Model Curriculum Content for Semester V and VI

Biochemistry

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 diastreoisomers. 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.

Glycerosphingolipids: Composition and importance of gangliosides and cerebrosides. 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 HNO_2, $LiAlH_4$. Ninhydrin, Phenyl isothiocyante, DANSYL Chloride, Flurodinitro 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, 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 (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

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 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) disaccarides (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
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
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.

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

UNIT I : **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, emphesema.
- **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.

UNIT III : 15 hours

- **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.

General mechanism of hormone action in brief - peptide and steroid hormones. membrane receptors and secondary messengers (cAMP, DAG, IP3, G- protein). Signal transduction pathway for steroidal and non-steroidal hormones.

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

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 C12 : PRACTICAL

COURSE TITLE	HUMAN PHYSIOLOGY
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 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

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

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 – C13

COURSE TITLE	**MOLECULAR BIOLOGY – 1**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to the molecular mechanisms via which genetic information is stored, expressed and transmitted among generations.

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					X	X
Analytical Skill	x				x	x				X		

UNIT I : Introduction and 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- Meselson and Stahl experiment: Mechanism of semi conservative replication- Steps involved in replication, Enzymes and proteins involved in replication, outline of DNA replication in eukaryotes.

UNIT II : DNA damage, repair and mutation 15 hours

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair

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 III : Transcription, Translation and 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, reverse transcription.

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 :

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

REFERENCES:

1. Molecular Biology - David Friefelder, Narosa Publication- house Pvt. Ltd. New Delhi,2020
2. A Textbook of Biochemistry: Molecular and Clinical Aspects S. Nagini . 2nd edition . Sci Tech Publ., Chennai, 2007

3. Principles of Biochemistry, Donald Voet, Judith G Voet, Charlotte W. Pratt, 4th Edition, John Wiley and Sons Inc, 2012
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications 2012
5. Biochemistry , Lubert Stryer , W.H Freeman and Company Limited , 5th edition 2002

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 V

DSC BIO-C14 PRACTICAL

COURSE TITLE	MOLECULAR BIOLOGY – I
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.

EXPERIMENTS :

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

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

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

DSE BIO E -1

COURSE TITLE	MICROBIAL BIOCHEMISTRY
COURSE CREDITS	03
CONTACT HOURS	45
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course Outcome:

On successful completion of the course, students will be able to: Familiarize basic concepts in microscopy and sterilization procedures: Explain general characters of different groups of microbes and culturing media: Explain classification of microbes and Examine different methods for bacterial identification, growth and regulation.

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

UNIT I: **15 hours**

- Spontaneous generation (abiogenesis), Biogenesis, Germ Theory of Disease, Koch's Postulates, Scope of Microbiology. Microorganisms in biological world Whittaker's Five-kingdom and three-kingdom concept of living organisms (General characteristics of those groups); General features of Eubacteria and Archaebacteria (major difference within Eubacteria).
- Staining techniques and bacterial morphology and subcellular structures. Definition of auxochrome; Chromophores; Acidic and Basic dyes; Classification of stains; Simple and differential staining: theories of staining, Gram staining; acid fast staining; endospore staining; mechanism of gram staining.

- Morphology of bacteria: Cell wall, Ribosome, Cytoplasmic membrane; Cytoplasmic inclusion bodies - (inorganic, organic); Exospores & Cysts: types & structure; Endospore, Flagella, Pilus, Fimbriae (structure, composition and functions).

UNIT II : **15 hours**

- Microbial Nutrition: Nutritional types (definition and example) - Photoautotrophs, Photo organotrophs, Chemolithotrophs (ammonia, nitrite, sulfur, hydrogen, iron oxidizing bacteria); Chemo organotrophs, Effect of oxygen on growth - classification on the basis of oxygen requirement and tolerance.
- Bacterial Growth and its regulation: Growth phases - Generation time. Kinetics of growth, Batch culture. Continuous culture. Synchronous culture (definition and brief description). Physical factors influencing growth temperature. pH, osmotic pressure, salt concentration. Sterilization, disinfection, antiseptic, sanitizer, germicide, antimicrobial agent (definition, application & examples); physical method of disinfection and sterilization - dry heat, moist heat, filtration, radiation (mode of action, applications); Chemical control – dye solutions, alcohol, acid, alkali, halogen, heavy metal, phenol, phenol derivatives, formaldehyde, ethylene oxide, detergents (mode of action, applications).

UNIT III **15 hours**

- Chemotherapeutic agents - sulphonamides, antibiotics, (definition types); mechanism of action and antimicrobial spectrum of penicillin, streptomycin, tetracycline, chloramphenicol, Nalidixic acid and metronidazole; drug resistance - phenomena and mechanism.

REFERENCES

1. Prescott L.M. Harley J.P. and Klein D.A. Microbiology (5th edition) McGraw Hill, New York. 2008
2. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. . Microbiology, Mc. Graw Hill. Inc, NewYork.2006

3. Salle, A.J. Fundamental principles of Bacteriology.(7thedition).Tata McGraw-Hill publishing company Ltd, New Delhi. 1996
4. Stainer, Ingharam, Wheelis and Painter. General Microbiology. 5th Edition. Macmillan Education, London.1987
5. A Text book of Microbiology. Dubey , RC and Maheswari D K . S. Chand & Company Ltd., New Delhi. 2005

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

DSE BIO E -1B

COURSE TITLE	CELL BIOLOGY
COURSE CREDITS	03
CONTACT HOURS	45
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course Outcome:

After completion of the course the student will be able to:

- 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.

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

UNIT I : Introduction to Cell Biology 15 hours

- History - Cell Theory, protoplasm theory and organizational theory. Cell types & their characteristics (prokaryotic and eukaryotic), compartmentalization & division of labor. Ultrastructure of cell. Molecular organization of cells (Water, carbohydrates, lipids, nucleic acids & proteins).

- Bio membranes - Plasma membrane structure and composition, Fluid mosaic model. Transport mechanisms across plasma membrane - simple diffusion, facilitated diffusion, symport, uniport & antiport, active & passive transport, Ion channels, exocytosis, endocytosis, pinocytosis & phagocytosis, sodium-potassium ATPase.

- Structure and functions of cell wall – bacterial cell wall and plant cell wall.
- Cell organelles: structure and functions - **:** Eukaryotic Cell organelles,

Mitochondria, Chloroplast, ribosomes and nucleus, Endoplasmic Reticulum, Golgi apparatus, Lysosomes and Peroxisomes, Membrane Vacuolar system

UNIT II : Cellular communication 15 hours

- Cytoskeleton - types & functions. Microtubules - Chemistry & functions. Centrioles and basal bodies.
- Cell-cell interaction (signaling through ions & signaling through enzymes), cell recognition, cell adhesion and cell functions. Cell-matrix interactions, components of extracellular matrix, collagen and non-collagen components. Tight junctions, gap junctions, desmosomes, hemi desmosomes, focal adhesion and plasma desmata. Role of cell interaction in cell development.

UNIT III : Cell Cycle and Regulation 15 hours

- Structure and function of nucleolus. Structure of chromosome and chromatin.
- Overview of the cell cycle, Eukaryotic cell cycle. Cell Cycle - phases of cell cycle. Events of Mitotic phase and meiotic phase. Cytokinesis. Regulation of cell division & cell growth.
- Apoptosis and Necrosis - Definition, outline of apoptotic pathway and role of Caspases.

REFERENCES :

1. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz and Graham T. Johnson, Cell Biology, 3rd edition, Elsevier, 2017
2. Lodish H , Berk, Kaiser, Krieger, Molecular Cell Biology, 6th edition.2016
3. De Robertis and De Robertis. Cell and Molecular Biology, Lea and Febiger, 8th edition 2000.
4. Cooper, G. M, Cell - A Molecular approach, 2nd edition, Oxford University press, 2000.
5. Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular biology of the cell, 4th edition, Garland Publishing Inc., 2000.
6. Lehninger - Principles of Biochemistry - David L Nelson, Michael M. Cox, Macmillan Worth Publishers. 2020

PEDAGOGY: MOOC / DESKWORK / BOOKCHAPTER / PROBLEMSOLVING/ 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

BIO – V 1 : VOCATIONAL COURSE

COURSE TITLE	**GENETICS AND COUNSELING**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to understand the fundamentals of genetics and counseling to work in healthcare clinics.

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

UNIT I : Basic Genetics **15 hours**

Genes, genomes, chromosomes, sex chromosomes, autosomes, mitochondrial chromosome, gene locus, alleles, homozygous, heterozygous. Mutation: germinal, somatic, chromosomal aberrations. Cell division types: mitosis and meiosis. Nondisjunction Syndromes: Translocation or inversion in chromosomes. Genes in Individuals: genotype and phenotype. Mendelian or monogenic disease, polygenic disease, dominant and recessive trait. Inheritance Patterns: Pedigree analysis, Autosomal Dominant Inheritance, Autosomal Recessive Inheritance, X-Linked Inheritance and Mitochondrial Inheritance. Human Genome Project.

UNIT II : Genetic Diagnosis. **15 hours**

Family History, Pedigree Analysis, Cytogenetic Studies: Karyotype- chromosome painting, Fluorescence in Situ Hybridization, Diagnosis by amniocentesis or chorionic villus sampling

(CVS), Aneuploidy: monosomy, trisomy, polysomy. Down syndrome, Klinefelter syndrome, Turner syndrome, DNA Analysis- Polymerase chain reaction for viral genomes, Biochemical Analysis- inborn errors of metabolism, phenylketonuria (PKU), cystic fibrosis (CF), Ethical Issues with Genetic Testing.

UNIT III : Counseling 15 hours

History of Genetic Counseling, Essentials of Genetic Counseling, Genetic counsellors. Impact of Advances in Genetics/Genomics on Genetic Counseling: information gathering, risk assessment, information sharing, psychosocial and support. Genetic Counseling Practice Areas, Referral and Access to Genetic Counselors.

REFERENCES :

1. Laura M. Gunder McClary , Essentials of medical genetics for nursing and health professionals Jones & Bartlett Learning ,2019
2. Benjamin A Pierce Genetics: A conceptual approach W. H. Freeman and Company, 2012
3. Hartl, D. L., & Jones, E. W., Essential genetics: A genomic perspective (4th ed.). Sudbury, MA: Jones and Bartlett Publishers. 2006
4. Uhlmann, W. R., Schuette, J. L., & Yashar, B. A guide to genetic counseling. Hoboken, NJ: Wiley. 2009
5. National Society of Genetic Counselors—www.nsgc.org Find a counselor: www.nsgc.org/page/find-a-gc-search
6. Gene Tests—International directories of genetic testing laboratories and genetic clinics: www.genetests.org
7. Gene Reviews—Expert authored, peer-reviewed disease descriptions: www.ncbi.nlm.nih.gov/books/NBK1116
8. Genetic Alliance—Organization focused on advocacy, education, and support for genetic and rare diseases: www.geneticalliance.org
9. Genetics Home Reference—Your Guide to Understanding Genetic Conditions, appropriate for patients: https://ghr.nlm.nih.gov/
10. Telegenetic Counseling • Informed DNA: http://informeddna.com » Genetic Counseling Services: www.geneticcounselingservices.com

PEDAGOGY: MOOC / DESKWORK / BOOKCHAPTER / PROBLEMSOLVING/ 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

BIO V 1 : VOCATIONAL -2

COURSE TITLE	NUTRITIONAL BIOCHEMISTRY
COURSE CREDITS	03
TOTAL CONTACT HOURS	45
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course Outcome:

- Students will get acquainted with the techniques used in the experimental determination of different nutrients such as vitamins, minerals and amino acids in food samples.
- Students will be able to understand the nutritional significance of vitamins and the role of minerals in metabolism.

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

UNIT I : 15 hours

Introduction:

Concept of nutrition, calorific value of foods and its determination (Bomb calorimeter), different components of energy expenditure, energy expenditure at rest and work, respiratory quotient. Basal metabolic rate (BMR), determination of BMR by indirect calorimetric method (Benedict's Roth apparatus), factors affecting BMR. Specific dynamic action of foods.

Carbohydrates:

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

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. Malnutrition - Kwashiorkar and Marasmus.

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.

UNIT II : **15 hours**

Vitamins:

Dietary sources, requirements, deficiency symptoms and biological role of water soluble vitamins - thiamine, riboflavin, niacin, pyridoxine, folic acid, vitamin-B_{12} and vitamin- C.

Fat soluble vitamins-A, D, E and K

Minerals:

Dietary sources, physiological functions, deficiency disorders.

Macronutrients- Ca, Na, Cl, and K and micronutrients-Fe, Zn, Cu, I_2,.

UNIT III : **15 hours**

Water Metabolism:

Functions and distribution of water in body fluid compartments. Factors influencing water metabolism and deficiency.

Anti-nutritional Factors:

Sources and harmful effects of anti vitamins (example: - avidin and dicoumarol), natural toxicants (example: - Lathyrus sativus), preservatives (vinegar , BHA) and adulterants (Butter yellow and malachite green).

Digestion and absorption:

GIT: secretion, composition and functions of saliva, gastric, bile, pancreatic and intestinal juices. Gastro intestinal hormones and its effects. Appetite, digestion, absorption and transport of carbohydrates, proteins and fats.

Nutraceuticals and Balanced diet:

Nutraceuticals: Introduction, functional foods, pre and pro-biotics in health and disease prevention.

Balanced diet - Composition of balanced diet for children and pregnancy.

REFERENCES :

1. Swaminathan M, Advanced Text Book On Food & Nutrition - Volume I & II , The Bangalore Printing and publishing Co Ltd (1985).

2. Mahtab S Bamji, Prahlad Rao N and Vinodini Reddy, Text book of Human Nutrition, Oxford and IBH Publishing Co. PVT. LTD, New Delhi (2003)

3. Sumati R Mudambi and Rajagopal M V , Fundamentals of Foods, Nutrition And Diet Therapy, New Age International Private Limited.

4. Srilakshmi B, Food Science, 3rd Edn., New Age International Publishers(2003).

5. Tom Brody, Nutritional Biochemistry 2nd Edn., Academic press(1999).

6. Garrow, J. S. and James, Human Nutrition and Dietetics, 10th Edn., Churchill Livingstone Publishers, UK(2000).

7. Lanham S, Mac Donald I and Roche H, Nutrition and Metabolism, 2nd Edn., The Nutrition Society, London, UK, (2012).

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 - C15

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

Course outcome:

These 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								
Critical thinking		x				x						
Subject clarity	X	x					x			x		X
Analytical Skill	X				x	x				x		

UNIT I : 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 II : 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 Vmax & Km from L-B plot and their significance, K_{cat} and turnover number.

Mechanism of action of enzymes:

General mechanisms of action - Acid-base and covalent catalysis (carboxypeptidase A, chymotrypsin and lysozyme)

Involvement of coenzymes in enzyme catalyzed reactions:

Coenzymes - Definition, structure and role of TPP, NAD and PLP.

UNIT III :

15 hours

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

.

Regulation of enzyme activity:

Control of activities of enzymes - end product inhibition, Allosteric enzymes, feedback inhibition (Aspartate Transcarbamoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage - Zymogen**.** Multienzyme complex as regulatory enzymes (PDH)

UNIT IV : 15 hours

Isolation and purification of enzymes :

Source, methods of cell disruption, Separation based on : solubility, size or mass, polarity, affinity or ligand based. Enzyme assay, Criteria of purity of enzymes.

Applications of enzymes

Clinical application of enzymes – SGPT and SGOT, LDH and CPK, Biotechnological and industrial applications of enzymes, Enzyme Immobilization, Methods, properties and applications of Immobilized enzymes.

REFERENCES:

1. Cox, Michael M. Lehninger principles of biochemistry. Freeman, 2013.
2. Lubert Stryer. Biochemistry, 5th edition , 2006
3. Palmer, Understanding enzymes, 4th edition, Prentice Hall/Ellis Horward, Landon 2000
4. Price, Nicholas C., and Lewis Stevens. Fundamentals of Enzymology. Oxford Science Publications. Second edition. New York, 2010
5. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. Biocatalysts and enzyme technology. John Wiley & Sons, 2012.
6. Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. "Fundamentals of

biochemistry." New York: John Wiley & Sons 2008.
7. 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 TESTS)	**20**
SEMINARS / CLASS WORK	**10**
ASSIGNMENT/ OPEN DISCUSSION	**10**
TOTAL	**40**

SEMESTER VI

DSC B I O C 1 6 : PRACTICAL

COURSE TITLE	**ENZYMOLOGY**
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 assay of enzymes from different sources and they will able to study the kinetics of enzymes.

EXPERIMENTS:

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 Km and Vmax 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. An introduction to Practical Biochemistry, David Plummer, 3r edition 2017
2. Laboratory manual in biochemistry, Jayaraman J , New Age International publications, 2011
3. Practical Manual of Biochemistry, Sattanathan G., Swaminathan P. and Balasubramanian B. Sky fox press, 2020
4. Practical manual of Biochemistry, S.P Singh, 7th edition, CBS publications, 2013
5. 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**
CONTINUOUS EVALUATION AND CLASS TEST	**15**
RECORD / VIVA VOCE	**10**
TOTAL	**25**

SEMESTER VI

DSC BIO - C17

COURSE TITLE	BIOENERGETICS AND METABOLISM
COURSE CREDITS	03
TOTAL CONTACT HOURS	45
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.

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.

UNIT III : 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, glycogenic and ketogenic amino acids. Urea cycle and its significance. Synthesis and catabolism of alanine, serine and cysteine

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.

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 18 :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 – C19

COURSE TITLE	**IMMUNOLOGY**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
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 : 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: Immunoglobulin genes, Molecular Structure - general features , light and heavy chains, Hyper variable and constant regions, Different isotypes and subtypes of immunoglobulins, Allotypes and idiotypes, Synthesis, Assembly and Expression of Ig molecules, Immunoglobulin superfamily.

UNIT II : Innate immunity 15 hours

Anatomical and physiological barriers, Soluble factors, Inflammation-characteristics, initiation of the inflammatory response, Recruitment of phagocytic cells, recognition by receptors, adhesion molecules, Chemotaxis, Phagocytosis, Acute inflammatory response, Role of innate immunity. Noncellular components of the immune system -Lipid mediators, Cytokines, Complement system, Acute phase proteins, Kinin system.

UNIT III : Adaptive immunity 15 hours

MHC molecules: genes, different classes, structure and function, Antigen processing and presentation: Endogenous and exogenous pathways.

Humoral Immunity – B cell development and selection, BCR, B-Cell maturation, Activation, Differentiation, generation of plasma cells and memory B cells.

Cell-mediated immunity :T cell development, Structural organization of T cell-receptors, T-cell maturation, Activation, Differentiation, Proliferation , B cell – T cell interaction, The germinal centre reactions, Class switch recombination, generation of CD4+and CD8 + cell responses, secondary immune responses, regulation of the adaptive immune response.

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.

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	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

- 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		

I : EXPERIMENTS

1. Counting and seeding of cells
2. Blood grouping
3. Hemagglutation 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

II : Report:

Visit to DIAGNOTIC LABORATORY / scientific/research institute – report.

REFERENCES :

1. A handbook of practical and clinical immunology , 2017 G.P Talwar and S.K Gupta
2. Practical Immunology ,2000, Frank C Hey, Publisher: John Wiley and Sons Ltd
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

DSE BIO – E2

COURSE TITLE	**GENETIC ENGINEERING**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

At the end of the course, students will be able to: Discuss the process of cloning and expression of gene and other techniques in genetic engineering.

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		
Analytical Skill	x				x	x				x		

UNIT I : **15 hours**

Introduction to Genetic Engineering : Restriction and modification systems; Production of DNA fragments, restriction endonucleases and other enzymes used in manipulating DNA molecules (DNA polymerases, RNA Polymerases, Reverse Transcriptase, Ligases, Taq polymerase, Kinases). Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters.

Plasmids: Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, and pUC18. Cloning vectors based on M13 and λ bacteriophage. Selection of plasmids: direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

UNIT II : **15 hours**

Introduction of DNA into cells and selection for recombinant clones : Uptake of DNA by competent bacterial cells. Selection for transformed cells. Identification for recombinants, Sequence dependent and independent screening, southern-western, colony and plaque hybridization - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages.

Expression of cloned genes : Vectors for expression of foreign genes in E. coli, cassettes and gene fusions. Detection of PCR products by Agarose gel electrophoresis.

UNIT III : **15 hours**

Polymerase chain reaction: designing primers for PCR. Studying PCR products. Cloning PCR products. and RTPCR.

DNA sequencing: DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing.

Applications of genetic engineering : Applications in medicine, production of recombinant pharmaceuticals such as insulin. Recombinant vaccines. Gene therapy. Transgenic animals. Applications in agriculture - plant genetic engineering, insect resistant crops, problems with genetically modified plants, safety and ethical concerns.

REFERENCES:

1. Gene Cloning and DNA Analysis : T.A. Brown , Wiley Blackwell publisher (Oxford, UK), ISBN: 978-1-4051-8173-0. , 2010

2. Principles of Gene Manipulation and Genomics, Primrose, S.B., and Twyman, R. M., Blackwell publisher (Oxford, UK) ISBN:13: 978-1- 4051-3544-3, 2006

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA: Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC), 2010

4. Recombinant DNA Technology : James D Watson , Scientific American Books, 1992

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 V

DSE BIO E -2

COURSE TITLE	CANCER BIOLOGY
COURSE CREDITS	03
CONTACT HOURS	45
DURATION OF ESA	03
FORMATIVE ASSESSMENT MARKS	40
SUMMATIVE ASSESSMENT MARKS	60

Course Outcome:

- To appreciate the role of immune system in cancer
- To describe self – tolerance machinery and immune surveillance
- To understand the cancer microenvironment and its influence on immune cells
- To have awareness on medical applications of cytokines and immune cells against cancer

UNIT I : Fundamentals of cancer

Cell cycle, regulation of cell cycle. Mutation that causes changes in signal molecule. Effect of receptors, tumor repressor genes, dys regulation of cell cycle. Different forms of cancer, development of cancer, tumor markers. Malignant tumor and benign tumor

UNIT II : Principle of carcinogenesis

Carcinogens, theory of carcinogenesis, chemical carcinogenesis, physical carcinogenesis, X- ray radiation - Mechanism of radiation carcinogenesis. Signal targets and cancer. Activation of kinases, oncogenes, proto-oncogenes activity, growth factors related to cancer transformation and metastasis.

UNIT III : Detection and treatment

Detection of cancer, use of signal targets towards therapy of cancer.
Different methods of therapy: Chemotherapy, radiation therapy, gene therapy and immune therapy.
Brief account of apoptosis.

REFERENCES :

1. Weinberg, R.A. “The Biology of Cancer” Garland Science, 2007
2. McDonald, F “ Molecular Biology of Cancer” 2nd Edition. Taylor & Francis, 2004.
3. King Roger J.B. “Cancer Biology” Addison Wesley Longman, 1996.
4. Ruddon, Raymond W. “Cancer Biology” 3rd Edition . Oxford University Press, 2000.

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

BIO V 2 : VOCATIONAL – A

COURSE TITLE	**CLINICAL BIOCHEMISTRY**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

These topics will enable students to understand the fundamentals of clinical biochemistry to work in clinical laboratories.

Course Outcomes / Program 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	x	
Analytical Skill	x				x	x						

UNIT I : 15 hours

Urine: Normal composition - volume, specific gravity. Constituents- urea, uric acid, creatinine, pigments and their clinical significance in brief. A brief introduction to renal physiology as a recall. Kidney disorders.

Blood: Introduction to haematology- formation of blood; drawing of blood. Erythrocyte sedimentation rate (ESR). Normal constituents of blood. Normal range of urea, uric acid, creatinine, glucose, bilirubin, total protein, albumin/ globulin ratio- Variation in pathological conditions such as liver diseases, cardiac diseases and diabetes mellitus. Lipid profile; normal range of cholesterol, triglycerides, lipoproteins, HDL and LDL.

UNIT II : **15 hours**

Diagnostic methods: Glucose tolerance test (GTT), Glycated haemoglobin(HbA1c), Diagnostic kits used in clinical biochemistry laboratories Ex: Glucose test by Glucose oxidase –peroxidase (GOD-POD) method; determination of lipids and lipoproteins.

Diagnostic enzymes: Normal range of enzymes and enzyme levels in clinical conditions. SGOT, SGPT, Alkaline Phosphatase. Cardiac injury profile- CPK and LDH.

Some diseases: Glycogen storage diseases, lactose intolerance, sickle cell anaemia, thalassemia.

UNIT III : **15 hours**

Inborn errors of metabolism: Inborn errors of amino acid metabolism-Phenyl ketonuria (PKU), Alkaptonuria, disorders of protein pattern studies. Disorders of Purine and Pyrimidine Metabolism- Gout. Disorders of Lipid Metabolism- Neiman Pick disease. Hyper lipo - proteinemia.

Lifestyle diseases: Causes, prevention and markers of cancer, diabetes mellitus**,** and atherosclerosis.

REFERENCES:

1. J L Jain, S. Jain and N. Jain. Fundamentals of Biochemistry- 2000, S. Chand.
2. Nelson and Cox. Lenhinger's Biochemistry- 2005 CBS Publishers.
3. U. Sathyanrayana and U. Chakrapani. Biochemistry- 2006.
4. D M Vasudevan, Sreekumari S, Kannan Vaidyanathan. Text book of Biochemistry for Medical Students. Ninth edition, 2019.

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

BIO – V 2 :VOCATIONAL - B

COURSE TITLE	**BIOSTATISTICS AND BIOINFORMATICS**
COURSE CREDITS	**03**
TOTAL CONTACT HOURS	**45**
DURATION OF ESA	**03**
FORMATIVE ASSESSMENT MARKS	**40**
SUMMATIVE ASSESSMENT MARKS	**60**

Course outcome:

- These topics will enable students to learn the basic concepts in statistics and to apply the statistical concepts in developing bioinformatics tools applied in life science research.
- To know Bioinformatics, its scope, importance and outreach.

Course Outcomes / Program 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	x	
Analytical Skill	x				x	x				x	x	x

UNIT I: 15 hours

Biostatistics: Aim, scope, definition and elementary idea of statistics in biology; Basic terminology - population, sample, variable, parameter.

Types of Data: Primary and secondary data; qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non-frequency data. Different types of scales - nominal, ordinal, ratio and interval.

Presentation of Data: Construction of tables with one or more factors of classification. Diagrammatic and graphical representation of grouped data. Frequency distributions,

cumulative frequency distributions and their graphical representation, histogram, frequency polygon and ogive.

UNIT II: 15 hours

Analysis of Quantitative Data: Univariate data; Concepts of central tendency (Mean, Mode and Median with one example for each), dispersion and relative dispersion, basics of skewness and kurtosis.

Bivariate Data: correlation analysis, scatter diagram. Product moment correlation coefficient and its properties. Rank correlation – spearmann's and Kendalls measures. Regression analysis; basics of regression and Coefficient of determination. Principle of least squares. Fitting of linear regression and related results.

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Application of computer in biostatistics: Introduction to MS EXCEL – use of worksheet to use of in-built statistical functions for computations of mean, SD, correlation, regression coefficient etc. Use of bar diagram, histogram, scatter plots etc., graphical tools in EXCEL for presentation of data.

UNIT III: 15 hours

BIOINFORMATICS:

Introduction; Definition and Scope; Different disciplines of Bioinformatics; Inter-relationship with various branches of life sciences; Computation approaches to biological questions.

Databases: Definition; Information generation; storage, editing and retrieval. Classification of databases - Database management system, RDBMS; Database management public agencies -NCBI data model, structures of EBI and Genome Net; Gene bank Sequence database.

Data Retrieval and Analysis: Introduction, Database search engines-Entrez and DBGET / Link DB, SRS, Searching sequence databases by similarities criteria, FASTA, BLAST and its variants.

Sequence alignment and database searching: Introduction; protein and nucleic acid sequence analysis; Models of sequence analysis; Tools for sequence search, analysis and alignment. Sequence comparison; Tools, approaches and models for multiple sequence analysis.

REFERENCES:

A. Biostatistics:

1. Anderson T.W and Sclove S.L (1978) An Introduction to the Statistical Analysis of Data, Houghton Miffin\Co.
2. Anthony Schork M. and Richard D. Ramington (1990) Statistics with applications to the Biological Sciences, 3rd edition, Pearson.
3. Bhat B.R, Srivenkatramana T. and Rao Madhava K.S.(1996): Statistics: A Beginner's Text, Vol. I, New Age International (P) Ltd.
4. Croxton F.E, Cowden D.J and Kelin S. (1973): Applied General Statistics,

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5. Cooke, Cramer and Clarke (1982): Basic Statistical Computing, Chapman and Hall.
6. Goon A.M., Gupta M.K., Das Gupta.B. (1991): Fundamentals of Statistics, Vol.I, World Press, Calcutta.
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   McGraw Hill.
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12. S.P. Gupta (1979) Statistical Methods. Sultan Chand & Sons.

Bioinformatics:

1. Andreas D Baxevains and B.F. Francis Ovellette. (2002). Bioinformatics – A practical guide to the Analysis of Genes and Proteins. --- John Wiley & Sons.
2. Cynthia Gibas & Per Jambeck. (2003). Developing Bioinformatics – Computer Skills.
   An Introduction to software tools for Biological Applications. --- O'RELLY Pubs.
3. David Mount (2003). Bioinformatics- Sequence and Genome Analysis--- CBS Publishers and Distributors.
4. Hooman H Rashidi. M.S. and Lukas K Buehler (2000). Bioinformatics: Sequence, Structure and databanks. Hortan, Moran, Ochs, Rawn, Scrimgeour. Prentice Hall
5. Hooman H. Rashidi and Lukas K. Buehler (2005) Bioinformatics Basics-Application in Biological Science and Medicine. CRC Press, Boca Raton.
   Publishers.
6. Rastogi C., Namita Mendiratta and Parag Rastogi (2003).Bioinformatics- Concepts, Skills and Applications. --- S CBS Publishers and Distributors, New Delhi.
7. Stuart M Brown. (2000). Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. Eaten Publishing – A Bio techniques Books Publication.

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**