

**B.Sc. Degree Course in Biochemistry**  
**Semester-I**  
**Core Paper-I: Nutritional Biochemistry**  
**Credits:5**  
**Teaching Hrs:90**

**Learning Outcome**

- To create awareness about the role of nutrients in maintaining proper health to study effect of nutrients in the biochemical process.
- To understand the nutritional significance of carbohydrates, lipids and proteins

**UNIT-1 (18 Hrs)**

Concepts of food and nutrition. Basic food groups - energy yielding, body building and functional foods. Units of energy. Calorific and nutritive value of foods. Measurement of Calories by bomb calorimeter. Basal metabolic rate (BMR) - definition, determination of BMR and factors affecting BMR. Respiratory quotient (RQ) of nutrients and factors affecting the RQ. SDA - definition and determination - Anthropometric measurement and indices – Height, Weight, chest and waist circumference BMI.

**UNIT-II (18 Hrs)**

Physiological role and nutritional significance of carbohydrates, lipids and protein. Evaluation of proteins by nitrogen balance method - Biological value of proteins - Digestibility coefficient, Biological value, Protein Energy Ratio and Net Protein Utilization. Protein energy malnutrition – Kwashiorkor and Marasmus.

**UNIT-III (18 Hrs)**

Balanced diet, example of low and high-cost balanced diet - for infants, children, adolescents, adults and elderly people. ICMR classification of five food groups and its significance food pyramid. Signs of obesity (types, prevention and treatment)

**UNIT-IV (18 Hrs)**

Minerals - sources, requirement, physiological function, deficiency and toxicity of calcium, sodium, potassium, iron, magnesium, chromium. Cobalt, copper, manganese, molybdenum, selenium, iodine and zinc. Vitamins - definition and types of vitamins, sources, requirement, biological functions, deficiency symptoms of thiamine, riboflavin, niacin, pyridoxine, panthothenic acid, folic acid, biotin, cyanocobalamine, vitamins C, A, D, E and K. Hypervitaminosis.

**UNIT-V (18Hrs)**

Human rights - introduction – definition, scope and need for study of human rights and relations. Categories - civil and political rights, economic relations and social relations. Institutions: International and National – United Nations Human Rights Commissions, State Human rights Commission. International convention on civil and political rights. International convention on economic and social rights. National Human rights Act - National commission for

minorities, SC/ST and Women Students activity – assignment, case study, term paper.

**Books for Study:**

1. M.Swaminadhan (1995) Principles of Nutrition and Dietetics. Bappa.
2. Aravind Kumar (1999). Human rights and social movements, Anmol publishers.
3. Margaret Mc Williams (2012). Food Fundamentals (10th ed) Prentice Hall
4. Tom Brody (1998). Nutritional Biochemistry (2<sup>nd</sup>ed), Academic press, USA

**Books for Reference:**

1. Garrow, JS, James WPT and Ralph A (2000). Human nutrition and dietetics (10<sup>th</sup> ed) Churchill Livingstone.
2. Andreas M. Papas (1998). Antioxidant Status, Diet, Nutrition, and Health (1<sup>st</sup> ed) CRC press.
3. Human Rights – Piarey Lal Mehta, Neena Verma, P I Mehta (1999).
4. Human rights and social movements - Aravind Kumar (ed) (1999).

**Web Resources:**

- <http://old.noise.ac.in/SecHmscicour/english/LESSON03.pdf>
- <https://study.com/academy/lesson/energy-yielding-nutrients-carbohydrates-fat-protein.html>.
- <https://www.nhsinform.scot/healthy-living/food-and-nutrition/eating-well/vitamins-and-minerals>

## **Non-Major Elective-I: Plant Biochemistry and Secondary Metabolites**

**Credit:2**

**Teaching Hrs: 75**

**Learning outcomes**

On completion of the course, the students will

- Understand the mechanism and significance of photosynthesis
- Gain insight into various reactions involved in nitrogen metabolism
- Apprehend the enormous scope of use of phytochemicals as nutraceuticals
- Acquire knowledge of different secondary metabolites used as therapeutics

### **UNIT I (15Hrs)**

Photosynthesis - Ultra structure of Photosynthetic organelle, Photosynthetic pigments, Overview of Photophosphorylation and Photosynthesis in C<sub>3</sub> and C<sub>4</sub> plants, Significance of Photosynthesis, Photorespiration.

### **UNIT II (15Hrs)**

Metabolism of N-compound in plants - Biological nitrogen cycle Denitrification, Nitrate reduction Nitrification, Symbiotic and Non symbiotic nitrogen fixation, Nitrogenase structure and function, Assimilation of fixed nitrogen by plants.

### **UNIT III (15Hrs)**

Definition & Classification of Primary and Secondary metabolites. Nutritional importance of Phytochemicals, use of Phytochemicals in Cosmetic industry. Outline of Primary Metabolites - Carbohydrates, Lipids, Proteins, Nucleic acids, Plant hormones  
Secondary metabolites – Basic Structure of Alkaloids, Glycosides & Phenolics.

### **UNIT IV (15Hrs)**

Therapeutic use of Secondary Metabolites – Alkaloids - Quinine, Vincristine. Glycosides - Saponins as Vaccine adjuvants, Phenolics - Biological importance of Flavanoid-Quercetin.

### **Recommended Books:**

1. A textbook of Plant Physiology Biochemistry and Biotechnology - Dr. S.K. Verma & Mohit Verma, 4th edition S Chand Publishers, 1995.
2. Plant Physiology - Salisbury & Ross, 3rd edition CBS Publisher, 2006.
3. Key notes on Plant Biotechnology - Venkatam R. Prakash Reddy, Daya Publishing, 2017.
4. Plant Biochemistry – Ayush Aggarwal, Pacific books International Publisher, 2013.

5. Plant Biochemistry - Dr.V.Arun Kumar & Dr. Senthil Kumar, APH Publishing Corporation, 2015.

**Reference Books:**

1. Plant Biochemistry- Devlin, 4<sup>th</sup> Edition, Prindle Weber and Schmidt, 1983.
2. Introduction to Plant Biochemistry- Goodwin & Mercer, 2<sup>nd</sup> Edition, CBS Publisher, 2005.
3. Plant Biochemistry - P.M. Dey & J.B. Harborne, 1<sup>st</sup> Edition, Academic Press, 1997.
4. Plant Biochemistry – Hans - Walter Heldt Birgit Piechulla, 4<sup>th</sup> Edition, Academic Press, 2010.

**Core Paper-II: Cell Biology**

**Credits:5**

**Teaching Hrs: 90**

**Learning Outcomes**

- To study the concept that the cell is the fundamental unit of life.
- To understand the structure and purpose of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
- To understand the communication between the cells.

**UNIT-I (18 Hrs)**

Cell theory, cell as basic unit of life. Cell size, shape, comparison of prokaryotic and eukaryotic cell types including cellular specialization and differentiation, differences in plant and animal cells.

**UNIT-II (18 Hrs)**

Detailed description of eukaryotic cellular Organelles, Plasma membrane, rough and smooth Endoplasmic Reticulum, Nucleus, Mitochondria, Lysosomes, Golgi Apparatus, Ribosomes, Peroxisome, Chloroplast and Glyoxisome.

**UNIT- III (18 Hrs)**

Biomembrane – structure, organization and basic functions, fluid mosaic model, Transport across cell membrane - uniport, symport and antiport. Passive and active transport and water channel. Animal structure of cytoskeleton - Composition and function of microfilament and intra nuclear filament, Proton and Na<sup>+</sup> – K<sup>+</sup> Pumps - examples and metabolic significance.

#### **UNIT-IV (18 Hrs)**

Chromosomes, types, structure and function. Cell division, mitosis, meiosis, their significance. Cell cycle – phase of cell cycle.

#### **UNIT-V (18 Hrs)**

Apoptosis, Cancer - differences between benign and malignant tumors. Characteristics of cancer cells. Agents causing cancer - Physical, chemical, Biological. Cancer therapy – Surgery, radiation, chemotherapy. Cancer prevention.

#### **Books for Study:**

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (6<sup>th</sup>ed). John Wiley and Sons.Inc.
2. Bruce Alberts and Dennis Bray (2013), Essential cell biology, (4<sup>th</sup>ed), Garland science.
3. P.S. Verma and V.K Aggarwal. (2014) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology (14<sup>th</sup>ed), S. Chand and Company Ltd.

#### **Books for Reference:**

1. Wayne M. Baker (2008). The World of the Cell. (7<sup>th</sup>ed). Pearson Benjamin Cummings Publishing, San Francisco. Cell Biology.
2. Cooper, G.M. and Hausman, R.E (2009). The Cell: A Molecular Approach. (5<sup>th</sup>ed). Sunderland, Mass. Sinauer Associates,Inc.
3. De Robertis, E.D.P and De Robertis, E.M.F. (2010). Cell and Molecular Biology. (8<sup>th</sup> ed) Lippincott Williams and Wilkins,Philadelphia.

#### **Web Resources:**

- <https://nicholls.edu/biol-ds/bio1155/Lectures/Cell%20Biology.pdf>
- <https://www.medicalnewstoday.com/article/320878.php>
- <https://biologydictionary.net/cell>

## **Core -III: Practical I**

**Credit: 4**

**I. Preparation of Standard buffers and determination of pH of a solution.**

**II. Titrimetric Procedures**

- 1 Estimation of glycine by Sorenson's formal titration
- 2 Estimation of calcium from milk
- 3 Estimation of Iron
- 4 Estimation of Oxalate
- 5 Estimation of Vitamin C (Ascorbic acid)

**III. Biochemical Preparation**

- 1 Preparation of starch from potatoes
- 2 Preparation of Caesin and lactalbumin from milk
- 3 Preparation of albumin from eggs

**IV. Group Experiments**

- 1 BMI -Measurement
- 2 Stages of cell division onion peel (Mitosis and meiosis)

**V. Spotters (Slides)**

- 1 Animal and Plant cell and cellular organelles
- 2 Stages of cell division - (Mitosis & meiosis)

**Distribution of marks**

- Practical – 100
- Internals -40
- Externals-60
- Record-10
- Practical Experiment-50
- Experiments marks - 30 (from group II&III)
- Spotters-  $4 \times 5 = 20$  (Compulsory)

## **Non-Major Elective-II: Clinical Nutrition and Dietary Management**

**Credit:2**

**Teaching Hrs: 75**

### **Learning outcomes**

- On completion of the course, the students will
- Understand the need of a Balanced diet for Healthy life
- Gain insight into Nutrition requirements during different stages of Life.
- Appreciate the importance of Dietary Management in different diseases
- Acquire knowledge on different modes of nutrition

### **UNIT I (15HRS)**

Definition of Nutrition, Overview of Balanced diet, Collecting and analyzing Nutritional information – Physical examination, Anthropometric measurements.

### **UNIT II (15HRS)**

Common food allergies, food intolerance – lactose intolerance. Cardiovascular diseases - atherosclerosis, and myocardial infarction, foods that increase LDL and HDL.

### **UNIT III (15Hrs)**

Bulimia and Anorexia Nervosa. Dietary management with reference to Constipation, Diarrhea, Dehydration, Peptic Ulcer, Hepatitis, Gall bladder diseases and Renal failure.

### **UNIT IV (15Hrs)**

Dietary management with reference to Hypertension, Diabetes Mellitus, AIDS and Cancer, Surgery and Nutritional support, outline of Enteral Nutrition and Parenteral Nutrition.

### **Recommended Books:**

1. Garrow, JS , James WPT and Ralph A (2000) . Human nutrition and Dietetics (10th ed) Churchill Livingstone.
2. Piarey Lal Mehta, Neena Verma, P I Mehta (1999) Human Rights Under the Indian Constitution. Deep & Deep Publications Pvt.Ltd.
3. Handbook of Food and Nutrition – Dr. M. Swaminathan, Bappco Publisher, 2014.
4. Nutrition Science- B.Srilakshmi, 7<sup>th</sup> edition, New age International Publisher, 2017.
5. William's Basic Nutrition and Diet Therapy – Staci Nix McIntosh, First South Asian Edition, Elsevier Publisher, 2016.
6. Nutrition essentials and diet therapy-Packenpaugh, 11<sup>th</sup> edition, Saunders Publishers, 2009.

**Reference Books:**

1. Davidson's Principles and Practice of Medicine – Sir Stanley Davidson, 21<sup>st</sup> edition, Elsevier Publishers, 2010.

**III SEMESTER****Core Paper-IV: Biomolecules****Credits:5****Teaching Hrs:90****Learning Outcomes:**

On completion of the course, the students will

- Demonstrate the chemistry and the role of mono and disaccharides in living systems.
- Elucidate the structural conformation of different types of polysaccharides
- Gain insight into the reactivity of amino acids and nutritional importance of proteins
- Apply the relationship between the structure and functions of proteins in biological context
- Elucidate the various levels of organization of Proteins and its biological importance

**UNIT-I (18 hrs)**

Carbohydrates - classification and biological significance, physical properties, stereo isomerism, optical isomerism and mutarotation. Configuration of aldo and keto trioses, tetroses, pentoses and hexoses. Reactions of monosaccharides due to the presence of hydroxyl, aldehyde and ketone groups. Structure and properties of reducing disaccharides (lactose & maltose), non-reducing disaccharide (sucrose). Identification of ketose, pentose, reducing and non-reducing sugars.

**UNIT-II (18 Hrs)**

Occurrence, structure and functions of polysaccharides - starch, glycogen and cellulose (structural elucidation is not needed). Structure and biological significance of mucopolysaccharides - hyaluronic acid, chondroitin sulphate and heparin. Structure of bacterial cell wall polysaccharides (peptidoglycan and teichoic acid), blood group polysaccharides and glycoproteins. Carbohydrates as informational molecules, importance of carbohydrates in biology.

**UNIT-III (18Hrs)**

Amino acids - biological role. General structure of amino acids. 3 - and 1- letter abbreviations. Classification of amino acids based on nature of R group (polar, non-polar,

acidic, basic, neutral). Modified amino acids in protein, non-protein amino acids. Physical properties of amino acids, isoelectric point, titration curve (alanine, lysine, glutamic acid), optical activity. Chemical reactions due to carboxyl group, amino group and side chains. Color reactions of amino acid.

#### **UNIT-IV (18 Hrs)**

Composition and biological importance of peptides. Examples of peptide hormones. Solid state peptide synthesis. Structure of oligopeptides like glutathione, vasopressin and oxytocin, Peptidases – exo and endo peptidases. Classification of proteins based on composition, solubility and functions. Properties of proteins - salting in and salting out, denaturation and renaturation, UV absorption. Estimation of protein by Biuret, Folin's phenol and UV methods.

#### **UNIT-V (18 Hrs)**

Definition and biological significance of hydrogen bond, hydrophobic interactions and van der waals forces. Levels of organization of protein structure – primary structure – composition, Outline of protein sequencing, Secondary structure –  $\alpha$  helix (egg albumin),  $\beta$ -pleated sheath (keratin), triple helix (collagen). Tertiary structure – forces involved in maintenance of tertiary structure like hydrogen bond, hydrophobic interactions, van der waals force, disulphide linkage and ionic bonds with reference to myoglobin. Quaternary structure with reference to haemoglobin.

#### **Books Recommended:**

1. Fundamentals of Biochemistry- J L Jain, Sunjay Jain and Nithin Jain, 2004 Edition, S.Chand Publishers.
2. Biochemistry - U Satyanarayana, 4th Edition, Elsevier India,2013.

#### **Reference Books:**

1. Lehninger Principles of Biochemistry- David L. Nelson & Michael M. Cox, 4<sup>th</sup> Edition, W. H. Freeman Publication, 2004.
2. Biochemistry- Donald Voet & Judith G. Voet, 3<sup>rd</sup> Edition, John Wiley and Sons Publication, 2004.
3. Biochemistry- Jeremy M Berg, John L Tymoczko, and Lubert Stryer, 6<sup>th</sup> Edition, Freeman Publications, 2006.
4. Textbook of Medical Biochemistry – MN Chatterjee & Rana Shindee, 7<sup>th</sup> Edition, Jaypee Publishers, 2007.
5. Introduction to Biochemistry – Mary K. Campbell & Shawn O. Farrell, 1<sup>st</sup> Edition, Cengage Learning, 2009.

**Reference E-Learning:**

- <https://youtu.be/iuW3nk5EADg>
- <https://www.youtube.com/watch?v=lijQ3a8yUYQ>
- <https://youtu.be/Fp1wKo72b2A>
- <https://youtu.be/6AfRX6oh9-E>
- <https://www.youtube.com/watch?v=IKh4TE3RAY8>

**SEMESTER IV****Major Paper-V: Biomolecules and Biochemical techniques****Credit:5****Teaching Hrs:90****Learning Outcomes:**

On completion of the course, the students will

- Gain insight into the classes of lipids and characterization of fats by their constants
- Establish the diverse role of lipids in biological system
- Relate the structure of lipids with their reactivity in biological membrane systems and life processes.
- Establish the role of purine and pyrimidine bases in nucleic acid structure
- Acquire knowledge about principle of various centrifugation types and its applications
- Appreciate the principle, instrumentation and the difference between various spectroscopic methods to choose analyzing biological samples

**UNIT-I (18 Hrs)**

Lipids- Chemical nature, biological functions and classification. Fatty acids – definition, classification – saturated, unsaturated, hydroxy and cyclic fatty acids, nomenclature, structure and properties of fatty acids. Simple and mixed triglycerides – structure and general properties, Isolation of fats (Folch method) and identification. Characterization of fats – iodine value, saponification value, acid number, acetyl number, Polensky number, Reichert-Meissl number.

**UNIT-II (18 Hrs)**

Sterols – structure of cyclopentanoperhydrophenanthrene nucleus. Animal sterol: cholesterol - properties and functions. Plant sterol: stigmasterol – Functions, Ergosterol: Functions. Lipoproteins: general structure, classification: chylomicrons, VLDL, LDL, IDL, HDL – composition and biological roles. Classification, structure, properties and biological

functions of phospholipids and sphingolipids. Lipids as signals, cofactors and pigment.

### **UNIT-III (18 Hrs)**

Structure of purine and pyrimidine bases, nucleosides and nucleotides and their biological importance. Function of nucleotides - source of energy, component of coenzymes, second messengers. Types of DNA: A, B, C, Z DNA, structure and biological significance, superhelicity. Types of RNA: mRNA, tRNA, rRNA, hnRNA, snRNA - location and role. Secondary and tertiary structure of tRNA. Isolation, purification, identification and estimation of DNA and RNA. Properties of DNA – hypochromic and hyperchromic effect, melting temperature, viscosity. Denaturation and annealing. Salient features of prokaryotic and eukaryotic RNA. RNA as a genetic material.

### **UNIT –IV (18 Hrs)**

Basic principles of sedimentation, centrifugal force, centripetal force, sedimentation rate. Types of centrifuges, types of rotors – fixed angle, vertical, swinging bucket, zonal, elutriator rotors. Preparative centrifugation – differential centrifugation – fractionation of subcellular organelles, density gradient centrifugation – gradient preparation, separation and recovery of sample, isopycnic centrifugation, analytical centrifugation - techniques and applications.

### **UNIT-V (18 Hrs)**

Basic principles of electromagnetic radiation, energy, wavelength, wave number and frequency. Absorption and emission spectrum. Colorimetry – Principle - Beer – Lambert's law, instrumentation and applications. Spectrophotometry - (UV and Visible) principle, instrumentation and applications. Spectrofluorimetry - principle, instrumentation and applications with reference to riboflavin. Atomic absorption spectroscopy and Flame photometry - principle, instrumentation and applications with reference to sodium and potassium analysis.

### **Books Recommended:**

1. Fundamentals of Biochemistry- J L Jain, Sunjay Jain and Nithin Jain, 2004 Edition, S.Chand Publishers.
2. Biochemistry - U Satyanarayana, 4th Edition, Elsevier India, 2013.
3. Practical Biochemistry (V Edition) - Keith Wilson & John Walker, Cambridge University press.
4. Biophysical chemistry – Debajyothi Das, 10<sup>th</sup> edition, 2000.

### **Reference Books:**

1. Lehninger Principles of Biochemistry- `David L. Nelson & Michael

- M.Cox, 4 th Edition, W. H. Freeman Publication, 2004
2. Biochemistry-Donald Voet& Judith G. Voet ,3 rd Edition, John Wiley and Sons Publication,2004
  3. Biochemistry- Jeremy M Berg, John L Tymoczko, and LubertStryer, 6 th Edition, Freeman Publications,2006.

## **Core-VI: Practical II**

**Credit: 4**

### **I. Qualitative testsfor**

- Carbohydrates
- Aminoacids

### **II. Titrimetric methods**

- Determination of saponification value of an edible oil.
- Determination of acid number of an edible oil.
- Determination of iodine value of an edible oil.

### **III. Colorimetry**

- Estimation of protein by Biuret method.
- Estimation of inorganic phosphorous by Fiske and Subbarow method.
- Estimation of amino acids by Ninhydrin method.
- Estimation of DNA by diphenylamine method.
- Estimation of RNA by orcinol method.
- Estimation of carbohydrate by Anthrone method/ Dubois method.

### **IV. Group Experiment**

- Isolation and assay of glycogen from animal tissue.
- Separation and Identification of Amino acids and carbohydrate by paper chromatography.

### **Distribution of marks**

- Practical – 100
- Internals - 40(Internship)
- Externals -60
- Record-10
- Qualitative – 25(Compulsory)
- Titration/ Colorimetry-25

## **Internship**

Students should be sent for Internship training (During summer Holidays) for 15 days and co-ordinate by staff members of the Department. Internship report to be evaluated by HOD and senior members of the department and 20 marks will be allotted for internship and 20 marks for internals.

## **SEMESTER V**

### **Core Paper-VII: Enzymes**

**Credits:5**

**Teaching Hrs: 90**

#### **Learning Outcomes:**

At the end of the course the student would have obtained a thorough knowledge about the nature, classification, specificity, kinetics, inhibition, mechanism of action, co-enzymes, isolation, Purification and characterization, immobilization, and applications of enzymes.

#### **UNIT-I (18 Hours)**

Enzymes - definition and chemical nature of enzymes. General properties; Nomenclature and classification Based on IUB with examples; enzymes as catalysts - Activation energy. Enzyme specificity - absolute, Group, linkage and stereo specificities. Concept of Active site; Lock and key hypothesis and Induced fit theory. Regulatory enzymes - allosteric enzymes with suitable examples. Isoenzymes: with reference to LDH and CK. Enzyme expression Units- IU, specific activity, Ktal.

#### **UNIT-II (18 Hours)**

Enzyme Kinetics: Rate of enzyme catalyzed reaction, Derivation of Michaelis-Menten equation. Lineweaver Burk plot and Eadie Hofstee plot. Factors affecting enzyme activity - pH, temperature, activators, cofactors, concentration of enzyme and substrate. Determination of  $K_m$  value by any 3 methods.

#### **UNIT-III (18 Hours)**

Enzyme inhibition – reversible and irreversible inhibition – types of reversible inhibitors: competitive, noncompetitive, uncompetitive inhibitors. (Derivation not required). Mechanism of enzyme activity: covalent catalysis, proximity and orientation, acid – base catalysis. Mechanism of action of chymotrypsin.

#### **UNIT-IV (18 Hours)**

Methods of isolation of enzymes: Homogenisation techniques, intracellular localization of enzymes; isolation of intracellular enzymes; separation procedure based on

molecular size - dialysis, ultrafiltration, molecular exclusion chromatography methods based on solubility – isoelectric precipitation. Salting in and salting out – methods based on electric charge – electrophoresis, Ion exchange chromatography, isoelectric focusing. Characterisation of purified enzymes - Ultracentrifugation and SDS-PAGE.

#### **UNIT-V (18 Hours)**

Coenzymes, function and action of TPP, PLP, NAD/NADP, FMN, FAD, coenzyme A, lipoic acid and Biotin. Multienzyme complexes – Pyruvate dehydrogenase complex. Metallo enzymes. Industrial uses of enzymes: Food, textile and pharmaceutical industries. Biosensors and their applications, immobilized enzymes and methods of immobilization.

#### **Books Recommended:**

1. Lehninger principles of Biochemistry international edition- David L. Nelson, Michael Cox. WH freeman, 7<sup>th</sup> edition (2017)
2. Biochemistry- Jeremy B. Berg, Lubert Stryer, John Tymoczko, Gregory Gatto. WH freeman 19<sup>th</sup> edition (2019)
3. Biochemistry- Geoffrey L. Zubay, William C Brown pub. 4<sup>th</sup> edition (1999)
4. Text Book of Biochemistry with clinical correlations- Thomas M. Devlin. John Wiley & sons, 7<sup>th</sup> edition (2010)
5. Principles and techniques of Biochemistry and molecular Biology- Wilson and Walker Cambridge University press. 8<sup>th</sup> edition (2018)
6. Understanding Enzymes- Trevor Palmer, Ellis Horwood Ltd. 4<sup>th</sup> edition (1995)

#### **Reference Books:**

1. Enzymes: Biochemistry, Biotechnology, Clinical chemistry- T Palmer, P L Bonner, Woodhead Publishing, 2<sup>nd</sup> edition (2007)
2. Fundamentals of Enzymology- Nicholas C. Price and Lewis Stevens, Oxford University Press, 3<sup>rd</sup> edition (1999).

#### **Web resources:**

- <http://www.yourarticlelibrary.com/biology/enzyme/enzyme-nomenclature-chemical-nature-and-mechanism/22734>
- <https://www.sciencedirect.com/topics/chemistry/industrial-enzyme>  
<https://www.easybiologyclass.com/enzyme-cell-immobilization-techniques/>  
<https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwj0jp39mKDnAhW-6XMBHZqPDJsQFjABegQIBRAB&url=https%3A%2F%2Frun.edu.ng%2Fdirectory>

%2Foermedia%2F8730122015152.pdf&usg=AOvVaw1rAkjRwn-3xFmRpmYX-7RRhttp://www1.lsbu.ac.uk/water/enztech/inhibition.html

- [https://en.wikibooks.org/wiki/Structural\\_Biochemistry/Enzyme/Cofactors#Metal\\_cofactors](https://en.wikibooks.org/wiki/Structural_Biochemistry/Enzyme/Cofactors#Metal_cofactors)

## **Core Paper-VIII: Metabolism**

**Credits:5**

**Teaching Hrs:90**

### **Learning outcomes:**

At the end of the program the student will learn the Concepts of thermodynamics and the mechanism of energy transfer in ETC the fate of the dietary carbohydrates the fate of the dietary lipids, fate of the dietary proteins and the metabolism of nucleotides, the interrelation among the carbohydrates, fat and proteinmetabolism.

### **UNIT I (18 Hrs)**

Bioenergetics - Free energy and the laws of thermodynamics; Role of high energy compounds as energy currency of the cell; free energy of hydrolysis of ATP and other organophosphates. The basic metabolic pathways, anabolic, catabolic and amphibolic pathways. Electron transport chain - Role of respiratory chain in mitochondria; in energy capture; respiratory control. Oxidative phosphorylation - Mechanism of oxidative phosphorylation; Chemiosmotic theory; uncouplers of oxidative phosphorylation.

### **UNIT II (18 Hrs)**

Fate of absorbed carbohydrates - Glycolysis - Pathways and energetics; Oxidation of pyruvate to acetyl CoA. TCA Cycle - Pathway and energetics; anaplerotic reaction Pasteur effect. Gluconeogenesis, Glycogenesis and glycogenolysis. Pentose Phosphate Pathway (HMP shunt). Glucuronic Acid Cycle and glyoxylate cycle (Enter- Doudoroff pathway) Metabolism of other hexoses - Fructose and galactose.

### **UNIT III (18 Hrs)**

Blood lipids and phase of dietary lipids. Oxidation of fatty acids: - Carnitine cycle; beta oxidation. Alpha oxidation and omega oxidation. Biosynthesis of propionyl CoA. Biosynthesis of saturated fatty acids: - Extra – mitochondrial in a microsomal system for synthesis of fatty acids. Biosynthesis of unsaturated fatty acids: - Monounsaturated and polyunsaturated fatty acids. Biosynthesis and degradation: - Lecithin, cephalin, inositol, phosphatidyl serine, cholesterol.

#### **UNIT IV (18 Hrs)**

Fate of dietary proteins, metabolic nitrogen pool. Catabolism of amino acid: Oxidative deamination, non – oxidative deamination, transamination and decarboxylation. Catabolism of carbon skeleton of amino acids. Catabolism of glycine, phenylalanine and tyrosine.

#### **UNIT V(18 Hrs)**

Metabolism of purines: - de novo synthesis, salvage pathways; catabolism. Metabolism of pyrimidines: - de novo synthesis, salvage pathways; catabolism. Interrelation between carbohydrates, fat and protein metabolism.

#### **Text Books:**

1. Harpers illustrated Biochemistry, Rodwell publishers, Lange international 31<sup>st</sup> edition (2018).
2. Fundamentals of Biochemistry- A.C. Deb, New central book agency- Kolkata 920010.
3. Lippincott illustrated reviews Biochemistry- Denise R. Ferrier. Lippincott Williams and Wilkins, 7<sup>th</sup>, north American edition (2016).
4. Biophysical chemistry- Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Himalaya Publishing House Pvt Ltd. 4<sup>th</sup> edition (2016).

#### **Reference books:**

1. Lehninger principles of Biochemistry international edition- David L. Nelson, Michael Cox. WH freeman, 7<sup>th</sup> edition (2017).
2. Biochemistry- Jeremy B. Berg, Lubert Stryer, John Tymoczko, Gregory Gatto. WH freeman 19<sup>th</sup> edition (2019).
3. Biochemistry- Geoffrey L. Zubay, William C Brown pub. 4<sup>th</sup> edition (1999).
4. Text Book of Biochemistry with clinical correlations- Thomas.M. Devlin. John Wiley & sons, 7<sup>th</sup> edition (2010).
5. Principles and techniques of Biochemistry and molecular Biology- Wilson and Walker Cambridge University press. 8<sup>th</sup> edition (2018).

#### **Web resources:**

- [https://www.brainkart.com/article/High-energy-compounds\\_26724/](https://www.brainkart.com/article/High-energy-compounds_26724/)
- <https://www.britannica.com/science/thermodynamics/Thermodynamic-equilibrium>
- <https://www.khanacademy.org/science/high-school-biology/hs-energy-and-transport/hs-introduction-to-metabolism/a/overview-of-metabolism>

- <https://courses.lumenlearning.com/suny-ap2/chapter/carbohydrate-metabolism-no-content/> <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5946176/>
- <http://fblt.cz/en/skripta/ii-premena-latek-a-energie-v-bunce/12-metabolismus-aminokyselin/>

## **Core Paper-IX: Analytical Biochemistry**

**Credits:5**

**Teaching Hrs:90**

### **Learning Outcomes:**

- Learning outcomes of students who complete this course include: understanding the concepts of acids, bases, buffers, various units used in expressing their strength and measuring their pH, buffers in bodyfluids.
- The students also will gain in depth knowledge about the techniques, types, operation and applications of oxygen electrode, Microscopy, chromatography, electrophoresis, understanding radioactivity, its measurements and applications, Basics of bioinformatics, Nanotechnology and its applications in various fields.

### **UNIT-I (18 Hrs)**

Definition of Molality, Molarity, Normality, Osmolarity, Definition of pH, pOH, determination of pH- Glass electrode, Buffers, Tonicity. Henderson – Hassel Balch equation. Buffers in body fluids, Red blood cells, tissues. Measurement of oxygen consumption - the Clark oxygen electrode. Light Microscopy: Principle, components and structure of compound microscope. Types- basic concepts only. Electron microscopy – Principle, techniques and applications of Transmission and scanning electron microscopy.

### **UNIT-II (18 Hrs)**

General principles of chromatography – partition and adsorption chromatography. Paper chromatography – principle, sample application, development, Rf value calculation, Applications - separation and detection of amino acids and sugars. Thin layer chromatography – principle, instrumentation and applications (separation of alkaloids). Column chromatography – principle, Techniques, Fraction collection and analysis. Basic principles and applications of Affinity chromatography, ion exchange chromatography, gel exclusion chromatography, HPLC and GLC.

### **UNIT-III (18 Hrs)**

General principle of electrophoresis, factors affecting migration rate – electrical potential, nature of the sample, nature of buffer, nature of the supporting medium. Tiselius moving boundary electrophoresis. Principle, procedure and application of paper, cellulose acetate, agarose and starch gel electrophoresis. Isoelectric focusing. Principle and applications of SDS -PAGE and 2-dimensional PAGE.

### **UNIT- IV (18 Hrs)**

Radioisotope techniques- Natural and artificial radioactivity, Types of radioactive decay, units of radioactivity, Rate of radioactive decay, interaction of radioactive decay with matter. Detection of radioactivity by- GM counter, Scintillation counter and autoradiography - Principle, techniques and applications. Applications of radioisotopes in biological sciences, radio dating and in clinical diagnosis. Biological effects of radiations. Safety measures in handling radio isotopes.

### **UNIT- V (18 Hrs)**

Fundamentals of Bioinformatics, Biological databases – Nucleotide sequence data bases and protein sequence data bases – types and applications. Basic concepts of proteomics and genomics. Industrial and pharmaceutical applications of Bioinformatics. Introduction to nanotechnology - Definition and scope of nanotechnology, Nano particle and Nano materials - structure and properties, Nano scale. Types of Nano materials – metallic and nonmetallic, - Applications of nano materials – Medicine, Agriculture, Environment & Health. Possibilities for the future, Pitfalls in nanotechnology.

### **Text Books:**

1. Principles and Techniques of Biochemistry and Molecular Biology - Keith Wilson, John Walker. Cambridge University Press. 8<sup>th</sup> edition(2018).
2. Biophysical chemistry- Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Himalaya Publishing House Pvt Ltd. 4<sup>th</sup> edition (2016)
3. Instrumental methods of chemical analysis- Grudeep R. Chatwal & Sham K. Anand, Himalaya publishing house, 5<sup>th</sup> edition (2014)
4. Physical Biochemistry: Principles and Applications - David Sheehan. Wiley-Blackwell 2<sup>nd</sup> edition. (2009)
5. Biophysics & Biophysical chemistry- Debjyoti Das. Academic Publishers (2007)
6. Basics Bioinformatics – Ignachimuthu S.J., Narosa publishing House Private Limited, New Delhi, (2013)

7. Bioinformatics - Methods and Applications, S.C.Rastogi, N.Mandiratta, P. Rastogi, 4<sup>th</sup> Edition, PHI Learning Private limited, New Delhi(2013).
8. Bioinformatics – Proteomics and Genomics, Ruchi Singh, Vikas Publishing House private Limited, New Delhi, (2015).
9. Introduction to Bioinformatics – Arthur M. Lesk, 1<sup>st</sup> Edition, Oxford University Press, USA, (2002).
10. A Text Book of Bioinformatics – Sharma, Munjal, Shanker, Rastogi publications, Utter Pradesh, 2006.
11. Bioinformatics – Basic principles and Applications – Sedek.H.A., Published by Trafford publishing, Bloomington USA,2006
12. Nanoscience and Nanotechnology: Fundamentals of Frontiers,[Shubra Singh M.S. Ramachandra Rao](#), Wiley publishers, 2012.
13. Introduction to Nanoscience and Nanotechnology, Chattopadhyay K.K , Banerjee A,N, PHI learning private limited,2009.
14. Textbook of Nanoscience and Nanotechnology by T. Pradeep, McGraw Hill Education (India) Private Limited: 2012.
15. NANO: The Essentials: Understanding Nanoscience and Nanotechnology, T. Pradeep, McGraw Hill Education (India) Private Limited,2017.

**Reference Books:**

1. Laboratory: Modern Theory and techniques- Rodney F.Boyer, Prentice Hall 2nd edition (2012)
2. Analytical techniques in Biochemistry and Molecular Biology- KalochRajan, Springer (2011)
3. Principles & Techniques of Practical Biochemistry – Wilson, Walker- Cambridge Univ. Press (2000)
4. Instrumental approach to chemical analysis- A.K.srivastava, P.C. Jain. S.Chand& Co Ltd. 4th edition (2008).
5. Biophysical chemistry- Alan cooper, RSC publishing. 2ndedition (2011).

**Web Resources:**

- [https://en.wikibooks.org/wiki/Structural\\_Biochemistry/Proteins/Gel\\_Electrophoresis](https://en.wikibooks.org/wiki/Structural_Biochemistry/Proteins/Gel_Electrophoresis)  
[https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A\\_Biochemistry\\_Free\\_For\\_All\\_\(Ahern%2C\\_Rajagopal%2C\\_and\\_Tan\)/08%3A\\_Basic\\_Techniques/8.03%3A\\_Electrophoresis](https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_(Ahern%2C_Rajagopal%2C_and_Tan)/08%3A_Basic_Techniques/8.03%3A_Electrophoresis)

- <http://www.biologydiscussion.com/biochemistry/chromatography-techniques/top-12-types-of-chromatographic-techniques>  
<http://www.biologydiscussion.com/biochemistry/12730><https://micro.magnet.fsu.edu/primer/anatomy/introduction.html><https://en.wikibooks.org/wiki/Nanotechnology/Introduction>
- <https://academic.oup.com/bioinformatics>
- [https://chem.libretexts.org/Courses/Northeastern\\_University/13%3A\\_Kinetic\\_Methods/13.3%3A\\_Radiochemistry](https://chem.libretexts.org/Courses/Northeastern_University/13%3A_Kinetic_Methods/13.3%3A_Radiochemistry)
- <https://www.world-nuclear.org/information-library/non-power-nuclear-applications/radioisotopes-research/radioisotopes-in-industry.aspx><https://opentextbc.ca/introductorychemistry/chapter/uses-of-radioactive-isotopes-2/>

### **Elective Paper-I: Human Physiology**

**Credit:5**

**Teaching Hrs:90**

#### **Learning Outcomes:**

- Understand the structure and function and different components of digestive and urinary system.
- Have Knowledge about Blood composition and its function, blood clotting mechanism.
- Gain knowledge about blood pressure and to create awareness about cardiovascular diseases
- To inculcate knowledge about the muscular and nervous system, role of neurotransmitters in Physiology.
- To acquire in-depth knowledge about respiratory and to create awareness about lung disorders.
- To learn about the reproductive system and to know about the reproductive disorders
- To introduce the organization of endocrine system and classification of hormones

#### **UNIT I (18 hrs)**

Structure of digestive system, digestion and absorption of carbohydrates, lipids and protein, Mechanism of HCl formation in stomach, role of various enzymes and hormones involved in digestive process and defecation. Excretory system – structure and function of kidney, structure of a nephron, mechanism of urine formation.

## **UNIT-II (18 hrs)**

Composition of blood cells, plasma components, and lymph Arteries, Arterial BP and measurement, Capillaries and bulk flow across the capillary walls, Veins and determination of venous pressure and blood groups. Bleeding and clotting time. Mechanism of blood clotting. Circulatory system - basic anatomy of heart. Systemic, pulmonary and portal circulation. Heart beat, cardiac cycle and pacemaker. Long term and short-term regulation of cardiac efficiency and BP.

## **UNIT-III (18 hrs)**

Nervous system – Brain (parts of brain and ventricles), spinal cord, central and autonomous nervous system (sympathetic and parasympathetic). Structure of a neuron, synaptic transmission. Reflex action and neurotransmitters. Muscular system - types of muscles, structure and composition of skeletal muscle structure of a myofibril, mechanism of muscle contraction and theories of muscle contraction. Outline of neurotransmitters and cAMP. Synapses - chemical and electrical synapse, nerve impulse, action potential and neurotransmitters.

## **UNIT-IV (18 hrs)**

Respiratory system- composition of air, significance of O<sub>2</sub>, carbon dioxide and nitrogen in biological system. Partial pressure of oxygen and carbon dioxide. Gaseous exchange in the lungs, tissue, arterial and venal capillaries, Role of kidney and lungs in maintaining the pH of blood, Pulmonary surfactants.

## **UNIT-V (18 hrs)**

Reproductive Physiology: Sex determination and differentiation, Development of female and male genital tracts. Oogenesis, Spermatogenesis, capacitation and transport of sperm-blood testis barrier. Fertilization early development, Implantation, Placentation and Parturition. Hormones - classification of hormones, endocrine glands and their secretion. Insulin, thyroxine, growth hormone. Structure and function. Steroid hormones. Corticosteroids (Structure and Function only) - sex hormones – testosterone and estrogen, menstrual cycle.

### **Recommended Text Books:**

1. Text book of Medical Biochemistry Physiology – MN.Chatterjee and Rana Shinde, 7<sup>th</sup> edition, Japee Brothers – Medical Publishers, 2007
2. Animal physiology – Mariakuttikan and Arumugam, Saras Publication, 2017.

### **Reference Books:**

1. Textbook of Medical Physiology – Guyton & Hall, 12<sup>th</sup> edition, Saunders Publishers,

2010.

2. Davidson's Principles and Practice of Medicine - XX Edition)
3. John.A.A.Hunter, 21<sup>st</sup> Edition, Elsevier Publishers, 2010.
4. HumanAnatomy & Physiology – Elaine N.Marieb, 3rd edition. Benjamin/Cummings (a Pearson Education company), 1995.
5. Essentials of Medical Physiology –Sembulingam, 7thEdition, JaypeeBrothers Medical Publishers, 2016.
6. Best and Taylor's Physiological Basis of Medical Practice – Tandon, 13<sup>th</sup> Edition, Wolters Kluwer India Pvt. Ltd, 2011.

### **E-Learning Resources:**

- [physiologyonline.physiology.org](http://physiologyonline.physiology.org)
- [www.brainmac.co.uk/physoil.html](http://www.brainmac.co.uk/physoil.html)
- <https://youtube/SPRPKLOKp8>
- <https://youtube/ousflozhc>
- [https://youtube/Zr4onA2K\\_LY](https://youtube/Zr4onA2K_LY)

## **SemesterVI**

### **Core Paper-X: Clinical Biochemistry**

**Credits:5**

**Teaching Hrs:90**

### **Learning outcomes:**

- To gain knowledge on scope of clinical biochemistry
- To understand the alteration in biochemical components during various clinical conditions
- To highlight the importance of various biochemical parameters in the diagnosis of diseases.

### **UNIT-I (18 Hrs)**

Maintenance of blood glucose by hormone with special reference to insulin and glucagon. Abnormalities in glucose metabolism. Diabetes mellitus-types, causes, biochemical manifestations, diagnosis and treatment, Inborn errors of carbohydrate metabolism, Galactosemia, Fructosuria and Glycogen storage disease.

## **UNIT-II (18 Hrs)**

Liver function tests, Tests based on bile pigment metabolism. Enzymes pattern in health and diseases with special mention of plasma lipase, amylase, cholinesterase, alkaline and acid phosphatase, SGOT, SGPT, LDH and CPK. Clinical enzymology - enzymes of diagnostics importance: LDH, Creatinine kinase, transaminases and pancreatic lipase.

## **UNIT-III (18 Hrs)**

RBC, WBC, epithelial cells, cast and calculi. Normal and abnormal constituent in urine, Inulin, urea and creatinine clearance tests. Concentration and dilution test. Phenol red test. Kidney function tests, measurement of urine Ph, volume, specific gravity, Osmolality sediments in urine. Levels of plasma proteins and its significance related to kidney function. Proteinuria.

## **UNIT-IV (18 Hrs)**

Levels of cholesterol, triglycerides, phospholipids, free fatty acids and lipoprotein in blood. Abnormal levels of these lipids in diseases. Atherosclerosis, hyper and hypoproteinemias, Sphingolipidoses, Niemann- pick disease, Gaucher's and Tay-ach's disease-causes and pathology. Inborn errors of amino acid metabolism-alkaptonuria, Phenylketonuria, albinism, gout and hyper-uricemia causes, types and treatment.

## **UNIT-V (18 Hrs)**

Diagnostic tools: Principles and applications. Clinical chemistry analyser- semi and fully automated. Electrolyte analyser. Blood gas analyser- ECG. Glucometer - HbA<sub>1c</sub> analyser and other point care devices.

### **Books for Study:**

1. Thomas M.Devlin(2014) Textbook of Biochemistry with clinical correlations (7<sup>th</sup> ed). John Wiley and sons.
2. Montgomery R, Conway TW, Spector AA (1996), Biochemistry: A Case- Oriented Approach (6<sup>th</sup>ed) Mosby Publisher, USA.
3. Dinesh puri, (2002). Textbook of Biochemistry: A clinically oriented approach- Churchill Livingstones Inc., India.
4. M.N.Chatterjee and Rana Shinde (2007). Textbook of Medical Biochemistry (7<sup>th</sup>ed)
5. Manual of Medical Laboratory techniques by Ramakrishna Jaypee Publication.
6. Textbook of Medical Biochemistry (3<sup>rd</sup> ed) S.Ramakrishnan *et al.*, Orient Blackswan (2004).

**Books for Reference:**

1. Tietz Fundamentals of clinical chemistry and MolecularDiagnostics (2014) (7<sup>th</sup>ed). Saunders.
2. Zilva and Panel- clinical Biochemistry (1<sup>st</sup> published in 1971) (8<sup>th</sup>ed)

**Web Resources:**

- <https://www.unifr.ch/biochem/assets/files/dreyer/cours/BC0103%20ch13.pdf>.
- <https://www.slideshare.net/numeranansir/mn-chatterjea-textbook-of-medical-biochemistry-third-edition-charlotte-w-pratt.pdf>.
- <http://archive.org/details/clinicalchemistre2zilv/page/n7>.

**Core Paper-XI: Molecular Biology****Credit:4****Teaching Hrs:75****Learning Outcomes:**

- Gain knowledge about the various types of DNA, the organization of genes to chromosomes in prokaryotes and eukaryotes.
- Understand the molecular basis of DNA synthesis, Know the importance of the process, and the role of inhibitors of DNA as drugs.
- Understand the process of RNA synthesis, post transcriptional modifications and apply the same to understand the role of antibiotics.
- Discuss about the genetic code, molecular basis of protein synthesis & modification.
- Detail the mechanism of DNA mutation, Repair system and understand the use of molecular process in disease diagnosis.

**UNIT I (15 Hrs)**

DNA as the unit of inheritance. Griffith, Avery, McLeod, McCarthy, Hershey and Chase experiments and their significance. Definition of gene, organization of gene and non-coding sequence in prokaryotes, mitochondrial DNA, plasmid DNA. Viral genome - bacteriophages (M13 and  $\Phi$ X174), animal virus (influenza virus), plant virus (TMV). Organisation of genes in Eukaryotes, Satellite DNA

**UNIT II (15 Hrs)**

Prokaryotic replication - model of replication - semiconservative mode of replication - replication forks, semi-discontinuous replication, Okazaki fragments. Bacteriophages M13 and  $\Phi$ X174 replication, rolling circle model of replication. Enzymology of replication - role

of DNA polymerases I, II, III, gyrase, topoisomerases, helicase, ligases and SSB proteins. Theta replication in E. coli - initiation events at Ori C, elongation events on the replication fork and termination- fidelity of replication- Inhibitors of replication and their applications as drugs.

### **UNIT III (15 Hrs)**

Transcription - prokaryotic RNA polymerases - role of sigma factor. TATA box, promoter, closed and open promoter complexes - initiation, elongation and termination of transcription, post transcriptional modifications in prokaryotes (tRNA and rRNA). Inhibitors of Transcription and their applications as antibiotics.

### **UNIT IV (15 Hrs)**

Genetic code - characteristics of genetic code - Wobble hypothesis - protein biosynthesis - activation of amino acids, initiation, elongation and termination of translation in prokaryotes. Inhibitors of protein biosynthesis and their use as antibiotics.

### **UNIT V (15 Hrs)**

DNA damage, Mutation - types of mutation with examples, causes - physical and chemical agents, site - specific mutagenesis and mutational hot spots. DNA repair by direct reversal of damage, photoreactivation, excision repair, recombination repair, SOS repair. Application oriented Topic: Molecular Diagnostic techniques in DNA, RNA and Protein.

### **Books Recommended:**

1. Voet Donald and Voet Judith (2004) Biochemistry, Wiley International Edition, 3<sup>rd</sup> Edition, John Wiley & Sons.
2. Nelson David and Cox Michael (2004), Lehninger Principles of Biochemistry, W.H. Freeman & Co: New York
3. Lodish, Harvey, Berk, Arnold, Zipursky, Lawrence, Matsudaira, Paul, Baltimore: (2006), Molecular cell biology, 4<sup>th</sup> Edition, W.H Freeman & Co.
4. Krebs Jocelyn, Lewis Benjamin, Goldstein, Elliott, Kilpatrick, Stephen (2009) Lewin's Genes X. Jones and Bartlett.

### **Reference Books:**

1. Becker, Wayne, Kleinsmith, Lewis, Hardin, Jeff, Bertoni, Gregory Paul (2009), The world of cell, 7<sup>th</sup> Edition, Pearson Education Inc.
2. Geoffrey M. Cooper & Robert E. Hausman, The Cell – molecular approach (2002), 3<sup>rd</sup> Edition, 2002.

## **Elective Paper-II: Immunology**

**Credit:5**

**Teaching Hrs:90**

### **Learning outcomes:**

- On completion of the course, the students will
- Understand about the types of immunity, lymphoid organs and the cellular basis of immunity
- Obtain knowledge on types of antigens, antibodies and activation of complements
- Gain insight into various in vitro reactions between antigen and antibody and its application in clinical diagnosis
- Apprehend the enormous scope of different types of vaccines
- Acquire knowledge on autoimmunity, hypersensitivity and transplantation immunology

### **UNIT I**

Types of immunity - innate and acquired. Determinants of innate immunity – anatomical, Biochemical and Cellular Factors - Phagocytosis, Inflammation. Humoral and cell mediated immunity. Immune system – functions and structural components - lymphoreticular system – lymphoid organs - primary and Secondary lymphoid organs. Types, structure and functions of lymphoid cells – B, T and null cells.

### **UNIT-II**

Antigens – definition – types – haptens, isoantigens, neoantigens. Factors affecting antigenicity and immunogenicity of antigens. Antibodies – definition and classification. General structure and functions of IgM, IgD, IgA, IgG and IgE, Isohemeagglutinins and natural antibodies. Clonal selection theory of antibody formation. Complement – biochemical functions. Activation by classical and alternative pathways.

### **UNIT-III**

Antigen – antibody interaction – types – precipitation and agglutination mechanism. Applications of agglutination reaction in diagnosis of diseases – Widal test – complement fixation test, Coombs's test Blood grouping - major and minor blood groups. Erythroblastosis fetalis, Blood transfusion. Mismatched blood transfusion and its consequences, Principle and applications of RIA and ELISA, immunoelectrophoresis and immunofluorescence.

#### **UNIT-IV**

Immunization practices - passive and active immunization. Commonly used vaccines - killed and live attenuated vaccines. DNA vaccine, Recombinant vector vaccine. Vaccination schedule for children. Production of monoclonal antibodies - principle and applications.

#### **UNIT-V**

Disorders of immune system – hypersensitivity – causes, types and pathology of type I, II, III and IV hypersensitivity – Auto immunity – causes and the pathology of Rheumatoid arthritis, systemic lupus erythematosus, Hashimoto's thyroiditis, thyrotoxicosis, autoimmune hemolytic anemia. Immunomodulation. Transplantation immunology - graft acceptance and rejection.

#### **Recommended Books:**

1. Immunology- Peter, Alex and Micheal, 2<sup>nd</sup> edition, 2004.
2. Fundamentals of Medical Immunology - Venugopal Jayapal, 2007.
3. Text book of Microbiology - Ananthanarayanan and Panickar, 9<sup>th</sup> edition, 2013.

#### **Reference Books:**

1. Immunology - Kuby , 5<sup>th</sup> edition, 2003.
2. Essential Immunology – Roitt, 3<sup>rd</sup> edition.

### **Core-XII: Practical III**

**Credit: 4**

#### **I. Collection and preservation of urine samples.**

**II.** Qualitative analysis of normal constituents of urine such as urea, Creatinine, Phosphorus, Calcium and abnormal constituents such as calcium, sugar, protein, amino acid ketone bodies and bile pigments with clinical significance.

#### **III. Quantitative Analysis of urine**

1. Urea
2. Uric acid
3. Creatinine
4. Calcium

#### **IV. Collection and preservation of blood sample**

## **V. Quantitative Estimation in blood**

1. Haemoglobin
2. Cholesterol
3. Glucose
4. Urea
5. Creatinine
6. Protein by Lowry's method
7. Determination of albumin and A/G ratio in serum

## **VII. Enzyme assay**

1. AST
2. ALT
3. Alkaline phosphatase.

## **VIII. Group Experiments**

1. RBC Counting
2. Total and differential count of white blood cells
3. Packed cell volume
4. Erythrocyte sedimentation rate
5. Blood clotting time
6. Blood grouping

## **Distribution of marks**

- Internals - 40
- Externals - 60
- Record- 10

Two experiments to be taken from each sub unit but not from the same unit. Each experiment will carry 25 marks.

## **Core-XIII: PROJECT**

- Project- related to Biochemistry should be innovative and experimental in nature. Under the supervision of faculty carried out at the institution.
- Project report will be evaluated for 100 marks by the external examiner.

## **Distribution of Marks**

- External - 60
- Project – 40

- Presentation-10
- Viva voce -10
- Internal marks - 40

### **Elective Paper-III: Biotechnology**

**Credits:5**

**Teaching Hours:90**

#### **Learning outcomes:**

- The students will acquire basic knowledge of recombinant DNA technology, DNA manipulation in prokaryotes and eukaryotes, engineering of DNA molecules using restriction and modification enzymes.
- They will get acquainted with the use of cloning and vectors, creation of genomic and cDNA libraries and their applications.
- Students will also understand the methods for production of proteins using recombinant DNA technology and their applications, basics of tissue culture, transgenesis, stem cell technology, risks, and safety aspects and patenting in biotechnology.

#### **UNIT -I (18 Hours)**

Scope and importance of biotechnology. Recombinant DNA technology - Principles of gene cloning: restriction endonucleases and other enzymes used in manipulating DNA molecules. Ligation of DNA molecules, DNA ligase, linkers and adapters, homopolymer tailing. Plasmids and bacteriophages as vectors for gene cloning - Cloning vectors based on E. coli plasmids, pBR322, pUC8. Cloning vectors based on M13 and  $\lambda$  bacteriophage. Uptake of DNA by cells, Selection and identification for transformed cells - colony hybridization, screening with antibodies.

#### **UNIT-II (18 Hours)**

Construction of genomic library. Synthesis of cDNA, Construction of cDNA library. Production of recombinant pharmaceuticals such as insulin, humangrowth hormone, factor VIII and Recombinant vaccines. PCR –Principle, Steps, Types and its application in clinical diagnosis and forensic science. Southern blotting, Northern blotting and DNA finger printing Technique and their applications.

### **UNIT-III (18 Hours)**

Plant genetic engineering: gene isolation, gene transfer systems, Ti plasmid, plant virus vectors, electroporation, microinjection, micro projectile technology, gene expression, regeneration. Applications - Resistance to biotic stress - insect resistance and virus resistance. Resistance to a biotic stress - Herbicide resistance. Improved nutrition - Golden rice. Production of low-cost Pharmaceuticals - Production of edible vaccines.

### **UNIT-IV (18 Hours)**

Tissue culture – Culture media, Plant tissue culture, protoplast culture, protoplast fusion and regeneration, embryo rescue - techniques and applications. Animal cell lines and organ culture - culture methods and applications. Transgenic animals: transgenic mice Production and its applications. Stem cell technology: definition, types, culture and applications.

### **UNIT-V (18 Hours)**

Fermentation technology – Fermentors - general design, fermentation processes - Media used, downstream processing. Production and applications of ethanol, streptomycin, and Proteases. Biotechnology and society: safety, legal, social and ethical aspects of biotechnology. Patenting biotechnological inventions.

#### **Text Books:**

1. A Text book of Biotechnology- R. C. Dubey, S. Chand & company Pvt. Ltd 5<sup>th</sup> edition (2014).
2. Biotechnology- Satyanarayana U, Books & Allied (P) Ltd. (2008)
3. Industrial Microbiology - Casida L, New Age International (2007)
4. Prescott and Dunn's Industrial Microbiology- Reed G, CBS Publishers & Distributors (2004)
5. Advances in animal Biotechnology- Singh. B, Mal. M, Gautam S. K, Mukesh. M, Springer (2019).

#### **Reference books:**

1. Biotechnology: applying the genetic revolution- David P. Clark, Pazdernik N. J, Elsevier (2009).
2. Molecular Biotechnology: Principles and Applications of Recombinant DNA - Click B.R. and Pasternak J.J. American Society for Microbiology, 4<sup>th</sup> edition. (2010)
3. (2006), Recombinant DNA: Genes and Genomes - a Short Course - James D. Watson, Amy Caudy, Richard M. Myers, Jan Witkowski, W.H. Freeman & Co, 3<sup>rd</sup> edition (2006).

### **Web Resources:**

- <https://futureoflife.org/background/benefits-risks-biotechnology/><https://www.sciencedirect.com/topics/neuroscience/genetic-engineering><http://www.biologydiscussion.com/biotechnology/techniques-biotechnology/important-techniques-of-biotechnology-3-techniques/15683>
- <https://iopscience.iop.org/book/978-0-7503-1347-6/chapter/bk978-0-7503-1347-6ch1>[https://www.slideshare.net/zeal\\_eagle/fermentation-technology](https://www.slideshare.net/zeal_eagle/fermentation-technology)[https://www.slideshare.net/zeal\\_eagle/fermentation-technology](https://www.slideshare.net/zeal_eagle/fermentation-technology)<https://www.slideshare.net/Chepkitwai/blotting-techniques-6129300>