

ANNAMALAI UNIVERSITY

210 - B. Sc. Biochemistry

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted in Affiliated Colleges from
the academic year 2022 -2023 onwards)

Course Code	Part	Study Components & Course Title	Hours /Week	Credit	Maximum Marks		
					CIA	ESE	Total
		SEMESTER – I					
22UTAML11	I	Language Course - I : Tamil /Other Languages	5	3	25	75	100
22UENGL12	II	English Course - I : Communicative English I	5	3	25	75	100
22UBIOC13	III	Biomolecules	4	4	25	75	100
22UBIOC14		Cell Biology	4	4	25	75	100
		Core Practical – I	3	-	-	-	-
22UCHEA01		Allied - I : Chemistry– 1	4	4	25	75	100
		Allied Chemistry Practical – I	3	-	-	-	-
22UENVS18	IV	Environmental Studies	2	2	25	75	100
	Total		30	20			600
		SEMESTER – II					
22UTAML21	I	Language Course - II : Tamil/Other Languages	5	3	25	75	100
22UENGL22	II	English Course - II : Communicative English II	5	3	25	75	100
22UBIOC23	III	Human Physiology	4	4	25	75	100
22UBIOP24		Core Practical – I	3	4	40	60	100
22UCHEA02		Allied – I Chemistry -II	4	4	25	75	100
22UCHEP02		Allied Chemistry Practical – I	3	3	40	60	100
22UBIOE27		Internal Elective - I	2	3	25	75	100
22UVALE27	IV	Value Education	2	1	25	75	100
22USOFS28		Soft Skill	2	1	25	75	100
	Total		30	26			900

INTERNAL ELECTIVE COURSES

Internal Elective - I :	22UBIOE27A	Nutritional Biochemistry
	22UBIOE27B	Food Technology
	22UBIOE27C	Health and Diseases

Allied Courses offered by the Department of Biochemistry

22UBIOA01	Theory	Biochemistry I
22UBIOA02	Theory	Biochemistry II
22UBIOP02	Practical	Allied Biochemistry Practical - I

SEMESTER-I CORE	22UBIOC13: BIOMOLECULES (60 hrs)	HRS/WK-4 CREDIT-4
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COURSE OBJECTIVES

1. To study the structure, classification, types and functions of carbohydrate.
2. To acquire knowledge about the structure and function of amino acids and proteins.
3. To learn the structure, classification and importance of lipids.
4. To study the structure and function of nucleic acid.
5. To learn the structure and functions of lipids and heterocyclic compounds.

EXPECTED COURSE OUTCOMES

On the successful completion of the course, student will be able to:

- CO1** Understand the nature, types, structure and function of carbohydrates.
CO2 Comprehend the classification of proteins and their properties.
CO3 Gain knowledge about the classification and properties of complex lipids.
CO4 Acquire knowledge about the structure, properties and types of DNA and RNA.
CO5 Understand about the structure and functions of heterocyclic compounds.

Unit: 1 CARBOHYDRATES

Hours: 12

Classification, General properties with reference to glucose, isomers, anomers, epimers, enantiomers and mutarotation. Fischer projections, Haworth projection, pyranose and furanose structure chair and boat conformations. Source, structure and biological functions – monosaccharides (glucose and fructose), disaccharides (sucrose, lactose, maltose), polysaccharides (starch, glycogen, inulin, cellulose, chitin). Heteropolysaccharides (hyaluronic acid, heparin).

Unit :2 AMINO ACIDS AND PROTEINS

Hours: 12

Classification, stereoisomerism, and general properties, 3-letter and 1-letter abbreviation. Essential, non essential amino acids and non protein amino acids. General properties of amino acids and zwitter ion. Classification of proteins based on size and shape, solubility and functions. Peptide bond. Structure of proteins - Primary, secondary, tertiary & quaternary. Bonds stabilizing the structure of proteins, Biologically important peptides - Glutathione, vasopressin, and oxytocin.

Unit :3 LIPIDS

Hours: 12

Classification of lipids and fatty acids, Properties of fatty acids (Iodine number, Acid number, RM number, Saponification number and Rancidity). Structure and functions of phospholipids - Lecithin, cephalin, phosphatidyl inositol and phosphatidylserine, sphingomyelin, plasmalogen. Sterols-cholesterol. Glycolipids - cerebrosides and gangliosides.

Unit: 4 NUCLEIC ACIDS

Hours: 12

Nitrogen bases, nucleosides and nucleotides. Phosphodiester linkage. Watson – Crick double helical structure of DNA. A, B and Z forms of DNA. Properties of DNA- Denaturation, renaturation, T_m and hyperchromicity. Major classes of RNA- structure and biological functions. Differences between DNA and RNA.

Unit: 5 VITAMINS AND HETEROCYCLIC COMPOUNDS**Hours: 12**

Definition and classification of vitamins - Fat-soluble vitamins - sources, requirements, biological actions of vitamins A, D, E, and K. Water-soluble vitamins - sources, requirements, biological actions of thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid and vitamin B12. Structure and biological importance of heterocyclic compounds-Pyridine, pyrrole, furan, and thiophene.

Textbooks:

1. RenukaHarikrishnan ,1995, “ *Biomolecules and Enzymes*” (2nd edition), Madurai, IndiraPathipagam.
2. Lehninger, Nelson and Cox, (1982), *Principles of Biochemistry*, (4th ed) UK, Macmillan Worth Publishers.
3. Jain J.L., Sanjay Jain and Nitin Jain, (1997), “*Fundamentals of Biochemistry*”(6thEdition), New Delhi, S. Chand & Company Ltd.
4. Power &Chatwal*Biochemistry* (4thed) Himalaya Publishing House.

Supplementary Readings

1. Cambell& Farrell (2007), *Biochemistry* (5thed), Delhi, Baba Borkhanath printers.
2. Pattabiraman T. N. (1993) *Principles of Biochemistry* (5thed), Bangalore, Gajanana Book Publishers and Distributors
3. Dr. Deb A C., (1983), *Fundamentals of Biochemistry* (8thed), Kolkata, New Central Book Agency.
4. Voet and Voet. *Fundamentals of Biochemistry*. Wiley. 5th ed. 2018.
5. JyothiRoshan Kumar *Chemistry of chemical bonding*. 2008.

MAPPING WITH PROGRAMME OUTCOMES (PO)

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	3	3	2	1
CO3	3	3	3	2	1
CO4	3	3	3	2	1
CO5	3	3	3	2	1

3- Strong;2- Medium;1-Low;

SEMESTER-I CORE	22UBIOC14: CELL BIOLOGY (60 hrs)	HRS/WK-4 CREDIT-4
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COURSE OBJECTIVES

1. To know the classification and composition of cells.
2. To gain knowledge on structure and composition of membrane.
3. To acquire information on cell organelles.
4. To study about the cytoskeleton of the cell.
5. To know the stages of mitosis and meiosis cell division.

EXPECTED COURSE OUTCOMES

Upon successful completion of the course, student will be able to:

- CO1 Understand the origin, classification and types of cell.
- CO2 Apprehend membrane composition and transport mechanisms.
- CO3 Understand the structure and function of the cell organelles.
- CO4 Comprehend the cytoskeleton of the cell.
- CO5 Understand cell steps involved in cell cycle and division.

Unit :1 INTRODUCTION TO CELL

[12 hrs]

An overall view of cells – origin and evolution of cells, cell theory. Classification of cell – prokaryotic and eukaryotic cells. Difference between prokaryotic and eukaryotic cells. Molecular composition of cells- Water, carbohydrate, Lipids, Nucleic acids and proteins.

Unit: 2 CELL MEMBRANE

[12 hrs]

Cell membrane structure - Fluid mosaic model of membrane structure. Membrane protein and their properties. Membrane carbohydrate and their role. Endocytosis and exocytosis. Transport across membranes: diffusion, active and passive transport.

Unit: 3 CELL ORGANELES

[12 hrs]

Endoplasmic reticulum –types, structure and function. Golgi apparatus – structure and function. Lysosomes structure and functions. Ribosomes – Types structure and functions.

Unit: 4 CELL CYTOSKELETON

[12 hrs]

Mitochondria structure and functions. Cytoskeleton - Types of filaments and their functions. Microtubules - Chemistry and function (Cilia and flagella).

Unit: 5 CELL DIVISION

[12 hrs]

Chromosome- chromatin structure. Cell cycle – phases of cell cycle. Meiotic and mitotic divisions, cell-cell communications. Cell recognition, cell adhesion and cell functions.

Text Books:

1. Rastogi SC. *Cell Biology*. New Age International Publishers.
2. Lodish et al., (2016) *Molecular Cell Biology*. (8thed) Freeman.

Supplementary Readings

1. Martin BM. (2013) *Tissue Culture Techniques-An Introduction*. Springer Science and Business Media.
2. Karp. (2016) *Cell & Molecular Biology* (8thed) Wiley.
3. Alberts et al. *Molecular Biology of the Cell*. Garland Sci. 6th ed. 2014

MAPPING WITH PROGRAMME OUTCOMES (PO)

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	2	2	3	2
CO3	3	2	2	3	2
CO4	3	2	2	3	2
CO5	3	2	2	3	2

3- Strong;2- Medium;1-Low;

SEMESTER-II CORE	22UBIOC23: HUMAN PHYSIOLOGY (60 hrs)	HRS/WK-4 CREDIT-4
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COURSE OBJECTIVES

1. To learn about the blood composition and circulatory system.
2. To gain knowledge about the respiratory process.
3. To know the digestive and excretory process.
4. To study the role of proteins in muscle contraction.
5. To learn about the brain structure and transmission of impulse.

EXPECTED COURSE OUTCOMES

Upon successful completion of the course, student will be able to:

- **CO1** Understand the blood composition and its circulation.
- **CO2** Apprehend the importance of respiratory system.
- **CO3** Understand the component of digestion and mechanism of urine formation.
- **CO4** Analyze the muscle contraction.
- **CO5** Understand the transmission of nerve impulse.

Unit :1 BLOOD AND CIRCULATORY SYSTEM [12 hrs]

Composition of blood, types and functions of blood cells. Blood groups - ABO group and Rh type. Composition of lymph. Blood coagulation mechanism. Anticoagulants (Heparin and EDTA).

Heart - basic anatomy, cardiac cycle, cardiac output and pace maker.

Unit :2 RESPIRATORY SYSTEM [12hrs]

Structure of lungs - Mechanism of gaseous exchange. Role of Hemoglobin in transport of O₂ and CO₂. Oxygen dissociation curve, Bohr Effect, Chloride shift.

Unit: 3 DIGESTIVE AND EXCRETORY SYSTEM [12 hrs]

Salivary digestion, gastric digestion - Mechanism of hydrochloric acid secretion, pancreatic digestion, intestinal digestion, Role of bile salt in digestion. Digestion and absorption of carbohydrates, proteins, and lipids. Structure of nephron, Mechanism of urine formation - Glomerular filtration, tubular reabsorption of glucose, water and electrolytes.

Unit: 4 MUSCULAR SYSTEM [12 hrs]

Types of muscle, Ultra structure of skeletal muscle - light band, dark band, Sarcomere, thick filament-myosin, thin filament - actin, myosin, tropomyosin and troponin. Molecular basis of skeletal muscle contraction. Bone structure and formation. Ligaments and tendons.

Unit: 5 NERVOUS SYSTEM [12 hrs]

Structure of neuron. Transmission of nerve impulse. Synapse - types of synapse, synaptic transmission, Neurotransmitters, Neuromuscular junction.

Anatomy of brain - meninges, cerebrum, brain stem, cerebellum and functions. Spinal cord and its function. CSF and Limbic system (brief description only).

Text Books

1. Sembulingam, Premasembulingam, (2012). *Essentials of medical Physiology*- (6thed), Jaypee Brothers Medical Publishers (P) Ltd.
2. Goel K A, Sastri K V., *A Text book of Animal Physiology*, Rastogi publications, Meerut.
3. Jain A.K., (2016). *Textbook of Physiology - Vol - I & II*, (6th Ed) Avichal Publishing Company.
4. Arthur C. Guyton and John E. Hall, (2016). *Textbook of Medical Physiology*, (10thed) Harcourt Asia Pvt. Ltd.

Supplementary Readings

1. Ganong W. E. (2003). *Review of Medical Physiology*, (21sted). McGraw Hill Meyer BJ, HsMeij, Meyer AC, *Human Physiology*, (2nded) – AITBS Publishers and distributon.
2. Giese, *Cell Physiology*, (5th ed), W. B Saunders company, Tokyo, Japan.
3. Agarwal, RA Anil. K. Srivastav, Kaushal Kumar *Animal Physiology and Biochemistry* – S. Chand & CO.,
4. Zubay (1998), *Biochemistry* (4th edition, WMC Brown Publishers, USA.

MAPPING WITH PROGRAMME OUTCOMESS (PO)

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

3- Strong;2- Medium;1-Low;

SEMESTER- I &II CORE PRACTICAL-I	22UBIOP24: CORE PRACTICAL-I (45 hrs)	HRS/WK-3 CREDIT-4
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COURSE OBJECTIVES

On the successful completion of the course, student will be able to

CO1 Understand the principles, procedure and results of qualitative and quantitative analysis.

CO2 Gain practice in reagent preparation and standardization of reagents.

CO3 Recognize the presence of sugar in the sample by qualitative analysis.

CO4 Grasp the presence of amino acid in the sample by qualitative analysis.

CO5 Comprehend the separation techniques of biomolecules.

REGENENTS

[3 hours]

- Preparations of per cent (W/V and V/V %), normal and molar solutions.
- Preparations of isotonic, hypertonic and hypotonic solution.

II VOLUMETRIC ANALYSIS

[15 hours]

- Estimation of amino acid by Formal titration method.
- Estimation of ascorbic acid using Dichlorophenol indophenol dye.
- Estimation of reducing sugar by Benedict's method.
- Estimation of calcium using EDTA by titration method.
- Determination of saponification value of oils.
- Determination of acid number of edible oils.

III CARBOHYDRATES ANALYSIS

[9 hours]

Qualitative analysis of carbohydrates.

IV AMINO ACIDS ANALYSIS

[9 hours]

Qualitative analysis of amino acids.

V PREPARATION

[9 hours]

Isolation of starch from potato.

Isolation of casein from milk.

Isolation of lecithin from egg yolk.

Isolation of cholesterol from egg yolk.

Text Books

1. Dr. Jayaraman J., *Manuals in Biochemistry* (2011) New Age International pub, Bangalore.
2. David T., Plummer (2000). *Introduction to practical Biochemistry* New Delhi: Tata McGraw Hill Publishing Company,
3. Pattabiraman, *Laboratory manual in biochemistry*.

MAPPING WITH PROGRAMME OUTCOMES (POS)

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	3	3	2	2
CO5	3	3	3	2	2

3- Strong;2- Medium;1-Low;

ELECTIVE COURSES

SEMESTER-II INTERNAL ELECTIVE -I	22UBIOE27A : NUTRITIONAL BIOCHEMISTRY (30 hours)	HRS/WK-2 CREDIT-3
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COURSE OBJECTIVES

1. To study the nutritional aspects of various foodstuffs and its measurement.
2. To study the functional aspects of carbohydrate, protein and lipid.
3. To acquire knowledge about the balanced diet and dietary fiber.
4. To study the functional aspects of vitamins and minerals.
5. To learn the importance of nutrient requirements in different age groups

EXPECTED COURSE OUTCOMES

On the successful completion of the course, student will be able to

- **CO1** Understand and demonstrate the nutritional measurement of different food stuffs.
- **CO2** Gain knowledge about the biological value of proteins by different methods.
- **CO3** Gain insights depth about the deficiency and functional aspects of different types of vitamins.
- **CO4** Acquire knowledge about the physiological functions and deficiency of minerals.
- **CO5** Prepare different dietary plan for different age groups.

Unit: 1 ENERGY METABOLISM**[6hrs]**

Basic concepts of energy expenditure. Unit of energy. Basal metabolic rate (BMR), its measurements by bomb calorimeter and factors influencing measurement of BMR. Respiratory Quotient(RQ), factors affecting RQ. Specific dynamic action of foods (SDA).

Unit: 2 PROTEINS IN NUTRITION**[6hrs]**

Quality of protein - Biological value (BV), Net protein utilization (NPU). Amino acid composition of dietary protein. Protein-energy malnutrition (PGM) – Kwashiorkor and Marasmus.

Unit :3 CARBOHYDRATES AND LIPIDS IN NUTRITION**[6hrs]**

Role of carbohydrates and lipids in diet. Balanced diet. Role of dietary fiber. Nutritional composition – Milk, egg, meat and fish, cereals and pulses, roots and tubers.

Unit : 4 VITAMINS AND MINERALS**[6hrs]**

Vitamins – Sources, RDA, deficiency diseases of fat soluble vitamins - A,D,E,K and water soluble vitamins - B- complex – B₁, B₂, B₅, B₆, B₉, B₁₂ and vitamin-C.

Minerals – physiological role, nutritional significance and deficiency of essential trace elements - Sodium, potassium, calcium, magnesium, phosphorus, copper, zinc, iron, iodine, fluorine.

Unit : 5 NUTRITIONAL REQUIREMENTS**[6hrs]**

Nutritional requirements for infants, children, adolescent, adult (male and female), pregnant and lactating women and geriatrics. Nutritional requirements in diseased condition – hypertension, diabetes and ulcer.

Textbooks:

1. Swaminathan M (1987), *Food and Nutrition* Vol. I&II, Second edition, Bangalore, Bappco Publishers.
2. Chatterjea M.N. and RanaShinde. *Text book of Medical Biochemistry*, (4th edition) Jaypee Publishers, New Delhi

Supplementary Readings

1. Patricia Trueman, (2007), *Nutritional Biochemistry* (1sted), Chennai, MJ publishers
2. Darnell J, Lodish H, Baltimore D, (1986), *Molecular Cell Biology*, England, WH Freeman publishers.
3. William's *Basic Nutrition and Diet Therapy* Williams (14thed), Staci Nix.
4. Sathyanarayana and U. Chakrapani U., *Biochemistry*, Books and Allied Publishers.
5. Deb A C., (1983), *Fundamentals of Biochemistry* (8thed), Kolkata, New Central Book Agency

MAPPING WITH PROGRAMME OUTCOMES(PO)

COs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	1
CO2	3	3	3	2	1
CO3	3	3	3	2	1
CO4	3	3	3	2	1
CO5	3	3	3	2	1

3- Strong; 2- Medium; 1-Low;

SEMESTER –II INTERNAL ELECTIVE -I	22UBIOE27B : FOOD TECHNOLOGY (30 hours)	HRS/WK-2 CREDIT-3
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COURSE OBJECTIVES

1. To learn the constituents of food.
2. To study about the nature of food spoilage.
3. To know about the preservation methods.
4. To impart about the basic knowledge about food regulations and quality control.
5. To gain idea about food products.

EXPECTED COURSE OUTCOMES

On the successful completion of the course, student will be able to

CO1 Understand the food types, constituents, nutritive value and adulteration.

CO2 Recognize food spoilage and its control.

CO3 Perceive the methods of preservation.

CO4 Grasp the industrial food products.

CO5 Apprehend food regulations and quality control.

Unit:1 COMPOSITION OF FOOD**(6 Hrs)**

Composition of food- Carbohydrate, lipid, proteins, fiber, water, vitamins and minerals. Pulses, grains, vegetables and fruits. Milk-whole milk, low fat and skimmed milk. Nutritive value and pasteurization. Food adulteration, impact of adulteration in humans.

Unit: 2 FOOD SPOILAGE**(6 Hrs)**

Food spoilage: Characteristics features, dynamics and significance of spoilage in vegetables, fruits, meat, sea foods, milk and milk products, canned and packed foods. Factors affecting growth and survival of microbes in food.

Unit: 3 FOOD PRESERVATION**(6 Hrs)**

Food preservation: Principles and methods of food preservation-freezing, high pressure, heating, dehydration, canning and packaging. Application of enzymes in food processing and preservation. Food additives.

Unit: 4 INDUSTRIAL FOOD PRODUCTS**(6 Hrs)**

Industrial food products: ice cream, bread, cakes, mashed potatoes, chips, jams and jellies. Cheese making, fermented vegetables, vinegar, beer and wine.

Unit: 5 FOOD REGULATIONS**(6 Hrs)**

Food regulations and quality control: History of Indian food regulation - BIS, ISI, FPO, PFA and FDA. HACCP, MFPO, AGMARK and FSSAI. Legal aspects related to storage and disposal.

Text Books

1. John, L., Ingraham and Catherine A., Ingraham *Microbiology introduction* (2nded) Cengagelearning, New Delhi.
2. Gabriel Virella (1997), *Microbiology and infectious disease*(3rd ed.) Ingraham international, New Delhi.
3. Rao,E.S. (2013). *Food quality Evaluation*.

Supplementary Readings

1. Sivasankar, B. (2005) *Food processing and preservation* (3rded), Prentice Hall India (P) Ltd.
2. Vijayakhader (2009) Text book of food science and technology(5thed) Indian Council of Agricultural research.
3. Avantina Sharma, *Text book of science and technology*, (3rded) CBS Publishers.

MAPPING WITH PROGRAMME OUTCOMES(POS)

COS	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	2	1
CO2	2	3	1	2	1
CO3	2	3	1	2	1
CO4	2	3	1	2	1
CO5	2	3	1	2	1

3- Strong;2- Medium;1-Low;

SEMESTER –II INTERNAL ELECTIVE -I	22UBIOE27C : HEALTH AND DISEASES (30 hours)	HRS/WK-2 CREDIT-3
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COURSE OBJECTIVES

1. To learn the biochemistry and disorders of various diseases affecting human beings.
2. To know the genetically inherited disorders.
3. To gain information about the prevention of certain diseases by life style modification.
4. To acquire knowledge about the root causes of communicable diseases and its prevention.
5. To know the occurrence and severity of disease by analyzing enzymes activity.

EXPECTED COURSE OUTCOMES

On the successful completion of the course, student will be able to

- CO1 Understand about balanced diet, nutrients, nutritional disorders and dietary supplements.
- CO2 Apprehend the inherited disorders, monogenic and multifactorial disorders and diagnostic tests for inherited disorders.
- CO3 Acquire knowledge on lifestyle disorders like diabetes, cancer and cardiovascular diseases preventive measures and treatment.
- CO4 Understand the communicable disease, prevention methods, and treatment.
- CO5 Students understand the diagnostic markers enzymes, organs functional tests, and diagnostic imaging technologies.

Unit: 1 NUTRITIONAL DEFICIENCY DISORDERS

(6 Hrs)

Balanced diet. Importance of macronutrients and micronutrients. Protein and Energy malnutrition. Iron deficiency anaemia, Vitamin A deficiency, Vitamin-B12 deficiency, Iodine deficiency disorders - hyper and hypothyroidism. Nutritional supplements.

Unit: 2 INHERITED DISORDERS

(6 Hrs)

Chromosomal disorders - Down syndrome, Klinefelter syndrome, Turner syndrome. Monogenic disorders – cystic fibrosis, sickle cell anemia and phenylketonuria. Multifactorial inherited disorders – Alzheimer's disease and congenital heart defects. Prenatal screening. Karyotyping.

Unit: 3 LIFE STYLE DISEASES

(6 Hrs)

Diabetes mellitus- sugar levels in blood, renal threshold for glucose, factors influencing blood glucose level. Acute and chronic complications. Cardiovascular diseases – atherosclerosis - risk factor and management. Fatty liver – alcoholic and non-alcoholic. Obesity. Cancer – Carcinogens and chemoprevention.

Unit: 4 COMMUNICABLE DISEASES

(6 Hrs)

Communicable diseases: Epidemic, endemic and pandemic. Common cold, COVID-19. Chickenpox, Malaria. Sexually transmitted diseases – HPV infection, HIV/AIDS. Prevention- Vaccination schedule. Antiviral antibiotics – types and mechanism of action.

Unit: 5 DIAGNOSTIC ENZYMES AND TESTS**(6 Hrs)**

Diagnostic enzymes – enzymes in health and diseases. Cardiac, hepatic, bone functional marker enzymes. Hepatotoxicity and nephrotoxicity. Liver and kidney function tests. Renal calculi. Complete blood count. Diagnostic imaging tests – ECG, ultrasound and MRI.

Text Books:

1. Chatterjea, MN., and Rana Shinde (2007) *Textbook of Medical Biochemistry*, (7th edition) Jaypee Brothers, New Delhi.
2. Zilva J.F., and Pannall thed P.R., (1984) *Clinical Chemistry in Diagnosis and treatment*, G Publishing pvt limited.

Supplementary Readings

1. William S. Hoffman (1964) *The Biochemistry of Clinical Medicine*, Year Book Medical publishers,
2. Krishna Das K V (2013), *Clinical Medicine (A Textbook of Clinical Methods and Laboratory Investigations)*. Jaypee Brothers Medical publishers, New Delhi
3. Kaplan A., Jack R., Opheim K.E., Toivola B., Lyon A.W., Williams and Wilkins, USA (1995) *Clinical Chemistry Interpretation and techniques*, (4thed).
4. Devlin T.M. (2010). *Biochemistry with clinical Correlation*, (7th ed), Wiley Publications..

MAPPING WITH PROGRAMME OUTCOMES (POS)					
COS	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	1
CO2	3	2	2	2	1
CO3	3	2	2	2	1
CO4	3	2	2	2	1
CO5	3	2	2	2	1

3- Strong; 2- Medium; 1-Low;