Annexure II

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
AUTONOMOUS
(Affiliated to Saurashtra University, Rajkot)

Department of Biochemistry
M. Sc. BIOCHEMISTRY

OBJECTIVES OF THE PROGRAMME:

The curriculum is framed to accomplish the following programme objectives which students shall accomplish by the end of their post graduation study.

1. To provide a thorough knowledge of contemporary Biochemistry at the cellular and molecular level.
2. Acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral programme.
3. Independently carry out a complete scientific work process, including the understanding of theoretical background, hypothesis generation, collection and analysis of data, and interpretation and presentation of results.
4. Enable students to make significant and holistic contributions to the advancement of knowledge in their field, and become lifelong scholars with an appreciation of the impact of Biochemistry on society.

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Department of Biochemistry

M. Sc. BIOCHEMISTRY

Scheme of Instruction and Examinations

For Students Admitted From A.Y. 2017-2018 & Onwards

SEMESTER I							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
17PBCCC01	**Core 1:** Biomolecules	4	3	30	70	100	4
17PBCCC02	**Core 2:** Cell Biology I	4	3	30	70	100	4
17PBCCC03	**Core 3:** Human Physiology	4	3	30	70	100	4
17PBCCC04	**Core 4:** Genetics	4	3	30	70	100	4
17PBCDC01/ 17PBCDC02	**Discipline Specific Elective- ID I (**Evolution and Ecology / Basic Microbiology)	4	3	30	70	100	4
17PBCCC05	**Biochemistry Practical- I**	5	6	80	120	200	3
17PBCDC03/ 17PBCDC04	**Discipline Specific Elective Practical - I (**Evolution and Ecology Practicals / Basic Microbiology Practicals)	4	3	40	60	100	2
		29				**800**	**25**
Part III							
17PVE01	Value Education	1	-	Remarks			1
Total		**30**					**26**

SEMESTER II							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
17PBCCC06	**Core 5**: Enzymology	4	3	30	70	100	4
17PBCCC07	**Core 6**: Intermediary Metabolism and Regulation	4	3	30	70	100	4
17PBCCC08	**Core 7**: Techniques in Analytical Biochemistry	4	3	30	70	100	4
17PBCCC09	**Core 8:** Cell Biology II & Endocrinology	4	3	30	70	100	4
17PBCCC10	**Core 9:**Molecular Biology - I	4	3	30	70	100	4
17PBCCC11	**Biochemistry Practical II**	8	6	100	150	250	4
Total		**28**				**750**	**24**

Summer Internship for one month

SEMESTER III							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
17PBCCC12	**Core 10:** Immunology	4	3	30	70	100	4
17PBCCC13	**Core 11:** Molecular Biology- II	3	3	30	70	100	3
17PBCCC14	**Core 12 :** Recombinant DNA Technology & Genetic Engineering	4	3	30	70	100	4
17PBCCC15	**Core 13 :** Computer Based Test:	1	-	1	-	100	1
17PBCDC05/ 17PBCDC06	**Discipline Specific Elective- ID II (**Nutritional Biochemistry and Molecular Medicine / Stem Cells and Regenerative Biology)	3	3	30	70	100	3
17PBCCC16	**Biochemistry Practical – III**	8	9*	100	150	250	4
17PBCCC17	**Mini Project**	4	-	50	-	50	1
		29				**800**	**20**
Part II							
17PBCCE01	Summer Internship	-		100	-	100	1
17PBCCE02	Educational Tour	-	-	50	-	50	1
Total		**29**				**950**	**22**

* Day One-6 hrs and Day Two-3 hrs.

SEMESTER IV							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
17PBCCC18	**Core13**: Biostatistics & Bioinformatics	3	3	30	70	100	3
17PBCCC19	**Core 14**: Neurobiochemistry	4	3	30	70	100	4
17PBCCC20	**Biochemistry Practicals- IV**	4	3	40	60	100	2
17PBCCC21	**Dissertation /Internship**	18	-	120	80	200	14
Total		**30**				**500**	**24**
TOTAL OF ALL SEMESTERS						**3000**	**96**

Option of Internship entails minimum two months in the semester

TOTAL MARKS AND CREDIT DISTRIBUTION

S.NO	PART	Total Marks	Total Credits
1.	**PART I:** Core, Discipline Specific Electives	2850	86
2.	**PART II :** Skill Enhancement Courses	150	9
3.	**PART III:** Value Education	Remarks	1
TOTAL		**3000**	**96**

Part- I: CORE, DSE ALLIED, DSE CORE

- **CORE COURSES [THEORY]**

S.No	Semester	Course Code	Course
1.	**I**	17PBCCC01	Biomolecules
2.	**I**	17PBCCC02	Cell Biology I
3.	**I**	17PBCCC03	Human Physiology
4.	**I**	17PBCCC04	Genetics
5.	**II**	17PBCCC06	Enzymology
6.	**II**	17PBCCC07	Intermediary Metabolism and Regulation
7.	**II**	17PBCCC08	Techniques in Analytical Biochemistry
8.	**II**	17PBCCC09	Cell Biology II & Endocrinology
9.	**II**	17PBCCC10	Molecular Biology- I
10.	**III**	17PBCCC12	Immunology
	III	17PBCCC13	Molecular Biology- II
11.	**III**	17PBCCC14	Recombinant DNA Technology & Genetic Engineering
12.	**III**	17PBCCC15	Computer Based Test
13.	**IV**	17PBCCC18	Biostatistics & Bioinformatics
14.	**IV**	17PBCCC19	Neurobiochemistry

- **CORE COURSE [PRACTICAL]**

S.No	Semester	Course Code	Course
1.	**I**	17PBCCC05	Biochemistry Practical I
2.	**II**	17PBCCC11	Biochemistry Practical II
3.	**III**	17PBCCC16	Biochemistry Practical III
4.	**IV**	17PBCCC20	Biochemistry Practical IV

- **OTHER CORE COURSES**

S.No.	Semester	Course Code	Course
1.	**III**	17PBCCC17	Mini Project
2.	**IV**	17PBCCC21	Dissertation /Internship

DISCIPLINE SPECIFIC ELECTIVE – I

(Student shall select any one of the following Course as Elective in first semester)

S. No	Course Code	Name of the Course	Course Code	Name of the Course
1.	17PBCDC01	Evolution and Ecology	17PBCDC03	Evolution and Ecology Practicals
2.	17PBCDC02	Basic Microbiology	17PBCDC04	Basic Microbiology Practicals

DISCIPLINE SPECIFIC ELECTIVE – II

(Student shall select any one of the following Course as Elective in third semester)

S. No	Course Code	Name of the Course
1.	17PBCDC05	Nutritional Biochemistry and Molecular Medicine
2.	17PBCDC06	Stem Cells and Regenerative Biology

Part- II :COMPETENCY ENHANCEMENT COURSES

S.No	Semester	Course Code	Course
1.	**III**	17PBCCE01	Summer Internship
2.	**III**	17PBCCE02	Educational Tour

- **PART – III : COMPETENCY ENHANCEMENT COURSES**

S. No.	Semester	Course Code	Course
1	**I**	17PVE01	Value Education

M.Sc. BIOCHEMISTRY Syllabus
SEMESTER -I

17PBCCC01	Core 1: Biomolecules	4 Hrs/wk	4 Credits

Objectives:

To enable students to

1. Understand the basis for the molecular structure of different biochemical compounds.
2. Understand the biosynthesis of basic biochemical "building blocks".
3. Understand the conformation, dynamics, and function of biomolecules

Unit1: Carbohydrates

(10 hrs)

- Introduction to structure and properties of carbohydrates
- Polysaccharides - Occurrence, structure, properties, importance of storage polysaccharides – (starch and glycogen) and structural polysaccharides – Cellulose.
- A brief account on chitin, pectin, hemicelluloses – xylans, mannans and Agar-Agar.
- Occurrence, structure, properties and importance of mucopolysaccharides - (Glucosaminoglycans-hyaluronic acid, chondrotin sulphate and heparin).
- Glycoproteins- proteoglycans, Bacterial cell wall polysaccharides, N-linked (Ribonuclease B) and O –linked (Mucins), ABO blood group antigens and sialic acid.

Unit 2: Structural Organization of Proteins
(10 hrs)

- Structure, Properties, classification, functions and Nomenclature of amino acids.
- Proteins – Classification. Peptide bond. Biologically important peptides. Primary structure and its determination, Conformation of proteins - Ramachandran plot.
- Secondary structure-α-helix, other polypeptide helices (310, π helix, poly glycine conformations), β-pleated sheets. Super secondary structures – β bend, β-α-β, β - hairpin motif, α - α motif, β barrels.
- Tertiary structure-organization and forces involved in stabilizing protein structure
- Quaternary structure-subunit Interactions and symmetry (cyclic, dihedral and rotational).

UNIT 3: Protein dynamics:
(10 hrs)

- Detail studies on Structural proteins (fibrous proteins-α-keratin, collagen – single amino acid change and its defects).
- Elementary details of role of accessory proteins (PDI and molecular chaperones) Globular proteins – role of PDI and molecular chaperones in folding.
- Hemoglobin- mechanism of oxygen binding and cooperativity, Bohr's effect, CO2 transport and effect of 2, 3-BPG.
- Protein Evolution**:** Hemoglobin - Gene duplication - evolution of globin genes. Variants of hemoglobin: Sickle cell anemia-pathological effect and evolutionary benefit.
- A brief account on Cytochromes.

UNIT 4: Lipids: (**9hrs**)

- Classification- physical and chemical properties of lipids.
- Structure and importance of simple lipids, compound lipids and derived Lipids (fatty acids, plant, animal and fungal sterols). TAG as efficient energy reservoir.
- Structure and importance of eicosanoids (prostaglandins and leukotrienes).
- Lipoproteins – classification, composition and functions. Properties of lipid aggregates-liposomes, micelles and bilayers.

UNIT 5: Nucleic Acids: (**9 hrs)**

- Structure of DNA - Watson and Crick model. Types of DNA - A, B and Z DNA.
- Properties of DNA - buoyant density, viscosity, denaturation, renaturation, Tm, hypo and hyperchromism. Cot curve value.
- Super Coiled DNA - superhelix topology-linking number-twist-writhing number. Interwinding and relaxation of supercoiled DNA.
- DNA -Protein interactions-histone and Non-histone proteins – protein motifs - leucine zipper, zinc finger, HLH motif.
- Miscellaneous alternative conformation of DNA - slipped mispaired DNA, parallel stranded DNA and anisomorphic DNA.
- RNA - Types, structure and functions of mRNA, tRNA, rRNA, snRNA, hnRNA.
- Brief account on micro RNA and SiRNA.

REFERENCE BOOKS:

1. Christopher K. Mathews., Van Holde, K. E. and Kevin G. Ahern. 2005. Biochemistry. [Third Edition]. Pearson Education, New Delhi
2. Donald Voet and Judith, G. Voet. 2011. Biochemistry. [Fourth Edition]. John Wiley and Sons, New York.
3. Nelson David, L. and Cox, M. M. 2011. Lehninger Principles of Biochemistry. [Fifth Edition]. Macmillan/ Worth, New York .
4. Jeremy M. Berg., John L. Tymoczko and Lubert Stryer. 2007. Biochemistry. [Sixth Edition]. W H Freeman and Co., New York.
5. Geoffrey L. Zubay., William W. Parson and Dennis E. Vance. 1995. Biochemistry. [Fourth Edition]. WMC. Brown Publishers, England.

6. Reginald H. Garrette and Charles M. Grisham. 2005. Principles of Biochemistry. [Third Edition]. Thomson Brooks/Cole, Australia.

P17BCCC02	Core 2: Cell Biology	4hrs/week	4 Credits

Objectives:

To enable students to

1. Describe the structure and explain the function of cell organelles and membrane function of both prokaryote and eukaryote cells
2. Understand the different types of cellular communication and explain their importance in terms of cellular metabolism.
3. Understand comprehensive overview of the role of cellular metabolism and cellular organelles involved
4. Demonstrate basic molecular laboratory techniques, such as microscopy, basic laboratory calculations, electrophoresis, etc.
5. Describe the relevance of cell biological processes and techniques to understanding human disease and related societal issues.

Unit 1: An overview of the cell and cell structure (9 hrs)

- Introduction to the cell, its chemical composition, molecular organization, origin and evolution. Prokaryotic and eukaryotic cells.
- Cell theory and Modern Cell Biology.
- cell organelles: structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton, subcellular fractionation.
- Cell wall structure and function- Bacterial, Fungal and Plant.
- Cytoskeleton: Microtubules Polymerization, Dynamic, and Functions, Microtubules in Cell Division, Role of Cytoskeleton Filaments in Cancer

Unit 2: Membrane Biochemistry and Function (10 hrs)

- Chemistry and function of Membrane: chemical composition and its structural plan; membrane models; membrane as a two dimensional fluid; factors affecting the membrane fluidity; phase transition
- Membrane proteins
- Movement of small and large molecules across the cell membrane; osmosis; diffusion; endocytosis; clathrin mediated endocytosis; phagocytosis
- Artificial Membranes.

Unit 3: Major Cell Function (10 hrs)

- Cytoplasmic membrane or endomembrane system; secretion and transport of proteins to various cell compartments.
- Signal hypothesis; protein targeting to peroxisomes;
- Packaging of DNA into eukaryotic chromosome; nucleosomes and higher levels of organization; nuclear pore complex; molecular trafficking

- Nucleolus and the synthesis of ribosome.
- Electric properties of membrane; patch clamp and voltage clamp techniques.

Unit 4: Signal transduction (10 hrs)

- Concept of Receptors and ligands
- Transduction of signal into the cell
- G protein coupled receptors; growth factors and receptor tyrosine kinase.
- Second messengers.

Unit 5: Cell Signaling

- Cell signaling in development and differentiation; regulatory genes in the development of Drosophila.

17PBCCC03	Core 3: Human Physiology	4hrs/week	4 Credits

Objectives:

To enable students to

- Describe the fundamental mechanisms underlying normal function of cells, tissues, organs, and organ systems of the human body.
- Explain the basic mechanisms of homeostasis by integrating the functions of cells, tissues, organs, and organ systems.
- Apply knowledge of functional mechanisms and their regulation to explain the pathophysiology underlying common diseases.
- To explain the roles of the endocrine system in maintaining homeostasis, integrating growth and development and successful reproduction.

Unit 1: Blood and cardiovascular system (9 hrs)

- Composition and functions of blood, plasma, erythrocytes, Hb, leucocytes, platelets
- Blood groups, ABO system, Rh system
- Blood clotting
- Anatomy of heart and blood vessels, physiology of cardiac muscles
- Overall design of circulatory system, pulmonary and systemic circulation
- Cardiac cycle and ECG

Unit 2: Respiration (9 hrs)

- Functional Anatomy of Respiratory System,
- Diffusion of respiratory gases, Role of Hb in Oxygen and carbon-Dioxide Transport
- Regulation of Respiration

Unit 3:Renal Physiology

- Basic Anatomy of Kidney and nephron
- Body Fluid Compartments, Water Balance and Regulation of Fluid Balance,
- Urine Formation, Regulation of Extracellular Sodium and osmolarity

- Renal Mechanisms for The Control Of Blood Volume
- Regulation of Acid-Base Balance

Unit 4: Gastrointestinal Physiology (10 hrs)

- General Anatomy and Principles of Gastrointestinal Function, Propulsion and Mixing of Food in the Alimentary Tract.
- Composition, Mechanism of Secretion and Functions of Different Digestive juices.
- Digestion and Absorption of Various Dietary Components in the Gastrointestinal Tract.

Unit 5: The Skeleto-Muscular System (10 hrs)

- Contraction and Excitation of Skeletal Muscles, Smooth Muscles and Cardiac Muscle

REFERENCE BOOKS:

1.Kathleen, J.W. Wilson and Anne Waugh. 1998. Ross and Wilson Anatomy and Physiology in health and illness. [Eight Edition]. Churchchill Livingstone, New York.
2. Gerald J. Tortora and Sandra Reynolds. 2003. Principles of Anatomy and Physiology. [Tenth Edition]. John Wiley and Sons. Inc. Pub. New York.
3. Robert K. Murray., Peter A. Mayes., Peter A. Mayes and Victor W. Rodwell. 2003..
4. Arthur C. Guyton and John. E. Hall. 2007. Text Book of Medical Physiology. [Eleventh Edition]. Elsevier Publications, New Delhi.
5. Francis S. Greenspan and John D. Baxter. 1994. Basic and Clinical Endocrinology. [Fourth Edition]. Appleton and Lange Paramount Publishing Business and Professional Group, USA.
6. Sembulingam K and Sembulingam P. [sixth edition]. Essentials of Medical Physiology. Jaypee Publishers LTD.
6. Sembulingam K and Sembulingam P. [sixth edition]. Essentials of Medical Physiology. Jaypee Publishers LTD.

17PBCCC04	Core 4: Genetics	4hrs/week	4 Credits

Unit 1: Classical Genetics
Unit 2: Microbial Genetics
Unit 3: Drosophila Genetics

Unit 4: Human Genetics

Unit 5: Population Genetics

P17BCDC01	DSE ID-I Evolution and Ecology	4 hrs/week	4 Credits

Unit 1 : Evolution I

- Introduction to evolution

- Origin of life – Historical Aspects, process of origin of life, Molecular evolution, Evolution of eukaryotes ,
- Theories of organic evolution- Lamarckism, Darwinism and theories and example of natural selection, Germplasm theory and mutation theory
- Direct evidence of evolution– Fossils; Formation, Types and Significance
- Indirect evidence of evolution – Taxonomical Evidence, Comparative anatomy, Comparative Embryology, Comparative Physiology and Biochemistry, Evidence from Genetics, Evidence from Bio-geographical relations

Unit 2 : Evolution II

- Population genetics and Evolution – Mendelian population, Gene pool and gene frequency, Hardy –Weinberg's Law and factor influencing allelic frequency from Hardy Weinberg equilibrium, Speciation
- Evolution above Species level – Adaptation, Adaptive Radiation, Macro and Micro evolution, Mega evolution and Punctuated Equilibria
- Isolation and Speciation- Types and mechanism of isolation, Concept of Species, race and deme, Instantaneous speciation, Gradual Speciation
- Barriers – Topographic, Climatic, Vegetative, Water, Biological

Unit 3: Ecology I

- Introduction to ecology
- Environment – Structure and composition of Atmosphere, hydrosphere and Lithosphere
- Abiotic and Biotic Environmental factors- Types of abiotic environmental factors: light, radiation, temperature, humidity, physiographic factors.
  Types of biotic environmental factors: interspecific interactions.
- Biotic Communities – Communities, Niches and Bio-indicators

Unit 4 : Ecology II

- Ecological Succession – Causes, trends, Basic types and general process of succession.
- Ecosystem- Structure and function: Kinds and structure of ecosystem, Energy flow in ecosystem, ecological Pyramids.
- Terrestrial Ecosystem – physicochemical nature, classification of terrestrial ecosystem, biomes
- Aquatic Ecosystem – Fresh water ecosystem, Estuaries Ecosystem, marine ecosystem
- Biogeochemical cycles – water cycle, nitrogen cycle, carbon cycle, oxygen cycle, phosphorous cycle, sulphur cycle, micronutrient cycle

Unit 5 : Ecology III

- Pollution – origin of pollution, Creator of pollution, types of pollution; air, water, thermal, sewage, industrial, land, noise, radioactive.
- Ecology and natural resources – natural resources; classification and their conservation, renewable and non renewable energy sources,
- Human welfare and ecological managements – Agriculture and aqua culture, Forest management, Water resource management, Soil erosion and conservation, wild life management.
- Biogeography- Distribution of animals and plants, descriptive phytogeography, patterns of distribution of biota
- Adaptations- Aquatic, Volant and Desert

Reference Books

- Ecology - E.P. Odum, 1983, Holt-Saunders International Edition
- Handbook of environmental management and technology: Gwendolyn Holmes, Ben Ramnarine Singh, and Louis Theodore.

P17BCDC02	DSE ID-I Basic Microbiology	4 hrs/week	4 Credits

OBJECTIVES: To enable the students to

- List, classify, and contrast the main categories of microorganisms
- List the important events and their significance associated with microbial metabolism
- Outline the principle concept of microbial genetics and recombinant DNA technology
- List and discuss the principle reasons for and methods of controlling and/or eliminating microorganisms
- Describe microbial mechanism of pathogenicity

Unit 1: Morphology and Ultrastructure (9 hrs)

- Ultrastructure of bacteria, fungi, algae and protozoa.
- Classification of microbes, molecular taxonomy,
- Cell walls of eubacteria - peptidoglycan and related molecules. Structure and synthesis of cell wall and cell membrane of gram - positive and negative bacteria.
- Flagella and motlility.
- Cell inclusion bodies.
- Purple and green bacteria. Budding and appendaged bacteria, spirilla, spirochaetes, gliding and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria. Endospore forming rods and cocci, myobacteria, rickettsia and mycoplasma. Archaebacteria.

Unit 2: Microbial Growth and Metabolism (9 hrs)

- Microbial growth - definition. Mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth.
- Bacterial Cell division
- Microbial metabolism - overview, photosynthesis in microbes. Role of chlorophylls, carotenoids and phycobilins, Calvin cycle.
- Chemolithotrophy: hydrogen - iron - nitrite oxidizing bacteria: nitrate and sulfate reduction: methanogenesis and acetogenesis,
- Fermentations - diversity, syntrophy - role of anoxic decompositions.
- Nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

Unit 3: Microbiological Techniques (10 hrs)

- Methods in microbiology, Currents methods in microbial identification.
- Pure culture techniques. Theory and pratice of sterilization.
- Principles of microbial nutrition, construction of culture media.
- Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes.

Unit 4: Viruses (10 hrs)

- Bacteria, plant, animal and tumor viruses.
- Classification, structure and replication of viruses- Lytic cycle and lysogeny. DNA viruses: positive and negative strand. Double stranded RNA viruses.
- Herpes, Pox, Adenoviruses, Retroviruses, Viroids and Prions

Unit 5: Medical Microbiology (10 hrs)

- Disease reservoirs; Epidemiological terminologies.
- Infectious disease transmissions. Respiratory infections caused by bacteria and viruses; Tuberculosis, sexually transmitted diseases including AIDS.
- Vector borne diseases, water borne diseases, Public health and water quality.
- Pathogenic fungi
- Antimicrobial agents, Antibiotics. Penicillins and cephalosporins, Broad spectrum antibiotics. Antibiotics from prokaryocytes, antifungal antibiotics - mode of action, Resistance to antibiotics.

17PBCCC05	Biochemistry Practical- I	5 hrs/week	3 Credits

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2. Estimation of sugars
3. Estimation of Iron
4. Estimation of Phosphate

5. Estimation of Vitamin C
6. Estimation of organic acids
7. Microscopy,
8. Mitosis,
9. Meiosis
10. Methods of blood sampling
11. Anticoagulants.
12. Blood typing and compatibility tests..
13. Bleeding time Clotting time Prothrombin time (Quick-time).....
14. Hematocrit
15. Erythrocyte sedimentation rate as measured by theWestergren method
16. Blood cells counts
17. The blood smear (differential leukocyte count)
18. Blood pressure measurement
19. Spirometry
20. Determination of the respiratory pressure.
21. Effect of the breathing cycle on the circulation
22. The Color, Smell and Turbidity pH of Urine
23. The Specific Gravity of the Urine
24. Microscopic Investigation of the Urine Sediment

P17BCDC03	**DSE ID-I Evolution and Ecology Practicals**	**4 hrs/week**	**2 Credits**

Practicals

- Vegetation studies by line, quadrates and belt transect methods and their analysis
- Preparation of media for microbial culture, Isolation and culturing of microbes from soil / water samples.
- Estimation of halides in water samples by potentiometry
- Estimation of Co2+ and Ni2+ by colorimetry/ spectrophotometry
- Estimation of sulphates by turbidometry
- Estimation of alkali metals in various samples by flame-photometry
- Water analysis for physico-chemical characteristics

P17BCDC02	**DSE ID-I Basic Microbiology**	**4 hrs/week**	**4 Credits**

1 . Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve,
6. Measure of bacterial population by turbidometry

7. Studying the effect of temperature, pH, carbon and nitrogen on growth

Semester II

17PBCCC06	Core 5: Enzymology	4 Hrs/wk	4 Credits

Objectives:

To enable students to

1. Understand various theoretical , practical and clinical aspects of Enzymology
2. Learn structure, function and kinetics of enzyme and their role as catalyst and regulator of cell metabolism
3. Describe the role of enzymes in health and diseases
4. Explain enzyme application in diagnosis, prognosis, treatment, and biotechnology

Unit 1: Enzymology (9 hrs)

- Scope of enzymology, Classification and Nomenclature, Specificity of enzyme action, kinetics and catalysis of chemical and enzymatic reactions.
- Identification of binding and catalytic sites - trapping ES complex, enzyme modification (affecting aminoacid side chain, treatment with proteases, site directed mutagenesis and changing the pH). Theories of Enzyme action - Lock and Key, Induced fit (Hexokinase).
- Characteristics and applications of Isoenzymes (LDH) and Abzymes.
- Brief account on non- protein enzymes (Ribozymes, DNAzyme) and extremozymes.

Unit 2: Isolation and Purification of Enzymes (9 hrs)

- Extraction of soluble and membrane bound enzymes.
- Purification of enzymes (Ion exchange chromatography, Gel filtration chromatography and Affinity chromatography). Principle of ammonium sulphate precipitation.
- Criteria of purity, purification summary

Unit 3: Kinetics and Inhibition (10 hrs)

- Kinetics of single substrate enzyme-catalyzed reaction: M.M. Equation, L.B. Plot, Eadie-Hofstee and Hanes plot, Eisenthal and Cornish-Bowden plot, Haldane reaction, Rapid reaction kinetics,
- Kinetics of multi-substrate catalyzed reaction
- Enzyme inhibition: Reversible and Irreversible inhibition

Unit 4: Enzyme Catalysis and Regulation (10 hrs)

- Enzyme Catalysis (Acid, Base, Electrostatic, Metal ion), Mechanism of enzyme action with and without cofactor, Active site determination.
- Enzyme Regulation: Cooperativity in Hemoglobin, Allosteric regulation - Properties, Models and Mechanism

- Aspartate transcarbamoylase (ATCase) as a model of allosteric enzyme.
- Covalent modification of enzymes: Phosphorylation (glycogen phosphorylase and glycogen synthase), adenylation (glutamine synthetase).
- Proteolytic cleavage (chymotrypsinogen and fibrinogen), methylation and uridylation.
- Multi enzyme complex: Structure, mechanism of action and regulation of Pyruvate dehydrogenase.

Unit 5: Enzyme technology and applications (10 hrs)

- Immobilization of Enzymes
- Enzyme Technology for Industrial, Medicine and Clinical Applications
- Uses of Enzymes Electrodes and Biosensor, Biotransformation.
- Enzyme Engineering: Chemical Modification ,Site Directed Mutagenesis, Asymmetric Reactions
- Nonaqueous Enzyme Technology

Reference Books:

1. Nelson, D. L., Lehninger, A. L., & Cox, M. M. (2008). Lehninger principles of biochemistry. Macmillan.Stryer – Biochemistry. W.H.Freeman & Co.
2. Voet, D., &Voet, J. G. (2011). Biochemistry, 4-th Edition. NewYork: John Wiley&SonsInc, 492-496.
3. Mathews, C. K., Van Holde, K. E., & Ahern, K. G. (2000). Biochemistry. 2000. San Francisco: Benjamin Cummings.
4. Hames, B. D., & Hooper, N. M. Instant Notes in Biochemistry, Bios Scientific Pub.
5. Nicolas C. price and Lewis Stevens. Fundamentals of enzymology. Third edition. Oxford University Press

17PBCCC07	**Core 6:** Intermediary Metabolism and Regulation	**4hrs/week**	**4 Credits**

Objectives:

To enable students to

- To learn the metabolism and integration of biomolecules that takes place in human system.
- Integrate the various aspects of metabolism & their regulatory pathways.
- Estimate energy yield requirements and thermodynamic considerations.
- Extrapolate how abrogation of normal integrated metabolism can result in various disease states.

Unit 1: Bioenergetics and Basic concepts of metabolism: (9 hrs)

- Thermodynamics and biochemical equilibria – laws of thermodynamics, free energy, ΔG - Endergonic and exergonic reactions, group transfer potential and ATP as energy currency of the cell.
- Biological oxidation – reduction reactions and redox potential

- ROS and antioxidant mechanisms.
- Electron transport chain, oxidative phosphorylation - mechanism & control of ATP production. ATP synthase.
- Inhibitors of ETC & oxidative phosphorylation, Uncouplers. Shuttle systems (Malate-Aspartate, Glycerol-3-phosphate).

Unit 2 Carbohydrate metabolism: (10 hrs)

- Glycolysis- fate of pyruvate, regulation. Role of fructose 2, 6, bi phosphate in liver and muscle.
- Metabolism of hexoses (Fructose and Galactose) other than glucose.
- TCA cycle - metabolic sources of acetyl CoA, regulation & amphibolic nature of the TCA cycle. Anaplerotic reactions.
- HMP pathway - significance.
- Glycogen metabolism. Role of calcium and hormones in regulation of glycogen metabolism. Gluconeogenesis.
- Control of blood glucose - reciprocal regulation of glycolysis and gluconeogenesis.

Unit 3 Lipid metabolism: (9 hrs)

- Biosynthesis of saturated and unsaturated fatty acids, fattyacid elongation system. Regulation of acetyl CoA carboxylase.
- Role of hormones in lipogenesis.
- Biosynthesis of TAG and phospholipids and their regulation. Ketone body - Synthesis and utilization. Cholesterol - biosynthesis and regulation. Biosynthesis of bile acids.
- Fatty acid oxidation – alpha, beta and omega. Oxidation of unsaturated fatty acids.
- Role of carnitine cycle in regulation of β-oxidation.

Unit 4: Amino Acid Metabolism: (10 hrs)

- Biosynthesis of nutritionally non essential amino acids (serine and proline). Degradation of proteins- catabolism of amino acids–Transamination, deamination, decarboxylation.
- Biogenic amines and their importance. Transport of nitrogen to liver, urea cycle & its regulation, Krebs bicycle.
- Catabolism of the carbon skeletons of amino acids – ketogenic (Leu, Trp and Phe) & glucogenic amino acids (Thr, Met, His).
- Specialised products from amino acids (creatinine & serotonin).
- Integration of carbohydrate, protein and fat metabolism.

Unit 5 Nucleotide metabolism (10 hrs)

- *De novo* Synthesis of purine and pyrimidine nucleotides and regulation. Salvage pathways.
- Formation of deoxyribonucleotides - mechanism of action of ribonucleotide reductase.
- Catabolism of purine and pyrimidine nucleotides.
- Uricotelic, ureotelic and ammonotelic organism.
- Metabolic interrelationships of tissues in various nutritional and hormonal states-well fed state, fasting, pregnancy, exercise, obesity, diabetes mellitus and stress.

REFERENCE BOOKS:

1. Nelson David, L. and Cox, M.M. 2011. Lehninger Principles of Biochemistry. [Fifth Edition]. Macmillan/ Worth, New York
2. Robert K. Murray., Daryl K. Granner., Peter A. Mayes and Victor W. Rodwell. Harper's Biochemistry. [Twenty fifth Edition]. Mc Graw Hill Publishers, New York.
3. Thomas M. Devlin. 1997. Textbook of Biochemistry. [Fourth Edition]. John Wiley, Inc Publication, New York
4.Donald Voet and Judith G. Voet. 2001. Biochemistry. [Second Edition]. CBS John Wiley and Sons, New York .
5. Reginald H. Garrette and Charles M. Grisham. 2005. Principles of Biochemistry. [Third Edition]. Thomson Brooks/Cole, Australia.

17PBCCC08	Core 7: Techniques in Analytical Biochemistry	4hrs/week	4 Credits

Objectives

To enable students to

- Learn the modern and emerging approaches in techniques and its applications in Biochemistry.
- Understanding the experimental methods, by which biological molecules (especially proteins) are isolated, identified, quantified, and characterized

Unit 1. Radioisotopic techniques: (9 hrs)

- Types of radioactive decay; Rate of radioactive decay; Radioactive isotopes and their half-lives; Units of radioactivity
- Measurement of radioactivity- methods based upon gas ionization & excitation
- Autoradiography; Specific activity of a radioisotope; Safety aspects; Radiation dosimetry
- Applications of radioisotopes in biological sciences

Unit 2. Centrifugation: (9 hrs)

- Basic principles of sedimentation; types of centrifuge; types of rotor;
- Preparative & analytical centrifugation.
- Subcellular fractionation- Disruption of cells, isolation of subcellular organelles from liver & plant cells and marker enzymes.

Unit 3. Electrophoretic techniques: (10 hrs)

- General principles, Migration of charged particles in an electric field, Factors affecting mobility, Electrophoresis of proteins- Native-PAGE, SDS-PAGE,
- Gradient gels, isoelectric focusing gels, Two dimensional PAGE
- Detection, estimation & recovery of proteins in gels
- Western blotting; Electrophoresis of nucleic acids- Agarose gel electrophoresis,
- Pulse field electrophoresis, Capillary electrophoresis; Microchip electrophoresis, Di-electrophoresis.

Unit 4. Chromatography: (10 hrs)

- Principles and applications of paper, thin layer Chromatography, adsorption, ion exchange, gel-filtration, affinity,
- Principles and applications of gas chromatography, reverse phase chromatography, hydrophobic interaction chromatography and High Performance Liquid Chromatography.

Unit 5. Spectroscopy and Microscopy: (10 hrs)

- Nature of electromagnetic radiations; Principles of biophysical methods used for analysis of biopolymer structure.
- UV, Visible, Infrared, Raman, Fluorescence and NMR spectroscopy
- ORD and CD; Atomic absorption spectroscopy
- Microscopy: Light, electron (scanning and transmission), phase contrast, fluorescence and confocal microscopy

Reference Books:

1. Keith Wilson and John Walker(2000).Principles & Techniques of Practical Biochemistry, 6th edition Cambridge University Press.
2. D Friefelder (1983). Physical Biochemistry, 2nd edition, W.H. Freeman & Co., U.S.A.
3. A. Upadhyay, K. Upadhyay and N.Nath. (1998). Biophysical Chemistry: Principles and Techniques, 2nd edition Himalaya Publishing House, Delhi.
4. K. E.VanHolde (1985), Physical Biochemistry, 2nd edition, Prentice Hall Inc, New Jersey.
5. H.H.Willard, L.L Merritt Jr., J.A.Dean and F.A.Settle Jr. (1996), Instrumental Methods of Analysis, 7th edition CBS Publishers and Distributors, New Delhi.

17PBCCC09	Core 8: Cell Biology –II and Endocrinology	4hrs/week	4 Credits

Unit 1: Cell Cycle, Cell Death, Cell cycle and regulation.

- Cancer; characteristics of tumor cells; mechanism of carcinogenesis; angiogenesis
- Cancer Cell metabolism
- Overview of oncogenes and tumour suppressor genes.
- Autophagy and Cell Death.

Unit 2:

- Cell differentiation and development
- Cell adhesion and motility
- Tools of cell biology to be included- invitro invivo techniques
- Methods to study the cell: principles of microscopy, centrifugation, tissue culture and flow cytometry.

Unit 3:

- General principles of endocrinology; Neuro-endocrinology- Neuro-immuno endocrinology,
- Chemistry, synthesis, catabolism and physiological action and mechanism of action Hypothalamus and Pituitary.

Unit 4:

- Chemistry, synthesis, catabolism and physiological action and mechanism of action, Thyroid,
- parathyroid (calcium homeostasis hormones).
- GIT hormones, pancreatic Hormones
- And their disorders.

Unit 5:

- Chemistry, synthesis, catabolism and physiological action and mechanism of action of adrenals,
- Gonads and their disorders
- . Extra endocrine hormones- ANP, Erythropoietin, Melatonin, etc.

17PBCCC010	Core 9: Molecular Biology –I	4hrs/week	4 Credits

Unit : I
Nucleic acids and Genome: The central dogma, evidence that DNA is the genetic material. Structure of DNA and RNA, physical properties of DNA- cot plot, kinetic and chemical complexity, Tm, buoyant density, satellite DNA. Organization of the human genome. Chromosome, structure of chromatin-nucleosomes, solenoids, scaffolds. Chromatin domains and isochores, structure and functional organization of centromeres and telomeres

Unit II
Replication: prokaryotes and eukaryotes, models,
DNA dependent and RNA dependent polymerases, mode of action,
DNA amplification and polytenization.

Unit III

- Transcription : Structure of genes, promoters, enhancers.
- Structure and mode of action of E. coli RNA polymerase and eukaryotic RNA polymerase I.
- Structure and mode of action of RNA polymerases II and III. Co- and -post transcriptional modifications in prokaryotes and eukaryotes.

Unit IV

- Mechanism of translation in prokaryotes and eukaryotes,
- regulation and post translational modifications, inhibitors of protein synthesis in prokaryotes and eukaryotes.

Unit V:
Regulation of Gene expression

- Lac operon

17PBCCC11	Biochemistry Practical- II	5 hrs/week	3 Credits

1. Isolation of Enzymes such as alkaline phosphatase from plant tissue
2. Enzymatic Assays (Amylase):
3. Determination of optimum pH,
4. Effect of temperature and substrate concentration,
5. Determination of Km & Vmax,
6. Effect of inhibitors

7. Separation of Amino Acid and Sugars by TLC, Colorimetric Determination of pK of Amino Acids.
8. To determine concentration of an unknown protein by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law;
9. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
10. Protein purification and separation by gel filtration, ion-exchange chromatography and SDS-PAGE.
11. Isolation of genomic DNA from bacteria/ yeast
12. Quantification of DNA
13. Separation of DNA on Agarose gel electrophoresis