (Butter yellow, Lead chromate & malachite green) 2 Hr.

REFERENCES

1. Textbook 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

SEMESTER-III

PRACTICALS – 3

COURSE TITLE: BIOORGANIC CHEMISTRY -3	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 Hours/ Week	**DURATION OF ESA : 03 hrs**
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:

1. Estimation of Cholesterol by Zak's method.
2. Estimation of Vitamin C by titration method/ colorimetric method
3. Estimation of Flavones by colorimetric method
4. Estimation of Vitamin E
5. Qualitative analysis of food adulterants
6. Estimation of Phenolics

7. Extraction of casein from milk
8. Extraction of starch from potatoes
9. Extraction of caffeine from tea leaves

REFERENCES:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A. Chhikara 2009
2. Textbook of Practical Organic Chemistry Including Qualitative OrganicAnalysis by Arthur Israel Vogel 2003
3. Comprehensive practical organic chemistry- preparation and quantitative analysis. V. K.Ahluwalia and Renu Aggarwal 2004

SEMESTER -IV

COURSE TITLE : ANALYTICAL BIOCHEMISTRY	**COURSE CREDITS : 4**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 02 hours.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

UNIT-I

BIOLOGICAL SAMPLE PREPARATION AND FRACTIONATION

14 HOURS

Introduction and objectives of bioanalysis. Occurrence of proteins and polysaccharides in nature. Extraction of proteins and polysaccharides from tissues and cells. Extraction of phytochemicals from plants.

Centrifugation

Introduction, principles of centrifugation, relative centrifugal field(RCF). Types of centrifugations- Preparative and analytical. Differential, density gradient, ultra-centrifugation. Basic instrumentation; types of rotors. Laboratory centrifuge, AnalyticalCentrifuges- Sedimentation coefficient, maintenance of instrument.

UNIT- I I

CHROMATOGRAPHY 14 HOURS

General principles and historical developments in chromatography. Classification based on the types of separation (adsorption, partition,ion exchange and affinity).Paper chromatography - ascending, descending and circular, 2-D chromatography, Rf values. TLC. Gel-filtration, ion exchange and affinity-chromatography. Advanced chromatography- GLC, HPLC, FPLC and UPLC

UNIT III

ELECTROPHORETIC AND RADIO ISOTOPIC METHODS 14 HOURS

Electrophoresis: General principle of electrophoresis, Types- paper, agarose, polyacrylamide, polymerization of acrylamide, methodology and applications of native PAGE and SDS- PAGE, 2-D electrophoresis, Staining of proteins post electrophoresis. Isoelectric focusing. Principle and applications of immuno electrophoresis. 10Hr.

Radioisotopic methods: Radioisotopes and heavy Isotopes

Types of radioactive decay- α, β, γ radiations. Half-life period. Detection of radioactivity – GM counter and liquid scintillation counters (only principle and working) Applications of radioisotopes – ^{3}H, ^{14}C, ^{131}I, ^{60}Co and ^{32}P. Biological effects of radiations, safety measure in handling radio isotopes. 4Hr.

UNIT IV

SPECTROSCOPIC METHODS OF BIO-ANALYSIS 14 HOURS

Spectroscopic methods: Electromagnetic spectrum. Beer-Lambert's law and its limitations. Principle, design, application of Colorimeter and UV-Vis spectrophotometer. Determination of molar absorption coefficient of molecules. Working principle and application of flame photometer and fluorimeter. Principle and application of IR, Raman, ESR and NMR spectroscopy, MRI.

SEMESTER-IV

PRACTICALS – 4

COURSE TITLE: ANALYTICAL BIOCHEMISTRY-3	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 Hours/ Week	**DURATION OF ESA : 03 hrs**
FORMATIVE ASSESSMENT MARKS: 25	**SUMMATIVE ASSESSMENT MARKS: 25**

Course Outcome:

This course aims 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. Identification of amino acids by circular chromatography.
2. Ascending (amino acids) and descending (carbohydrates) Chromatography
3. Demonstration of separation of plant pigments by column chromatography
4. Separation of Leaf pigments by Thin Layer Chromatography
5. Demonstration of Agarose gel electrophoresis
6. Demonstration of SDS PAGE
7. Estimation of DNA by diphenylamine method
8. Isolation of chloroplast by centrifugation.

9. Recording the absorption spectrum of Riboflavin
10. Estimation of Na and K ions by flame photometer

REFERENCES

1. Practical Book of Analytical Chemistry (First Edition) (English, Paperback, Ms. pooja R. Popat)

SEMESTER - III

OPEN ELECTIVE

COURSE TITLE : BIOCHEMICAL TECHNIQUES	**COURSE CREDITS: 3**
TOTAL CONTACT HOURS: 42	**DURATION OF ESA : 02**
FORMATIVE ASSESSMENT MARKS : 40	**SUMMATIVE ASSESSMENT MARKS : 60**

Course outcome:

These topics will enable students to develop competence in handling various chromatographic, electrophoretic and isotopic techniques and apply them in isolating and characterizing different biological molecules.

UNIT I

CHROMATOGRAPHY **14 Hours**

General Principles of Chromatography and applications of - Adsorption Chromatography, Paper chromatography, Rf value, Principle and applications of TLC, Ion exchange chromatography, Affinity chromatography, Gel filtration chromatography, Gas liquid chromatography, HPLC

UNIT II

14 Hours

ELECTROPHORESIS –Introduction, Principles of Electrophoresis, Types- Paper and Zone electrophoresis, Basic principles of agarose electrophoresis, SDS-PAGE, 2D -electrophoresis

UNIT III

SPECTROSCOPY- Introduction, principle and application of Spectrophotometer, UV-spectroscopy, X- ray diffraction, Fluorimeter, principle of IR, NMR, Mass Spectroscopy, its application.

14 Hours

SEMESTER-IV

OPEN ELECTIVE

COURSE TITLE : **PLANT BIOCHEMISTRY**	COURSE CREDITS: 3
TOTAL CONTACT HOURS: 42	DURATION OF ESA : 02
FORMATIVE ASSESSMENT MARKS : 25	SUMMATIVE ASSESSMENT MARKS : 60

Course outcomes:

These topics will enable the students to

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

UNIT I **14 hours**

Plant cell- structure and molecular components: Cytoskeleton- an overview. Plant cell division, cell cycle.

An overview of photosynthesis: C3, C4 plants and crussulacean acid metabolism (CAM); photorespiration; Phytochromes.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps operate at 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: Cellulose, starch, sucrose, oligosaccharides; fructans, gums, mucilages, poly unsaturated fatty acids, lignin, suberin, surface waxes, sulfides and sweet proteins.

UNIT II **14 hours**

Plant growth regulators: Auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid, salicylic acid

Brief history of plant tissue culture, Principle, Laboratory requirements and general techniques involved in micro propagation techniques (Equipments, Media-types, preparation, explants, and sterilization techniques)

UNIT III **14 hours**

Plant secondary metabolites (Natural products):
Introduction; secondary metabolites (natural productions) definition; classification of plant secondary metabolites (natural products).

Alkaloids: Classification of alkaloids; Contribution of amino acids for alkaloid biosynthesis; Isolation, purification and characterization of alkaloids. (S)-Seticuline-the chemical chameleon.

Phenolics: Classification of phenolic compounds; Classification of flavonoids; Classification of anthocyanins; Isolation, purification and characterization of phenolics.

Terpenoids: Classification of terpenoids, biogenic isoprene rule; volatile compounds; plant growth regulator terpenoids – saponins. Isolation, purification, and characterization of terpenoids

REFERENCES:

1. Lehninger's Principles of Biochemistry - Nelson & Cox. CBS Publishers & Distributors,2013
2. Principles of Biochemistry - Moran, Horton, Scrimgeour, Perry. Pearson, 5thEdition , 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. AmericanSociety of Plant Physiologists. 2000
7. Natural Products from plants. Peter B. Kaufman, Leland J. Cseke, Sara Warber, James A.Duke, Harry L. Brielmann, 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. PhillipsNarosa 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. Misaka T. 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 SciCMLS. 63:1876-1888, 2006

SEMESTER -V

Course outcome

The objective of this paper is to offer insights into the basic clinical aspects, associated

COURSE TITLE : HUMAN PHYSIOLOGY AND CELL BIOLOGY	**COURSE CREDITS : 3**
TOTAL CONTACT HOURS: 4 2	**DURATION OF ESA: 02 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

disorder, and structure as well as function of a cell membrane. It also covers topics of radiochemistry and cancer. The course also aims to impart understanding of cell transport, cell death, endocytosis and various techniques of cell biology. It describes mechanism of cancer, treatment, carcinogens and properties of radioactive materials

HUMAN PHYSIOLOGY AND CELL BIOLOGY

UNIT I

14 HOURS

Water metabolism & body fluids: Distribution of water in body fluids, factors influencing water metabolism. Blood volume, composition and functions. RBC, WBC and platelets, their structure and functions. Mechanism of blood coagulation. Biochemical events in transport of CO_2 and O_2 in blood. Cerebrospinal fluids, Lymph and its function.

Acid base balance: Maintenance of normal pH of the body fluids. Blood buffers. Role of lungs and kidney in acid base balance. Acidosis and alkalosis.

Liver: Structure of a lobule, Liver functions- metabolic, storage and detoxification.

Neurons & Neurotransmitter: Structure & types of neurons, Resting membrane potential, action potential, Transmission of nerve impulse along an axon and across synapse. Neurotransmitters. Inhibitors of neurotransmission.

UNIT II

NUTRITION **14 HOURS**

Concept of nutrition, Calorific value of foods and its determination (bomb calorimeter), respiratory quotient, basal metabolic rate, determination of BMR, factors affecting BMR, specific dynamic action of foods.

Dietary proteins: Dietary sources, nutritional classification, nutritional value of protein-PER (protein efficiency ratio), NPU (Net Protein Utilization) and biological value of proteins. Essential amino acids, malnutrition –Kwashiorkor and Marasmus.

Dietary fat: Dietary sources of fats, invisible fats, essential fatty acids and their biological importance, oxidized fats.

Balanced Diets and Fad Diets

Fat soluble vitamins - A, D, E, & K, - dietary sources, requirements, deficiency symptoms and biological role.

UNIT III

CELL ORGANELLES **14 HOURS**

Chemistry and functions of Mitochondria, Endoplasmic reticulum, Golgi complex, lysosome, peroxisomes, vacuoles and nucleus .

Cytoskeleton – microtubules, actin filament, myosin, intermediate filaments. Mechanism of muscle contraction.

Cell Junctions, Basic aspects of intercellular communication; autocrine, paracrine, endocrine & neuronal. Concept of cell signaling-membrane receptors, types (GPCR, RTK)

MEMBRANE BIOCHEMISTRY

Structure, chemical composition and functions of biological membranes – Sandwich model, Fluid mosaic model & organization of membrane components. Membrane transport system – active versus passive transport systems; Transport of Glucose; Ion channels - voltage-gated ion channels (Na^+ /K^+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor). Ionophores. Functions of plasma membrane – Receptor mediated endocytosis and phagocytosis.

SEMESTER -V

COURSE TITLE : BIOCHEMISTRY OF MACROMOLECULES	**COURSE CREDITS : 3**
TOTAL CONTACT HOURS: 4 2	**DURATION OF ESA: 02 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course outcome:

The main aim of the course to provide students with an understanding of major four bimolecules, the basic building blocks of living organisms, focusing on their structure, unique properties, biological roles and functions. To obtain clarity on inter relations of bimolecules in the system. The course will outline the importance of protein, nucleic acid, carbohydrate and lipids as vital ingredients of life. Emphasis will be on the association between structure and function of various bimolecules at a chemical and molecular level and hands on approach in various laboratory techniques associated with it

BIOCHEMISTRY OF MACROMOLECULES

UNIT I

CARBOHYDRATES **11 HOURS**

Classification & biological importance of carbohydrates, Structure of Monosaccharides: Stereochemistry of monosaccharides (+) and (-), D and L, Epimers, anomers and diastereomers. Reactions of fructose and glucose, Elucidation of open chain structure of glucose. Mutarotation. Disaccharide: Establishment of glycosidic linkage in sucrose, maltose, lactose. Deoxy ribose & ribose sugar**.** Polysaccharides: Types, Partial structure, Occurrence and importance of starch, glycogen, inulin, cellulose, chitin, pectin.

UNIT II

LIPIDS **10 HOURS**

Classification and biological role of Fatty acids:nomenclature, structure & properties of saturated, unsaturated, essential fatty acids. Biological roles of Prostaglandins and Thromboxane. Triacyl glycerols: nomenclature, physical properties, Chemical properties (hydrolysis, esterification, Rancidity of fats, saponification value, iodine value, Acid value) and significance. Biological significance of fats. Glycerophospholipids: Structure of lecithins, Cephalins, Phosphatidyl serine, Phosphatidyl inositol,

plasmalogens and cardiolipin. Biological role of phosophoglycerides. Sphingolipids: Structure and importance of Sphingomyelin, ceramide. glycolipids-cerebrosides & gangliosides.

UNIT III

PROTEINS **11HOURS**

Amino acids- common structural features. Structure & classification of standard amino acids. Essential and non-essential amino acids. pH titration curve, isoelectric pH of amino acids & pKa value. Peptides: structure of peptide bond. Peptides- Glutathione, Valinomycin. Synthetic peptides - polyglutamic acid. Proteins-Classification based on solubility, nutrition & functions. Protein structure- Primary, secondary (helix, pleated sheet and bend), tertiary and quaternary structures of protein (Myoglobin and Haemoglobin). Forces stabilizing the secondary, tertiary and quaternary structures of proteins. Denaturation and renaturation of proteins- Anfinsen's experiment.

UNIT IV

NUCLEIC ACIDS **10 HOURS**

Nucleic acids: Introduction, nitrogenous bases - purines and pyrimidines. Nucleosides and nucleotides: structure and properties, phosphodiester bonds, 5'and 3'ends. Forms of DNA (B and Z),Types and functions of DNA and RNA (t- RNA, r-RNA, m-RNA, mi-RNA). Biological importance of DNA and RNA. Nucleic acid chemistry – UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers (cyclic AMP)

REFERENCES:

1. Fundamentals of Biochemistry (2005) by J.L Jain, 6th Ed, S. Chand & Co Ltd.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN: 13: 978-1-4641-0962-1 / ISBN: 10:1-4292-34148
3. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd.(New Jersey), ISBN:978-1180-25024.
4. Biochemistry (2013) by U. Satyanarayana and U. Chakrapani, 4th edition, Elsevier.

5. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4.
6. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A.,Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN: 978-0-07-176-576-3.

PRACTICALS V & VI

COURSE TITLE: BIOCHEMISTRY OF MACROMOLECULES	**COURSE CREDITS: 2**
TOTAL CONTACT HOURS: 4 Hours/ Week	**DURATION OF ESA : 03 hrs**
FORMATIVE ASSESSMENT MARKS: 25	**SUMMATIVE ASSESSMENT MARKS: 25**

Course outcome:

On successful completion of the course students will be: In the laboratory, able to independently apply various biochemical techniques to identify and quantify major bimolecules.

Experiments

QUALITATIVE ANALYSIS OF BIOMOLECULES

1. Carbohydrate – Glucose, Fructose, Lactose, Maltose and Sucrose.
2. Amino acids -Tryptophan, tyrosine or cysteine
3. Proteins –. Albumin or casein
4. Lipids- extraction of phosphatides from egg yolk
5. Nucleic acids by Bial's test

QUANTITATIVE ANALYSIS OF BIOMOLECULES

1. Estimation of glucose by Folin Wu method, GOD/POD method.
2. Determination of acid value of an oil or fat.
3. Determination of Iodine value of an oil or fat.
4. Isolation of DNA
5. Isolation of RNA
6. Estimation of DNA by diphenylamine method
7. Estimation of RNA by orcinol method

8. Isolation of chloroplast and UV spectra
9. Estimation of Nitrogen / ammonia colorimetric method
10. Estimation of Hemoglobin Sahli's method
11. Estimation of Calcium by colorimetric method

REFERENCES

Practical biochemistry by RC Gupta and S Bhargava by CBS publishers and distributors Pvt Ltd

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SEMESTER -V

VOCATIONAL-I

COURSE TITLE : BASICS IN MOLECULAR BIOLOGY	**COURSE CREDITS : 3**
TOTAL CONTACT HOURS: 4 2	**DURATION OF ESA: 02 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course outcome

The objective of the course is to introduce to the students, the basic concepts of genome, DNA structure, genes, chromatin and chromosomes. It provides comprehensive understanding of DNA replication, recombination, mutations and repair processes in a way that students can apply this knowledge in understanding the life processes and develop an interest to pursue high quality research.

BASICS IN MOLECULAR BIOLOGY

UNIT I

1. DNA & RNA **14 HOURS**

Nucleic Acids: Isolation of DNA from tissue sample. Chargaff's rule. Watson and Crick model of DNA, Circular DNA, hyperchromicity, T_m & Cot curve. RNA**:** Isolation of total cellular RNA. Secondary structures of tRNA- clover leaf model, Ribozymes. Chromosomes: Circular & linear chromosomes, structure of eukaryotic chromosome and nucleosome.

2. DNA REPLICATION

Central dogma of molecular biology and its modification (reverse transcription).DNA as genetic material- Griffith, *Avery*–MacLeod–*McCart*y & Hershey Chase experiment. DNA replication**:** Meselson and Stahl experiment. Over view of DNA replication- Semi conservative mechanism, replication fork, Okazaki fragments. Mechanism of replication in prokaryotes and special features of eukaryotic replication. Transcription**:** Prokaryotic

RNA synthesis: Role of RNA polymerase, promoters, initiation, elongation and termination of RNA synthesis. Reverse transcription, outlines of mRNA splicing, characteristics of eukaryotic pre-mRNA (introns & exons) and mature mRNA - 5'cap, poly A tail.

UNIT II

3. GENETIC CODE & TRANSLATION **14 HOURS**

General features of genetic code, deciphering genetic code. Wobble hypothesis. Ribosome structure, A- & P- sites, activation of amino acids, aminoacyl tRNA synthesis & its role in decreasing the translational errors. Translational initiation, elongation and termination in prokaryotes. Special features of eukaryotic translation & post translational modification in eukaryotes- glycosylation. Antibiotics as translation inhibitors (Eg: Tetracycline, puromycin & chloramphenicol)

UNIT III

4. REGULATION OF GENE EXPRESSION & MUTATION **14 HOURS**

Concept of Operon, Lac operon and catabolite repression. Molecular basis of mutation and types of mutations- Eg: Transition, Transversion, frame shift, insertion, deletion, germinal & somatic, dominant & recessive mutations, spontaneous & induced mutations. Mutagens -effect of HNO_2, Alkylating agents, interchelating agents and UV-radiation.DNA repair- UV repair systems in *E. coli*, Significance of thymine in DNA. DNA recombination mechanism**:** Mechanism in prokaryotes - Homologous and non homologous types (Holliday model). Mechanisms of Gene transfer in bacteria - conjugation, transformation and transduction.

References:

1 Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN: 0-321-50781 / ISBN: 978-0-321-50781-5.

2 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.

3 Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN: 978-0-470-39842-5.

4 Molecular Biology-Instant notes. P.C. Tumer, A.G. McLennan, A.D. Bates and M.R.H. White, 2001. Viva Books Pvt. Ltd., New Delhi.

5 Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4641-0962-1. 2.