JSS Mahavidyapeetha

JSS COLLEGE FOR WOMEN (AUTONOMOUS)

SARASWATHIPURAM, MYSORE-570 009

(AFFILIATED TO UNIVERSITY OF MYSORE & REACCREDITED BY NAAC WITH'A 'GRADE)

DEPARTMENT OF BIOCHEMISTRY

GRADUATE COURSE – NEP SCHEME

BIOCHEMISTRY SYLLABUS

III and IV Semester

LISTING OF COURSES III, IV, V & VI SEMESTER FOR THE FOUR YEAR UNDERGRADUATE PROGRAMME IN BIOCHEMISTRY

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Marks		
					T	P		IA	Exam	Total
III	DSC	BIOC5-T	BIO-ORGANIC CHEMISTRY	4	4		2	40	60	100
		BIOC6-P	BIO-ORGANIC CHEMISTRY	2		4	3	25	25	50
IV	DSC	BIOC7-T	ANALYTICAL BIOCHEMISTRY	4	4		2	40	60	100
		BIOC8-P	ANALYTICAL BIOCHEMISTRY	2		4	3	25	25	50
V	DSC	BIOC9-T	BIOCHEMISTRYOF BIOMOLECULES and NUTRITION	4	4		2	40	60	100
		BIOC10-P	QUALITATIVE ANALYSIS OF BIOMOLECULES and THEIR NUTRITIONAL ASPECTS	2		4	3	25	25	50
		BIOC11-T	HUMAN PHYSIOLOGY And ENZYMOLOGY	4	4		2	40	60	100
		BIOC12-P	HUMANPHYSIOLOGY and ENZYMOLOGY	2		4	3	25	25	50
V	DSC	BIOC13-T	METABOLISM WITH CLINICAL CORRELATIONS	4	4		2	40	60	100
		BIOC14-P	METABOLISM WITH CLINICAL CORRELATIONS	2		4	3	25	25	50
		BIOC15-T	MOLECLARBIOLOGY AND IMMUNOLOGY	4	4		2	40	60	100
		BIOC16-P	MOLECLARBIOLOGY AND IMMUNOLOGY	2		4	3	25	25	50

SEMESTER III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**03**
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

BIO-ORGANIC CHEMISTRY

UNIT 1: Reaction mechanisms and aliphatic hydrocarbons **14 hours**

Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage. Concept of inductive effect, mesomeric effect, resonance, and hyper conjugation. Classification of organic reactions (substitution, addition, elimination, and re-arrangement), with two examples for each. Concepts Reactive intermediates of the following – free radicals, carbo cations and carbanions, free radicals, carbines, nucleophiles and electrophiles (Formation and Stability).

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

UNIT 2: Mechanism of substitution, elimination, and addition reactions **14 hours**

S_N1 and S_N2 reactions on tetrahedral carbon, energy profile diagrams, Stereochemistry, factors affecting SN_2 and SN_1reactions. The Elimination reactions- E_2 reaction, Zaitsev rule, E_1 reaction. Stereochemistry of E_1 & E_2 reactions, E_2 & E_1 elimination from cyclic compounds. Substitution and Elimination reactions in Synthesis. Addition reactions - Aldehydes and Ketones - nucleophilic addition of acetals & ketals. Addition of Ammonia, primary amines, and other ammonia derivatives. Conjugate addition. Conjugation addition in alpha and beta unsaturated aldehydes and ketones 1, 2 and 1,4 addition.

UNIT 3: Mechanism of electrophilic aromatic substitution reactions **14 hours**

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

The reaction of the coenzymes.

Overall view of metabolism, thiamine pyrophosphate- structure and its role in decarboxylation of alpha- keto acids.

Biotin- structure and its role in carboxylation of some important biochemical reactions of carbohydrate and lipid metabolism.

Vit B_2 its role in rearrangement reactions.

Vit B_2 coenzymes its role in redox reactions with suitable examples.

UNIT 4: Bio-organic compounds **14 hours**

Alcohols: Classification, monohydric alcohols: examples, general and distinguishing reactions. Dihydric alcohols: glycols, Tri hydric alcohols: glycerol – synthesis from propene, properties and uses. Phenols: Classification, electronic interpretation of acidity of phenols, mechanism of Kolbe, Reimer– Tiemann and bromination reactions.

Hydroxy acids: Structure and properties: Lactic acid, Citric acid and Isocitric acid. Dicarboxylic acids: Maleic and Fumaric acid. Ketoacids: Pyruvic, α-Ketoglutaric, Oxaloacetic acid.

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

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

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

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

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

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

REFERENCES

1. 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
6. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, 1999
7. Reaction Mechanisms at a Glance, ed. M. Moloney, Blackwell Science 2000.

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER III

PRACTICALS III

COURSE TITLE	**BIO-ORGANIC CHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/Week**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course outcome:

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

Experiments:

I. Systematic qualitative analysis of organic compounds (6 practicals)

1. Urea	2. Aniline	3. Benzoic Acid
4. Salicylic acid	5. Benzaldehyde	6. Acetophenone
7. Chlorobenzene	8. Nitrobenzene	

II. Preparation of following organic compounds (2 practicals)

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

III. Extractions

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

REFERENCES:

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

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER IV

COURSE TITLE	**ANALYTICAL BIOCHEMISTRY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**56**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome: These topics will enable the students to

- Understand the concept of biological sample preparation
- Appreciate chemistry and application of analytical instruments.
- Get acquainted with care and maintenance of equipment and chemicals.
- Understand clinically relevant biochemical analysis of all biochemical components i.e., proteins, electrolytes, hormones etc.,
- Have basic knowledge of clinical and forensic analytical methods and their principles.

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

UNIT 1: Biological sample preparation and fractionation 14 hours

Introduction and objectives of ¨Bioanalysis and extraction of molecules from tissues and cells. Sample preparation types of sample living, postmortem extraction of macromolecules from tissues; liquid-liquid, liquid-solid and precipitation methods.

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

UNIT 2: Chromatography **14 hours**

General principles of chromatography, history of chromatography. Classification based on 1. physical way stationary and mobile phase are brought together- Planar and column chromatography, 2. based on types of mobile and/or liquid phase adsorption and partition- Gas chromatography and liquid chromatography. Based on stationary phase-thin layer chromatography, Paper chromatography - ascending, descending and circular, 2-D chromatography, Rf values.

Classification of chromatography based on separation: Principles, methodologies and applications of adsorption, partition, ion-exchange, gel-filtration hydrophobic chromatography and affinity-chromatography. Advanced chromatography- HPLC and FPLC, UPLC and GLC.

UNIT 3: Electrophoretic and Isotopic methods **14 hours**

Electrophoresis: General principle of electrophoresis, velocity of a charged molecule in the applied electric field,. Supporting media for electrophoresis; work of Tiselius, paper, agarose, polyacrylamide. Chemistry of polymerization of acrylamide gels, methodology and applications of native PAGE and SDS- PAGE, 2-D electrophoresis, Identification of proteins post electrophoresis- dyes and biological activities. Agarose gel and Pulse field electrophoresis, Applications of capillary electrophoresis and isoelectric focusing. Cellulose acetate electrophoresis. Principle and applications of immune- electrophoresis. Diagonal electrophoresis, Zymogram.

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

UNIT 4: Spectroscopic methods of bio-analysis **14 hours**

Spectroscopic methods: Wave particle duality of light, electromagnetic spectrum, transition in spectroscopy. Principle, design and application of UV-Vis spectrophotometer. Beer's law and its limitations, determination of molar absorption coefficient of molecules. Working principle and application of a colorimeter, flame photometer and Flurorescence and Phosphorescence fluorimeter. Principle and application of IR, and Raman, ESR and NMR spectroscopy.

REFERENCES:

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

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TESTS)	20
SEMINARS / CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER IV

PRACTICALS IV

COURSE TITLE	**ANALYTICAL BIOCHEMISTRY**
COURSE CREDITS	**02**
TOTAL CONTACT HOURS	**4 Hours/ Week**
DURATION OF ESA	**03**
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. Hematology: WBC Counting: TC and DC (2 Practical's)
2. Determination of packed cell volume/ hematocrit
3. Resolution of basic, acidic and aromatic amino acids by descending and circular paper chromatography.
4. Separation of plant pigments by Adsorption chromatography
5. Identification and resolution of pigments by thin layer chromatography.
6. Demonstration of Gel Filtration Chromatography
7. Recording the absorption spectrum of riboflavin
8. Colorimetric estimation of glucose by DNS method
9. Estimation of DNA by diphenylamine method
10. Electrophoretic separation of plasma proteins

REFERENCES:

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

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CONTINUOUS EVALUATION AND CLASS TEST	15
RECORD / VIVA VOCE	10
TOTAL	25

SEMESTER V
DSC–BIO C9

COURSE TITLE	**BIOCHEMISTRY OF BIOMOLECULES and NUTRITION**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**04**
FORMATIVE SSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:
The course provides fundamental insights on the types of Biomolecules ; and their unique structural features, 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 **15hours**

Definition, empirical formulae, Classification with examples (Haworth & cyclic structures). Biological importance.

Stereochemistry – Concept of + & -, D & L, epimers, anomers, diastereomers and mutarotation.

Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses (Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation – phenyl hydrazine, addition – HCN). Interconversion of aldoses and ketoses by chemical method. Ascending and descending series by chemical methods. Elucidation of open chain structure and ring structure of glucose. Conformation of glucose (only structures). Structure of galactose, mannose, ribose and fructose. Structure and biological importance of deoxy sugars (2'-deoxy-β-D- ribose), sugar acids (Glucuronic acids, Neuraminic acid & Muramic acid), amino sugars (Glucosamine & Galactosamine).

Disaccharides: Determination of nature of Glycosidic linkage of Sucrose and Lactose. structure and Biological Importance of Isomaltose, Trehalose and Maltose.

Polysaccharides:
Homopolysaccharides- Occurrence, Partial Structure & biological importance of storage & structural polysaccharides - Starch, Glycogen, Cellulose, Chitin, Pectin and Inulin.
Heteropolysaccharides- Hyaluronic acid, Chondroitin sulfate and Heparin.
Bacterial cell wall polysaccharides: Occurrence, Partial structure and biological importance

of Peptidoglycan & Teichoic acid.

Nutritional aspects of Carbohydrates:
Dietary sources of carbohydrates, dietary fibers (types,beneficial & adverse effects),protein sparing action, Glycemic index- importance with examples, lactose intolerance.

UNITII: Amino acids and Proteins 15hours

Amino acids: Structure and classification of amino acids based on polarity with examples. Zwitterionic properties. pKa values, D & L notation. Reactions of the amino groups with HNO_2, $LiAlH_4$. Ninhydrin, Phenyl isothiocyante, DANSYL Chloride, Flurodinitro benzene. Reaction of carboxyl group – Hydrazine.
Peptides: Peptide bond formation and structure , structure and biological importance of glutathione, Valinomycin. Synthetic peptides structure and biological importance of - polyglutamic acid, polylysine.

Proteins: Classification of proteins based on composition , structure and functions with examples. Forces that stabilise the structure of proteins,
Primary structure of proteins, methods of determining N- and C- terminal aminoacids, amino acid composition, sequencing by Edman's degradation method.
Secondary Structure – α helix, β-sheet, β- bend.
Tertiary Structure - Globular protein - Myoglobin and Fibrous protein - Collagen.
Quaternary structure -Hemoglobin.
Denaturation and Renaturation of proteins- Anfinsen's experiment.

Nutritional aspects of Proteins:
Dietary sources of proteins, Essential amino acids, nutritional classification, nutritive value of proteins- Protein Efficiency Ratio (PER) and biological value (BV). Nitrogen balance, mutual Supplementation of proteins. Protein energy malnutrition (PEM): Kwashiorkar and Marasmus

UNIT III: Lipids and Nucleic acids 15hours

Classification and biological role of lipids, fatty acids – nomenclature of saturated and unsaturated fatty acids.
Acylglycerols: Mono, di and triacylglycerols.
Chemical constants : Saponification, saponification value, iodine value, acid value and significance.
Physical and chemical properties - Hydrolysis, Hydrogenation and Rancidity.
Phosphoglycerides: Structure of lecithin (phosphatidylcholine), cephalins, phosphatidylinositol, plasmalogens, and cardiolipin. Biological role of phosphoglycerides.
Sphingolipids: Structure and importance of sphingomyelin.
Glycolipids:
Glycerosphingolipids: structure and importance of gangliosides and cerebrosides.
Prostaglandins: Types, structure of PGE2, PGI2, PGD2 and PGF2 Alpha. Biological roles of thromboxanes, leukotrienes, cys- eukotrienes and prostaglandins.
Plasma lipoproteins:Types and functions.

Nutritional aspects of Fats: Dietary sources of fats, visible and invisible fat, trans fats,

essential and omega fatty acids and their biological importance, role of DHA and EPA.

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.

UnitI V : Nutritional Biochemistry 15hours

Introduction: Concept of Nutrition, calorific value of foods and its determination (Bomb calorimeter). Respiratory quotient, Basal Metabolic Rate, factors affecting BMR. Specific dynamic action (SDA) of foods.

Vitamins: Biochemical functions and deficiency symptoms of Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Vit-B12and Vit - C. Fat soluble vitamins- A, D, E and K.

Mineral Metabolism: Physiological functions and deficiency disorders of Ca, P, Na, K, Cl, Mg, Fe, I

Antinutritional factors: Sources and harmful effects of anti-vitamins (Eg. Avidin, Dicoumarol), Natural toxicants (Eg. Lathyrus sativa) and adultrants (Eg. butter yellow, lead chromate).

REFERENCES

Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W.Pratt,4th Edition, John Wiley and Sons Inc, 2012
Lehninger-Principles of Biochemistry; D L Nelson and MMCox[Eds), 6th Edn. Macmillan Publications 2012
Biochemistry-the chemical reactions of living cells, David E Metzler, 2nd Edition, Elsevier Academic Press,
Fundamentals of Biochemistry, Jain, J.L, S.Chand publication 6th Edition, 2005.
Biochemistry,Jeremy M.Berg, JohnL. Tymoczko, LubertStryer, Freeman and company, 7th Edition, 2010.
Harper's Illustrated Biochemistry, Victor W Rodwell, et.al, 31st edition,McGrawHill Education Lange ® 2018.
Biochemistry, Lubert Stryer 5th edition 2015

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT/OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER V
DSC BIO -C10 PRACTICAL

COURSE TITLE	**QUALITATIVE ANALYSIS OF BIOMOLECULES and THEIR NUTRITIONAL ASPECTS**
COURSE CREDITS	**02**
CONTACT HOURS	**4HOURS/WEEK**
DURATION O FESA	**02**
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 Biomolecules. They will be able to qualitatively identify the presence of specific biomolecules when provided with solution of a mixture of biomolecules.

EXPERIMENTS:

1. **Carbohydrates:** monosaccharides (glucose, fructose, g) disaccarides (lactose, maltose, sucrose) Molisch Test, Iodine Test, Benedict'sTest, Barfoed'sTest, Seliwanoff's test, Bial's test, Fehling's Test, Picric Acid Test, OsazoneTest.

2. **Proteins:** Biuret Test, Ninhydrin Test, Precipitation reactions of proteins- Precipitation by salts (half-saturation test), precipitation by organic solvents, precipitation by acidic reagents, precipitation by heavy metal ion, precipitation by heat; colour reactions of proteins (gelatin and albumin) and any five amino acids Xanthoproteic test, Millon's Test, Sakaguchi Test, Hopkins- Cole Test, Lead acetate test, Sullivan and McCarthy's Test, Isatin Test, Pauly's Diazo Test.

3. **Lipids:** solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
4. **Nucleic acids:** diphenyl amine test, orcinol test
5. Estimation of amino acid by formal titration.
6. Nutrition experiments (Extractions and detection from natural sources, detection of food adulterants).
   Extraction and estimation of iron from drumstick.
   Extraction and estimation of vitamin C from lemon or gooseberry

REFERENCES:

Practical Biochemistry,Geetha Damodaran, Jaypee, 2011
Biochemical methods, S.Sadasivam, A.Manickam, 3rdEdition, NewAge International Pvt Ltd, 2007
An Introduction to Practical Biochemistry, David Plummer,3rd edition 2017
Laboratory manual in Biochemistry, J.Jayaraman 2011

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
RECORD/ VIVA VOCE	**10**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
TOTAL	**25**

SEMESTER V DSC BIO C11

COURSE TITLE	**HUMAN PHYSIOLOGY and ENZYMOLOGY**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course Outcome:
Physiology involves the study of how living systems functions at 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, expressing enzyme activity, enzyme Units, Specific activity etc.

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: HUMANPHYSIOLOGY

UNIT I : **15hours**

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: mechanism of respiration (pulmonary ventilation), gas exchange mechanism, biochemical events in the transport of gases & factors affecting, role of lungs in acid-base balance.

Cardio-vascular system: Blood vessels – types. Cardiac cycle, cardiac output, blood pressure, heart rate, ECG.

Body fluids – blood (composition, structure & functions of blood cells), blood clotting mechanism, Lymph and CSF.

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

UNIT II : **15hours**

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

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

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

Excretory System: Structure of Nephron. Formation of urine- Physiology of glomerular filtration and GFR, Tubular processing of the glomerular filtrate. Role of kidney in acid base balance

Endocrine System: Classification of hormones. Mechanism of action of hormones –Peptide hormones (water soluble)-second messenger concept (cAMP, cGMP, IP_3, DAG and Ca^{2+}). Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion.

Part-B: ENZYMOLOGY

UNIT III: **15hours**

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

Features of enzyme catalysis –transition state theory, reaction rates and thermodynamics of reaction & Catalytic power.
Specificity of enzymes – Group, Optical, substrate and reaction specificity.
Concept of Active site - Salient features.
Mechanism of interaction- Lock and Key theory and Induced fit model.

UNIT IV: **15 Hours**

Enzyme kinetics
Factors affecting enzyme activity- Substrate concentration - Michaelis- Menton equation (No derivation), Lineweaver-Burk plot-determination of Km & Vmax and their significance. pH, temperature, activators and inhibitors.

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 fromL-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:

Chatterjee C C, Human physiology, Medical allied gency. NewDelhi2020
Gerard Tortora, Bryan H Derrickson. Principles of anatomy and physiology, 13th edition, John Wiley & Sons 2000
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Devlin,Thomas M.Textbook of biochemistry :with clinical correlations. John Wiley & Sons, 2011.

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT /OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER V
DSC BIO C12: PRACTICAL

COURSETITLE	**HUMAN PHYSIOLOGY AND ENZYMOLOGY**
COURSE CREDITS	**02**
CONTACT HOURS	**4 HOURS/WEEK**
DURATION OF ESA	**02**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

Course Outcome:
At completion of this course, students are expected to gain concepts of assessing the human physiology using biological fluid and it is expected that the students will be able to understand measurement of few physiological parameters of various systems and their interrelations. Students will also be exposed to fundamental aspects of enzymology such as measuring enzyme activity, determining optimum parameters of enzymes etc.

EXPERIMENTS: HUMAN PHYSIOLOGY

1. Determination of ABO blood grouping
2. Enumeration of WBC count using Haemocytometer
3. Separation of Serum and Plasma from Blood
4. Estimation of hemoglobin content in blood
5. Examination of prokaryotic & eukaryotic cells
6. Study of different stages of mitosis & meiosis in onion root tip- squash preparation method.

EXPERIMENTS: ENZYMOLOGY

1. Salivary amylase/β-amylase
2. Construction of Maltose/ glucose calibration curve by DNS method and determination of activity of amylase
3. Determination of specific activity of amylase
4. Determination of pH optimum of amylase.
5. Determination of Km and Vmax of amylase.
6. Determination of initial velocity [time kinetics]of amylase.
7. Determination of optimum temperature of amylase.
8. Determination of titrable acidity and ammonia in urine.

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- Text book of Medical Physiology-C,Guyton and John .E. Hall. Miamisburg, O H, U.S.A, 12th edition 2011
- Textbook of Practical Physiology, C.L.Ghai, Jaypee brother's medical publishers, New Delhi, 10th edition 2022
- A Handbook of practical Microbiology, R.Saravanan, D.Dhachina moorthi, CH. MM.PrasadaRao,2019
- Essentials of Medical Physiology, K.Sembulingam and P.Sembulingam. Jaypee brothers medical publishers, New Delhi., 2019
- An introductionto Practical Biochemistry, David Plummer,3rd edition 2017
- Laboratory manual in Biochemistry, Jayaraman J, New Age International publications, 2011
- Practical Manual of Biochemistry, Sattanathan G.,Swaminathan P. and Balasubramanian B. Sky fox press, 2020
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PEDAGOGY: MOOC / DESK WORK /BOOK CHAPTER / PROBLEM SOLVING/ ASSIGNMENT

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
RECORD/VIVA VOCE	**10**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
TOTAL	**25**

SEMESTER VI
DSC BIO - C13

COURSE TITLE	**METABOLISM WITH CLINICAL CORRELATIONS**
COURSE CREDITS	**04**
TOTAL CONTACT HOURS	**60**
DURATION OF ESA	**04**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

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 : **15 hours**

Bioenergetics: Laws of thermodynamics, free energy change, equilibrium constant, energy charge, ATP cycle, phosphorylation potential,and phosphoryl group transfers.Chemical basis of high standard energy of hydrolysis of ATP.

Oxidative phosphorylation: Proton gradient generation, redox loop, Q cycle, Proton pumping. The electron transport chain. Peter-Mitchell ChemiOsmotic hypothesis. osmotic hypotheisis – proton motive force, Fo-F1 ATP synthase - structure and mechanism of ATP synthesis.

UNIT II : **15 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.

Disorders of Carbohydrate metabolism – Glycogen storage diseases and Diabetes Mellitus.

UNIT III: **15hours**

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

Metabolism. Disorders of lipid metabolism – Tay-Sach`s disease, Niemann-Pick disease.

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

Disorders of purine and pyrimidine metabolism: Gout, Lesch-Nyhan syndrome

UNIT IV: **15hours**

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

Disorders of amino acid metabolism: Phenyl ketonuria, Alkaptonuria, Maple syrup urine disease.

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

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT/OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER VI
DSC BIO–C14: PRACTICAL

COURSE TITLE	**METABOLISM WITH CLINICAL CORRELATIONS**
COURSE CREDITS	**02**
CONTACT HOURS	**4HOURS / WEEK**
DURATION OF ESA	**02**
FORMATIVE ASSESSMENT MARKS	**25**
SUMMATIVE ASSESSMENT MARKS	**25**

I : Experiments

1. Estimation of Blood glucose
2. Estimation of Urea
3. Estimation of Uricacid
4. Estimation of creatinine
5. Estimation of cholesterol
6. Qualitative analysis of urine for
7. urea, uricacid, creatinine and aminoacids. Chlorides, sulphates, phosphates and ammonia.
8. Abnormal constituents such as glucose, albumin, bile pigments, bile salts and ketone bodies.
9. Liver function test-Assay of SGOT, SGPT and alkaline phosphates.

II :Report:

Visit to scientific / research institute /Clinical laboratory-Tour report.

OR

Submission of assignment on recent trends in biochemistry

REFERENCES:

Practical Biochemistry, Geetha Damodaran, Jaypee, 2011
Biochemical methods, S.Sadasivam, A.Manickam, 3rd Edition, NewAge International Pvt Ltd, 2007
An Introduction to Practical Biochemistry, DavidPlummer, 3rd edition 2017
Laboratory manual in Biochemistry, J.Jayaraman 2011.

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
RECORD/VIVA VOCE	**10**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
TOTAL	**25**

SEMESTER VI
DSC BIO–C15

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

Course outcome:

Will be able to explain:
Concepts of central dogma of molecular biology spanning from DNA Replication till Protein Synthesis and Reverse transcription, mutations, DNA repair mechanism.
Defines the concept of immunology, concepts ofantigen and antibody
Explain immune system cells,Discuss activeimmunity and passive immunity
Explain the cellular immune mechanism
The students will learn about plasmids, vectors and gain knowledge on the construction of cDNA libraries
Student of this course have knowledge on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering.

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

MOLECULAR BIOLOGY
UNIT I:
15hours

DNA Replication and Mutation
History: Identification of DNA as genetic material- Experiments of Griffith, Hershey and Chase: Watson and Crick model of DNA. Central dogma of molecular biology and its modification

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

Mutation: Concept of mutation, Mutagens – chemical and physical, Molecular basis of mutation. spontaneous and induced mutations, effect of HNO2, alkylating agents, intercalating agents and UV- radiation. Point mutations: Concept of missense, nonsense and frame shift mutations.

UNIT II: **15hours**

Transcription, Genetic code, Translation and Regulation of gene expression
Transcription: Types of RNA, structure of RNA polymerases, promoters, enhancers, silencers, role of sigma factor, Structure of mRNA in prokaryotes, Mechanism- initiation, elongation and termination (Rho- dependent and independent), post transcriptional modification - 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.

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: **15hours**

GENETIC ENGINEERING
Historical development, Aim and scope of genetic engineering.

Isolation of DNA Cutting of DNA by restriction endonucleases–staggered cut and blunt end.
Outline of techniques of genetic engineering: Cutting genomic DNA, Separationof fragments by agarose gel electrophoresis. Vectors, plasmids-PBR322,insertion of Foreign DNA into Vectors.Transfections of vectors into host cells. cDNA(brief discussion), principles of polymerase chain reaction (PCR) and applications.
Blotting techniques: Principle of Southern,Northern blotting and Western blotting.
Applications of Genetic engineering.
Transgenic plants,transgenic animals and gene therapy.
Human genome project.

IMMUNOLOGY
UNIT IV: **15hours**
Immunity: Cellular and humoral immunity, cellular basis of immunity. Role of immunologically important organs and cells- bonemarrow, thymus, spleen and lymphocytes. Formation and functions of T & B Lymphocytes and macrophages. Helper T-cells and killerT-cells.
Antigens: Definition, Haptens, Epitopes, antigens and antigenicity.
Antibodies: Definition, types and their functions. Structure of a typical Immunoglobulin (lgG-Lightchain, heavychain, hyper-variable region, constant domains, Fab and Fc regions).
Immunization: Vaccination-Vaccines and their preparations, primary and secondary response.
Immunological disorders: Allergy (hypersensitivityreactions), AIDS.
Immunological techniques: Precipitation reaction, Immuno diffusion, RIA & ELISA

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- Cox, Michael M.Lehninger principles of biochemistry. Freeman, 2013.

- LubertStryer.Biochemistry,5thedition,2006
- Owen, Judith A., Jenni Punt, and Sharon A. Stranford. Kuby immunology. New York: WH Freeman, 2013.
- Delves,PeterJ.,Seamus J. Martin,Dennis R.Burton,andIvanM. Roitt. & Roitt's essential immunology. Vol. 20. John Wiley & Sons, 2011.
- Molecular Biology –David Friefelder,Narosa Publication-housePvt.Ltd.New Delhi,2020
- A Textbook of Biochemistry: Molecular and Clinical Aspects S. Nagini . 2nd edition . SciTech Publ., Chennai, 2007
- Principles of Biochemistry, Donald Voet, JudithG Voet,Charlotte W. Pratt,4th Edition, John Wiley and Sons Inc, 2012
- Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
- Biochemistry, Lubert Stryer, W.H Freeman and Company Limited
- T.A.Brown, Gene cloning: An introduction, Chapman and Hall,1995.

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

Formative Assessment	
ASSESSMENT OCCASION	**WEIGHTAGE IN MARKS**
CLASS TEST (2 CLASS TEST)	**20**
SEMINARS/CLASS WORK	**10**
ASSIGNMENT/OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER VI
DSC BIO–C 16: PRACTICAL

COURSETITLE	**MOLECULAR BIOLOGY AND IMMUNOLOGY**
COURSECREDITS	**02**
CONTACTHOURS	**4HOURS/WEEK**
DURATIONOFESA	**02**
FORMATIVEASSESSMENT MARKS	**25**
SUMMATIVEASSESSMENT 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 quantitative 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
Analytica lSkill	x				x	x				x		

EXPERIMENTS: MOLECULARBIOLOGY

1. Isolation of DNA from banana /endosperm of coconut /bacteria /any other source
2. Isolation of RNA from spinach leaves/ any other source
3. Determination of DNA
4. Determination of RNA
5. Visualization of DNA by agarose gel electrophoresis.(Demo)
6. Demonstration of Western blotting technique. (2 practical
7. Demonstration of DOT ELISA and sandwich ELISA
8. Immuno diffusion technique – ODD
9. Photographic identification of IgGs,
10. Radialimmune diffusion test,