St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC with 'A' Grade with CGPA 3.62/4
Recognised by UGC as "College with Potential for Excellence"
Conferred "College with "STAR STATUS" by DBT, Government of India.
Centre for Research Capacity Building under UGC-STRIDE

Course structure and syllabus of

B.Sc. BIOCHEMISTRY (HONOUR'S)

NEP SCHEME-2021 0NWARDS

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು (ಸ್ವಾಯತ್ತ)
ಮಂಗಳೂರು– 575 003
www.staloysius.edu.in

ST ALOYSIUS COLLEGE(AUTONOMOUS)
MANGALURU – 575 003
Phone: 0824-2449700, 2449701
Fax: 0824-2449705
Email: principal@staloysius.edu.in

ESTD : 1880

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Date: 17-08-2022

NOTIFICATION

Sub: Syllabus of **B.Sc. BIOCHEMISTRY** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6.13 2021-22)
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No: 14
3. Office Notification dated 21-02-2022
4. Office Notification dated 17-08-2022

Pursuant to the above, the Syllabus of **B.Sc. BIOCHEMISTRY** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021 & 09-07-2022 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL

ST. ALOYSIUS COLLEGE MANGALURU 575 003 AUTONOMOUS

REGISTRAR

To:

1. The Chairman/Dean/HOD.
2. The Registrar Office
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Head of the Department
Biochemistry
St. Aloysius College
Mangalore-575003

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:

- Advanced Inorganic Chemistry: A comprehensive Text,1999, Cotton A and GeoffreyWilkinson, 6th edition , Wiley publication
- Inorganic Chemistry, 2014, Miessler GL , Paul Fischer PJ, and Tarr DA, 5th edition, PearsonPublication
- Inorganic Chemistry, 2004, Catherine E and Sharpe AG, ACS publication
- Inorganic Chemistry , 2015, Overton, Rourke , Weller , Armstrong and Hagerman ,Oxford Press
- Physical Chemistry: A molecular approach, 2019, Donald A, McQuarrie and Simon JD, Viva Books Publication.
- Physical 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 /Programoutcomes	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 (a)

COURSE TITLE : BIOCHEMISTRY OF MACROMOLECULES	**COURSE CREDITS : 04**
TOTAL CONTACT HOURS: 56	**DURATION OF ESA: 2.5 HOURS.**
Formative assessment marks: 40	**Summative assessment marks: 60**

Course Outcome:

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

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

UNIT I :

CARBOHYDRATES **14 HOURS**

Definition, empirical formulae, classification, biological importance.

Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, condensation – phenyl hydrazine, addition –HCN. Stereochemistry of monosaccharides, (+) and(-), D and L, epimers, anomers, and diastereoisomers. Elucidation of open chain structure of glucose, 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.

UNIT II

LIPIDS **14 HOURS**

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, hydrolysis.

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

Sphingolipids: Structure and importance of sphingomyelin.

Glycerosphingolipids: Importance of gangliosides and cerebrosides.

UNIT III :

AMINO ACIDS AND PROTEINS **14 HOURS**

Amino acids: Structure and classification of amino acids based on polarity. Reactions of the amino groups with Ninhydrin, Phenyl isothiocyante, Dansyl Chloride, Fluro dinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionic properties. pKa values, D & L notation.

Peptides: Peptide bond, structure and biological importance of glutathione, Valinomycin. Synthetic peptides- polyglutamic acid, polylysine.

Proteins: Classification of proteins based on solubility, structure and functions with examples. Forces that stabilise the structure of proteins, Primary structure of proteins,

methods of determining N- and C- terminal aminoacids, sequencing by Edman's degradation method. Secondary Structure – α helix. β-sheet, β-bend. Tertiary and quaternary structures- hemoglobin, denaturation and renaturation of proteins. Anfinsen's experiment.

UNIT IV :

NUCLEIC ACIDS **14HOURS**

Nucleic acids: Composition of DNA and RNA. Nucleosides and Nucleotides. Other functions of nucleotides – source of energy, component of coenzyme and second messengers. Chargaff's rule. Watson and Crick model of DNA. Nucleic acid chemistry- UV absorption, Effect of alkali and acid on DNA, Chemical reactions of RNA and DNA. Melting of DNA (Tm). Types of RNA (mRNA, tRNA and rRNA), Secondary structures 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; 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, Lubert Stryer, Freeman and company, 7th Edition, 2010.
6. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw Hill Education Lange ® 2018.
7. Biochemistry , Lubert Stryer 5th edition 2015

SEMESTER V

(a) PRACTICAL

COURSE TITLE	**QUALITATIVE ANALYSIS OF MACROMOLECULES**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
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

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- solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
5. Extraction of phosphatides from egg yolk
6. Nucleic acids by diphenylamine test, orcinol test

QUANTITATIVE ANALYSIS OF BIOMOLECULES

7. Estimation of glucose by Folin Wu method, GOD/POD method.
8. Determination of saponification value of fat/oil
9. Determination of acid value of fat/oil
10. Antioxidant Assay

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 (b)

COURSE TITLE	**HUMAN PHYSIOLOGY AND ENZYMOLOGY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**2.5 hours**
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						

PART-A

HUMAN PHYSIOLOGY

14 Hours

UNIT I:

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. Action potential & resting 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. 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, structure & functions of blood cells), blood clotting mechanism, Lymph and CSF.

Bone and Cartilage: Structure and types of bone and cartilage. Long bone – Composition, structure, growth & remodeling, factors affecting.

UNIT -II

14 Hours

Digestive System and GIT: Anatomy of GIT and accessory organs, Digestion, absorption & transport of carbohydrates, lipids and proteins. Role of various enzymes involved in digestive process.

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 & 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 hormonesbased on structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion. Membrane receptors and secondary messengers (cAMP, DAG, IP3, G- protein).

Part-B: ENZYMOLOGY

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. 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:

Michaelis-Menten equation, equilibrium constant – mono substrate reactions, relationship between initial velocity and substrate concentration, Factors affecting the rate of chemical reactions - enzyme concentration, substrate concentration- pH, temperature and metal ions. Line weaver- Burk plot. Determination of Vmax & Km from L-B plot and their significance, Kcat and turnover number.

Enzyme inhibition:

Reversible inhibition- competitive, uncompetitive, non-competitive with graphical representations using L-B plots, Evaluation of Km and Vmax in presence of inhibitor mixed and substrate. 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, CellBiology, 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, 5thedition, W.W. Norton & Company, 2019

SEMESTER V(b)

PRACTICAL

COURSE TITLE	**HUMAN PHYSIOLOGY AND ENZYMOLOGY**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
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, Identify 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 Rh factor of blood
3. Staining of human blood cells
4. Demonstration of differential WBC count using Haemocytometer
5. Separation of Serum and Plasma from Blood
6. Estimation of hemoglobin content in blood By Sahl's method
7. Determination of blood pressure
8. Understanding principle, working & handling of simple microscope
9. Examination of prokaryotic & eukaryotic cells
10. Simple Staining
11. Gram staining
12. Isolation of mitochondria from chicken liver
13. Demonstration of biosafety & sterilization techniques
14. Demonstration of preparation of culture media for bacterial cultivation

15. Demonstration of pure culture techniques – Streak, pour plate and serial dilution

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. Textbook of Practical Physiology , C.L. Ghai, Jaypee brother's medical publishers, New Delhi, 10th edition 2022
4. A Hand book of practical Microbiology, R. Saravanan , D. Dhachinamoorthi , CH. MM. Prasada Rao , 2019.

SEMESTER VI (a)

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.

Photosynthesis-Ultra structure of Chloroplast, photosynthetic pigments**,** photoreaction & Calvin cycle in brief review, cytochrome, phytochrome & Bacterial photosynthesis.

Mitochondrial electron transport: Electron transport chain & oxidative phosphorylation- structure of mitochondria, sequence of electron carriers, flow chart of transport of electrons from reducing potential to O_2. inhibitors of ETC, oxidative phosphorylation, uncouplers of oxidative phosphorylation, ATP synthase- structure, Hypothesis of ATP synthesis – Binding change mechanism.

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

Metabolism of Lipids **14 Hours**

Hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, Beta-oxidation of even numbered saturated fatty acids, Energetics of β-oxidation. Biosynthesis of even number saturated fatty acids (Scheme only). Significance & source of Ketone bodies and ketosis. Outline of Cholesterol biosynthesis & regulation.

UNIT-IV

Metabolism of Amino acids

General reactions of amino acid metabolism- transamination, oxidative deamination & decarboxylation, Urea cycle, flow chart of degradation & biosynthesis of amino acids, glucogenic & ketogenic amino acids.

Nucleic Acid metabolism: Degradation of nucleic acids, action of nucleases-DNase I and II, RNase

and phosphodiesterases. De novo biosynthetic pathways of purine and pyrimidine nucleotides. Conversion of ribonucleotides to deoxy ribonucleotides. Catabolism of purines and pyrimidines. Salvage pathways.

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; 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, Lubert Stryer, Freeman and company, 7th Edition, 2010.
6. Harper's Illustrated Biochemistry, Victor W Rodwell, et.al,31st edition, McGraw Hill Education Lange ® 2018.

SEMESTER VI

PRACTICAL

COURSE TITLE	**BIOENERGETICS AND METABOLISM**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**03**
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, Blood urea nitrogen is a measure of how well the kidneys are working.
- Learning the structural levels of Nucleic acids.

I : Experiments

1. Estimation of Pyruvate by DNPH method
2. Estimation of Urea
3. Estimation of Uric acid
4. Estimation of RNA by orcinol method
5. Estimation of creatinine
6. Estimation of amino acid by Ninhydrin method

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

SEMESTER VI

COURSE TITLE	**MOLECULAR BIOLOGY AND IMMUNOLOGY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**2.5**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

Will be able to explain:

- the concept of immunology, concepts of antigen and antibody
- the immune system cells , Discuss active immunity and passive immunity
- the cellular immune mechanism

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		

UNIT I

Introduction and DNA Replication **14 Hours**

History: Identification of DNA as genetic material- Experiments of Griffith, Hershey and Chase: Overview of structure of DNA.

Introduction to Molecular Biology: Chromosomal organization in prokaryotes and Eukaryotes; Gene and gene concept: cistron, muton, and recon. Central dogma of molecular biology and its modification,

Replication: Types of replication -Conservative, semi conservative and dispersive: Evidence for semi conservative replication- Messelson and Stahl experiment: Mechanism of semi conservative replication- Steps involved in replication, Enzymes and proteins involved in replication, outline of DNA replication in eukaryotes.

DNA damage-Mutation: Concept of mutation, Mutagens – chemical and physical, Molecular basis of mutation: spontaneous and induced mutations, effect of HNO_2, alkylating agents, intercalating agents and UV-radiation. Point mutations: Concept of missense, nonsense and frame shift mutations.

UNIT II

Transcription and Translation Regulation of gene expression **14 Hours**

Transcription: Types of RNA, RNA polymerases, promoters, enhancers, silencers, role of sigma factor, Structure of mRNA in prokaryotes, Mechanism- initiation, elongation and termination (Rho- dependent and independent), Overview of eukaryotic transcription, post transcriptional processing: capping, splicing and poly adenylation.

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. Outline of translation in eukaryotes.

Regulation of Gene expression

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

UNIT III

Over view and Nature of Antigen and Antibody **14 Hours**

Organs of the immune system: Anatomy and functions of lymphoid tissues, Cellular components of the immune system - Hematopoiesis, stem cells, 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 heavychains, Hyper-variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes.

UNIT IV

Innate immunity **14 Hours**

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 – B cell receptors (BCR), B-Cell maturation, Activation, Differentiation, generation of plasma cells and memory B cells.

Cell-mediated immunity: Structural organization of T cell-receptors, T-cell maturation, Activation,

Differentiation, Proliferation, B cell – T cell interaction, The germinal center reactions.

Transplantation: Types of transplants, Graft rejection, process of graft rejection-sensitization and effector stage, role of immunosuppressive agents in clinical situation.

REFERENCES:

1. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
2. Lubert Stryer. Biochemistry, 5th edition , 2006
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.
5. Molecular Biology - David Friefelder, Narosa Publication- house Pvt. Ltd. New Delhi,2020
6. A Textbook of Biochemistry: Molecular and Clinical Aspects S. Nagini . 2nd edition .Sci Tech Publ., Chennai, 2007
7. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012
8. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
9. Biochemistry , Lubert Stryer , W.H Freeman and Company Limited

SEMESTER VI

PRACTICAL

COURSE TITLE	MOLECLAR BIOLOGY AND IMMUNOLOGY
COURSE CREDITS	02
CONTACT HOURS	4 HOURS/WEEK
DURATION OF ESA	03
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 nucleic acids. They will be able to isolate and quantitate DNA and RNA from different sources and characterization.

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. Isolation of RNA from spinach leaves/any other source
3. Purity check by UV spectrophotometer (DNA and RNA ratio)
4. Isolation of plasmid from E. *coli*
5. Agarose gel electrophoresis of nucleic acids
6. DNA analysis by Restriction endonucleases
7. PCR

EXPERIMENTS: IMMUNOLOGY

1. Double immune Diffusion Test
2. Radial immune diffusion test
3. Antibiotic Sensitivity Test
4. WIDAL test
5. ELISA test/assay
6. Total leucocyte count
7. Differential leucocyte count

8. Preparation of Erythrocyte Ghost cell

REFERENCES :

1. Molecular Biology: A Laboratory Manual by by Ashwani Kumar S.K. Gakhar, Monika Miglani, 2019
2. Wilson And Walkers Principles And Techniques of Biochemistry And Molecular Biology 8th ed (Sae) by Hofmann, 1983
3. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology by J. Saxena, M. Baunthiyal, I. Ravi , 2015
4. Biochemical methods, S. Sadasivam , A. Manickam, 3rd Edition, New Age International Pvt Ltd, 2007
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6. A handbook of practical and clinical immunology , 2017 G.P Talwar and S.K Gupta
7. Practical Immunology ,2000, Frank C Hey, Publisher: John Wiley and Sons Ltd
8. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 201