

Bangalore University
Department of Biochemistry
Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
V and VI Semester
B.Sc. Degree
Biochemistry as one of the Two Major subjects
Double Major Model

Framed according to the
National Education Policy
Karnataka State Higher Education Council
Bangalore 560001

August 24, 2023

BANGALORE UNIVERSITY
PROCEEDINGS OF THE MEETING OF THE UG-BOARD OF STUDIES (UG-BOS) IN
BIOCHEMISTRY HELD ON 24TH AUGUST 2023 AT 11.00AM IN THE CHAMBER OF THE
CHAIRMAN, DEPARTMENT OF BIOCHEMISTRY, JB CAMPUS, BANGALORE UNIVERSITY,
BENGALURU-560056

BOS Members

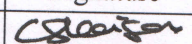
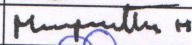
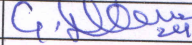
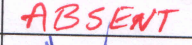
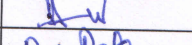

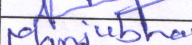
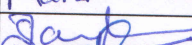

No.	Designation/College/University	UG-BOS
1	Prof. C. S. Karigar, Chairman, Dept. of Biochemistry, Bangalore University, Bangalore 560056	Chairman
2	Prof. Manjunatha H, Dept. of Biochemistry, Bangalore University, Bangalore-560056	Member (Co-Opted)
3	Dr. Dhanalakshmi, Assistant Professor, Dept. of Biochemistry, Padmashree Institute of Management and Sciences, Kommaghatta, Sulikere post, Kengeri, Bengaluru-560060	Member
4	Dr. Umesh H. R., Assistant Professor, Dept. of Biochemistry, The oxford College of Science, 32, 17 th b Main, Sector IV, HSR Layout, Bengaluru-560102	Member
5	Smt. Madhukala K. L., Assistant Professor, Dept. of Biochemistry, Acharya Institute of Management and Sciences, Andarahalli, Bengaluru- 560091	Member
6	Smt. Deepa Kumari, Assistant Professor, Dept. of Biochemistry, The oxford College of Science, 32, 17 th b Main, Sector IV, HSR Layout, Bengaluru-560102	Member
7	Smt. Vatsalya Krupa, Assistant Professor, Dept. of Biochemistry, The oxford College of Science, 32, 17 th B Main, Sector IV, HSR Layout, Bengaluru-560102	Member
8	Smt. Manju Bhargavi O. J., Assistant Professor, Dept. of Biochemistry, Padmashree Institute of Management and Sciences, Kommaghatta, Sulikere post, Kengeri, Bengaluru-560060	Member
9	Dr. Jayashree S., Professor, Dept. of Biochemistry, Reva University, Rukmini Knowledge Park, Kattgenahalli, Yelahanka, Bengaluru 560064	Member
10	Smt. Vidya A. S., Professor, Department of Biochemistry, Sheshadripuram FGC, Yelahanka, Bengaluru 560064	Member

The Chairman extended warm welcome to the members of the BOS and briefed about NEP BSc V and VI semester syllabus. Chairman being member of the state level committee (KSHEC Committee) explained the members on structuring of the V and VI semester syllabus on NEP framework.

Resolutions:

1. The BOS resolved to adopt the V and VI semester syllabus submitted to KSHEC in total with minor modifications.
 2. Paper VI for V semester DSC BIO C11-Human Physiology and Enzymology.
 3. Paper VIII for VI semester DSC BO C13- Molecular biology and Immunology
- Clubbing of papers as suggested by BOS members. Accepted and approved by Chairperson.

The following members attended the meeting

No.	Name	Designation	UG-BOS	Signature
1	Dr. C. S. Karigar,	Professor & Chairman	Chairman	
2	Prof. Manjunatha H.	Professor	Member (Co-Opted)	
3	Dr. Dhanalakshmi.	Assistant Professor	Member	
4	Dr. Umesh H. R.	Assistant Professor	Member	ABSENT
5	Smt. Madhukala K. L.	Assistant Professor	Member	
6	Smt. Deepa Kumari	Assistant Professor	Member	
7	Smt. Vatsalya Krupa	Assistant Professor	Member	
8	Smt. Manju Bhargavi O. J.	Assistant Professor	Member	
9	Dr. Jayashree S.	Professor	Member	
10	Smt. Vidya A. S.	Professor	Member	

Meeting concluded with vote of thanks by the chair.

 24/8/2023
Prof. C.S. KARIGAR
CHAIRMAN
 Dept. of Biochemistry
 Bangalore University
 Bengaluru - 560 056, India

**LISTING OF COURSES V and VI SEMESTER FOR THE FOUR YEAR
UNDER-GRATUE 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
V	DSC	BIO C9-T	BIOCHEMISTRY OF MACROMOLECULES	4	4		2	40	60	100
		BIO C10-P	QUALITATIVE ANALYSIS OF MACROMOLECULES	2		4	3	25	25	50
		BIO C11-T	HUMAN PHYSIOLOGY AND ENZYMOLOGY	4	4		2	40	60	100
		BIO C12-P	HUMAN PHYSIOLOGY AND ENZYMOLOGY	2		4	3	25	25	50
VI	DSC	BIO C13-T	BIOENERGETICS AND METABOLISM	4	4		2	40	60	100
		BIO C14-P	BIOENERGETICS AND METABOLISM	2		4	3	25	25	50
		BIO C15-T	MOLECULAR BIOLOGY AND IMMUNOLOGY	4	4		2	40	60	100
		BIO C16-P	MOLECULAR BIOLOGY AND IMMUNOLOGY	2		4	3	25	25	50

SEMESTER V

DSC – BIO C9

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

Course Outcome:

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

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

15 hours

Definition, empirical formulae, classification, biological importance.

Monosaccharides: Configuration relationship of D-aldoses, D-ketoses. General properties of aldoses and ketoses. Oxidation, reduction, reducing property, formation of glycosides, acylation, methylation, condensation – phenyl hydrazine, addition – HCN. Interconversion of aldoses and ketoses by chemical method. Ascending and descending series by chemical methods. Stereochemistry of monosaccharides, (+) and (-), D and L, epimers, anomers, and diastereoisomers. Elucidation of open chain structure and ring structure of glucose. Conformation of glucose (only structures), mutarotation. Structure of galactose, mannose, ribose and fructose. Structure and biological importance of deoxy sugars and sugar acids.

Disaccharides: Establishment of structures of Sucrose and Lactose, Biological Importance and structure of Isomaltose, Trehalose and Maltose.

Polysaccharides: Partial structure, occurrence and importance of Starch, Glycogen, Inulin, Cellulose, Chitin, and Pectin.

Glycosaminoglycans: Structure of amino sugars, neuraminic and muramic acid. Occurrence, importance and the structure of the repeating units of heparin, hyaluronic acid, teichoic acid and chondroitin sulphate. Bacterial cell wall polysaccharide, peptidoglycans.

UNIT II: Lipids

15 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.

Glycosphingolipids: Composition and importance of gangliosides and cerebroside.

Prostaglandins: Types, structure of PGE₂, PGI₂, PGD₂ and PGF₂ Alpha. Biological roles of thromboxanes, leukotrienes and prostaglandins.

Plasma lipoproteins: Types and functions.

UNIT III: Amino acids and Proteins

15 hours

Amino acids: Structure and classification of amino acids based on polarity. Reactions of the amino groups with HNO₂, LiAlH₄. Ninhydrin, Phenyl isothiocyanate, DANSYL Chloride, Fluorodinitro benzene. Reaction of carboxyl group – Hydrazine. Zwitterionic properties. pK_a 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, amino acid composition, 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**15 hours**

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 (T_m). 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

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 - C 10 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 :

1. **Carbohydrates:** mono saccharides (glucose, fructose, galactose) disaccharides (lactose, maltose, sucrose) and polysaccharides (starch, glycogen), ribose, deoxy ribose- Molisch Test, Iodine Test, Benedict's Test, Barfoed's Test, Seliwanoff's test, Bial's test, DPA Test, Tollen's Test, Fehling's Test, Picric Acid Test, Osazone Test.
2. **Proteins:** Biuret Test, Ninhydrin Test, Precipitation reactions of proteins- Precipitation by salts (half-saturation test), precipitation by organic solvents, precipitation by acidic reagents, precipitation by heavy metal ion, precipitation by heat; colour reactions of proteins (gelatin and albumin) and any five amino acids (tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine)- Xanthoproteic test, Millon's Test, Sakaguchi Test, Hopkins- Cole Test, Lead acetate test, Sullivan and McCarthy's Test, Isatin Test, Pauly's Diazo Test.
3. **Lipids:** solubility, acrolein test, Salkowski test, Lieberman-Burchard test.
4. **Nucleic acids:** diphenylamine test, orcinol test

REFERENCES :

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

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

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	03
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

UNIT I:

15 hours

- Basic body plan in humans & Location of organs.

Nervous System: Brief outline of nervous system, Neurons – types, structure of multipolar neuron, mechanism of nerve impulse transmission- along axon, across synapse. 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.
- **Muscular System:** Types of muscles and their structure. Ultrastructure of skeletal muscle. Contractile & regulatory proteins of muscle. Sliding filament model of skeletal muscle contraction.

UNIT II:

15 hours

- **Bone and Cartilage:** Structure and types of bone and cartilage. Long bone – Composition, structure, growth & remodeling, factors affecting.
- **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 hormones based on structure and site of production. Physiological role of hormones of hypothalamus, pituitary, adrenal, thyroid, pancreas and gonads. Regulation of their secretion.

Part-B: ENZYMOLOGY

UNIT III:

15 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:

15 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. Lineweaver- Burk plot. Determination of V_{max} & K_m from L-B plot and their significance, K_{cat} and turnover number.

Reversible inhibition- competitive, uncompetitive, non-competitive with graphical representations using L-B plots, Evaluation of K_m and V_{max} 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, Cell Biology, 3rd edition, Elsevier 2017

6. Lodish, Berk, Kaiser, Krieger et al, Molecular Cell Biology, 6th edition, 2010
7. Bruce Alberts, Hopkin, Johnson Morgan, Raff, Roberts, and Walter, Essential Cell Biology, 5th edition, W.W. Norton & Company, 2019
8. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
9. Lubert Stryer. Biochemistry, 5th edition , 2006
10. Palmer, Understanding enzymes, 4th edition, Prentice Hall/Ellis Horward, Landon 2000
11. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2010
12. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
13. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of Biochemistry." New York: John Wiley & Sons 2008.
14. 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 (2 CLASS TEST)	20
SEMINARS/CLASS WORK	10
ASSIGNMENT/ OPEN DISCUSSION	10
TOTAL	40

SEMESTER V

DSC BIO C 12: 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 : HUMAN PHYSIOLOGY

1. Determination of ABO blood grouping
2. Determination of Blood clotting time
3. Enumeration of RBC and WBC count using Haemocytometer
4. Separation of Serum and Plasma from Blood
5. Estimation of haemoglobin content in blood
6. Study of pulmonary function test using spirometer
7. Determination of blood pressure
8. Understanding principle, working & handling of simple microscope
9. Examination of prokaryotic & eukaryotic cells
10. Study of different stages of mitosis & meiosis in onion root tip - squash preparation method
11. Gram staining
12. Demonstration of biosafety & sterilization techniques
13. Demonstration of preparation of culture media for bacterial cultivation
14. Demonstration of pure culture techniques – Streak, pour plate and serial dilution

EXPERIMENTS: ENZYMOLOGY

1. Isolation of Urease and demonstration of its activity.
2. Isolation of Acid phosphatase and demonstration of its activity.
3. Salivary amylase/ β -amylase
 - a) Construction of Maltose/glucose calibration curve by DNS method and determination of activity of amylase
 - b) Determination of specific activity of amylase
 - c) Determination of pH optimum of amylase.
 - d) Determination of K_m and V_{max} of amylase.
 - e) Determination of initial velocity [time kinetics] of amylase.
 - f) Determination of optimum temperature of amylase.
 - g) Effect of sodium chloride on amylase.
4. Determination of activity of yeast invertase.

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
5. Essentials of Medical Physiology, K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi., 2019
6. Text book of Medical Physiology- C, Guyton and John.E. Hall. Miamisburg, OH, U.S.A, 12th edition 2011
7. Textbook of Practical Physiology, C.L. Ghai, Jaypee brother's medical publishers, New Delhi, 10th edition 2022
8. A Hand book of practical Microbiology, R. Saravanan, D. Dhachinamoorthi, CH. MM. Prasada Rao, 2019
9. An introduction to Practical Biochemistry, David Plummer, 3rd edition 2017
10. Laboratory manual in Biochemistry, Jayaraman J, New Age International publications, 2011
11. Practical Manual of Biochemistry, Sattanathan G., Swaminathan P. and Balasubramanian B. Sky fox press, 2020
12. Practical manual of Biochemistry, S.P Singh, 7th edition, CBS publications, 2013.
13. Sawhney, S. K., and Randhir Singh. Introductory practical biochemistry. Alpha Science Int'l Ltd., 2000.

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	BIOENERGETICS AND METABOLISM
COURSE CREDITS	04
TOTAL CONTACT HOURS	60
DURATION OF ESA	03
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 :

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's Chemiosmotic hypothesis and 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.

UNIT III:**15 hours**

Metabolism of Lipids:

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

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

UNIT IV:**15 hours**

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

REFERENCES

1. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, 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.

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 14: 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, and glucose, which indicates whether there is a normal amount of sugar in the blood. Blood urea nitrogen is a measure of how well the kidneys are working.
- Learning the structural levels of Nucleic acids.

I : Experiments

1. Estimation of Blood glucose
2. Assay of Digestive enzyme (Salivary amylase)
3. Estimation of Urea
4. Estimation of Uric acid
5. Estimation of DNA and RNA
6. Estimation of creatinine
7. Estimation of cholesterol

II : Report:

Visit to scientific/research institute – Tour report.

OR

Submission of assignment on recent trends in biochemistry

REFERENCES:

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

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

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	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course outcome:

Will be able to explain:

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

15 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 HNO₂, 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 **15 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 **15 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 heavy chains, Hyper-variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes.

UNIT IV: Innate immunity**15 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.

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

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 20: 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. Determination of DNA
4. Determination of RNA
5. Purity check by UV spectrophotometer (DNA and RNA ratio)
6. Isolation of plasmid from *E. coli*
7. Agarose gel electrophoresis of nucleic acids
8. DNA analysis by Restriction endonucleases
9. Western blotting

I. EXPERIMENTS: IMMUNOLOGY

1. Counting and seeding of cells
2. Blood grouping
3. Hemagglutination inhibition test
4. WIDAL test
5. ELISA test/assay
6. Isolation of antibodies
7. Total leucocyte count
8. Differential leucocyte count
9. Radial immune diffusion test
10. Agglutination reactions
11. Serum electrophoresis

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
5. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
6. Laboratory manual in Biochemistry , J. Jayaraman 2011
7. A handbook of practical and clinical immunology , 2017 G.P Talwar and S.K Gupta
8. Practical Immunology ,2000, Frank C Hey, Publisher: John Wiley and Sons Ltd
9. An Introduction to Practical Biochemistry, David Plummer , 3rd edition 2017
10. 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