Enclosure-V

Shree Manibhai Virani and Smt. Navalben Virani Science College, Rajkot
AUTONOMOUS COLLEGE
(Affiliated to Saurashtra University, Rajkot)
Department of Biochemistry
M. Sc. BIOCHEMISTRY

SCHEME OF INSTRUCTION AND EXAMINATIONS
FOR STUDENTS ADMITTED FROM A.Y. 2016-2017 & ONWARDS

PROGRAM OBJECTIVES:

The curriculum is framed to accomplish the following program 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 program.
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.

SEMESTER I							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
16PBCCC01	**Core 1:** Fundamentals of Biochemistry	4	3	30	70	100	4
16PBCCC02	**Core 2:**Enzymology	4	3	30	70	100	4
16PBCCC03	**Core 3:** Cell Biology	4	3	30	70	100	4
16PBCDC01/ 16PBCDC02	**Discipline Specific Elective- I (**Microbiology/ Plant Biochemistry)	4	3	30	70	100	4
16PBCCC04	**Combined Practical (Core)- I** : Cell and Biomolecules Practical	10	9*	100	150	250	5
Part II							
16PBCCE01	Poster Presentation	1	-	50	-	50	1
16PBCCE02	Biochemical Calculations	2	-	100	-	100	1
		29				**800**	**23**
Part III							
16PVE01	Value Education	1	-	Remarks			1
Total		**30**					**24**

SEMESTER II							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
16PBCCC05	**Core 4:** Intermediary Metabolism and Regulation	4	3	30	70	100	4
16PBCCC06	**Core 5**:Human Physiology and Endocrinology	4	3	30	70	100	4
16PBCCC07	**Core 6**: Analytical Biochemistry	4	3	30	70	100	4
16PBCDC03/ 16PBCDC04	**Discipline Specific Elective- II (**Nutritional Biochemistry/ Clinical Biochemistry	4	3	30	70	100	4
16PBCCC08	**Combined Practical (Core papers) II:** Physiology and Metabolism Practical's	8	6	80	120	200	4
16PBCDC05/ 16PBCDC06	**Discipline Specific Elective Practical- I :** Nutritional Biochemistry/ Clinical Biochemistry Practical's	2	3	20	30	50	1
Part II							
16PBCCE03	**Research Paper presentation**	1	-	50	-	50	1
16PBCCE04	Technical Skill II	2	3	100	-	100	2
Total		**29**				**800**	**24**

Students have to complete Career Competency Skills Course during their first year (I & II Semester) for 1 hr/week in each Semester to earn their degree

SEMESTER III							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
16PBCCC09	**Core 7:** Molecular Biology	4	3	30	70	100	4
16PBCCC10	**Core 8**: Immunology	4	3	30	70	100	4
16PBCCC11	**Core 9**: Genetic Engineering	4	3	30	70	100	4
16PBCCC12	**Core 10:** Computer Based Test	-	-	100	-	100	1
16PBCDC07/ 16PBCDC08	**Discipline Specific Elective- III** (Genetics/ Pharmaceutical Biochemistry)	4	3	30	70	100	4
16PBCCC13	**Combined Practical (Core) – IV** Advanced Biochemistry Practical's	8	9	80	120	200	4
	Project	4	-	-	-	-	-
Part II							
16PBCCE05	**Peer Tutoring**	-	-	50	-	50	1
16PBCCE06	Technical Skill III	2	3	100	-	100	2
Total		**30**				**850**	**24**

SEMESTER IV							
Course Code	**Course**	**Hrs of Inst**	**Exam Duration (Hrs)**	**Max Marks**			**Credit**
				CIE	**SEE**	**Total**	
Part I							
16PBCCC14	**Core11:** Biostatistics and Bioinformatics	4	3	30	70	100	4
16PBCDC09/ 16PBCDC10	**Discipline Specific Elective IV** : Research Methodology / Bioethics and IPR	5	3	30	70	100	5
16PBCCC15	**Practical (Core) – V** Biostatistics and Bioinformatics	3	3	40	60	100	2
16PBCCC16	**Project / Internship/ Training**	18	-	120	80	200	12
Part II							
16PBCCE07	**Educational Tour**	-	-	50	-	50	1
Total		**30**				**550**	**24**
TOTAL OF ALL SEMESTERS						**3000**	**96**

TOTAL MARKS AND CREDIT DISTRIBUTION

S.NO	PART	Total Marks	Total Credits
1.	**PART I:** Core, Discipline Specific Electives	2500	86
2.	**PART II :** Skill Enhancement Courses	500	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**	16PBCCC01	Fundamentals of Biochemistry
2.	**I**	16PBCCC02	Enzymology
3.	**I**	16PBCCC03	Cell Biology
4.	**II**	16PBCCC05	Intermediary Metabolism and Regulation
5.	**II**	16PBCCC06	Human Physiology and Endocrinology
6.	**II**	16PBCCC07	Analytical Biochemistry
7.	**III**	16PBCCC09	Molecular Biology
8.	**III**	16PBCCC10	Immunology
9.	**III**	16PBCCC11	Genetic Engineering
10.	**III**	16PBCCC12	Computer Based Test
11.	**IV**	16PBCCC14	Biostatistics and Bioinformatics

- **CORE COURSE [PRACTICAL]**

S.No	Semester	Course Code	Course
1.	**I**	16PBCCC04	Cell and Biomolecules Practical
2.	**II**	16PBCCC08	Physiology and Metabolism Practical's
3.	**III**	16PBCCC13	Advanced Biochemistry Practical's
4.	**IV**	16PBCCC15	Biostatistics and Bioinformatics Practical's

- **OTHER CORE COURSES**

S.No.	Semester	Course Code	Course
1.	**V-VI**	16PBCCC16	Project / Internship / Training

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
1.	16PBCDC01	Microbiology
2.	16PBCDC02	Plant Biochemistry

DISCIPLINE SPECIFIC ELECTIVE – II

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

S. No	Course Code	Name of the Course	Course Code	Name of the Course
1.	16PBCDC03	Nutritional Biochemistry	16PBCDC05	Nutritional Biochemistry Practical
2.	16PBCDC04	Clinical Biochemistry	16PBCDC06	Clinical Biochemistry Practical

DISCIPLINE SPECIFIC ELECTIVE - III

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

S. No	Course Code	Name of the Course
1.	16PBCDC07	Genetics
2.	16PBCDC08	Pharmaceutical Biochemistry

DISCIPLINE SPECIFIC ELECTIVE - IV

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

S.No	Course Code	Name of the Course
1.	16PBCDC09	Research Methodology
2.	16PBCDC10	Bioethics and IPR

Part- II :COMPETENCY ENHANCEMENT COURSES

S.No	Semester	Course Code	Course
1.	**I**	16PBCCE01	Poster Presentation
2.	**I**	16PBCCE02	Mathematical Calculations in Biochemistry
3.	**II**	16PBCCE03	Research Paper presentation
4.	**II**	16PBCCE04	Technical Skill II
5.	**III**	16PBCCE05	Peer Tutoring
6.	**III**	16PBCCE06	Technical Skill III
7.	**IV**	16PBCCE07	Educational Tour

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

S. No.	Semester	Course Code	Course
1	I	16PVE01	Value Education

M.Sc. BIOCHEMISTRY Syllabus
SEMESTER -I

16PBCCC01	Core 1: Fundamentals Of Biochemistry	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 biomolecule

Unit1: Carbohydrates (10 hrs)

- 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)

- Nomenclature of aminoacids (one letter and three letter code).
- Proteins – Classification. Peptide bond. 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)

- Conformational properties of 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 conformation of Cytochrome.

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.

16PBCCC02	Core 2: 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: Introduction and basics of 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, Edie-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 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. Satyanarayana, U. (2002). Biochemistry. Kolkata, India: Books and Allied.

P16BCCC103	Core 3: 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)

- An overview of the cell and cell structure
- Introduction to the cell, its chemical composition, molecular organization, origin and evolution.
- Prokaryotic and eukaryotic cells.
- Cell theory and Modern Cell Biology.

Unit 2: Cell organelles and Cytoskeleton (9 hrs)

- cell organelles; structure and function of endoplasmic reticulum, Golgi body, endosome, lysosome, vacuole, peroxisome, ribosome, mitochondria, chloroplast, nucleus, cytoskeleton
- cell wall; subcellular fractionation; cytoplasm and cytosol
- Cytoskeleton: Microtubules Polymerization, Dynamic, and Functions, Microtubules in Cell Division, Role of Cytoskeleton Filaments in Cancer
- Methods to study the cell: principles of microscopy, centrifugation, tissue culture and flow cytometry.

Unit 3: 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 4: 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 5: Signal transduction, Cell Cycle, Cell Death, Stem Cell and Regeneration (10 hrs)

- Receptors and ligands; transduction of signal into the cell; G protein coupled receptors; growth factors and receptor tyrosine kinase; second messengers.
- Cell cycle and regulation.
- Cancer; characteristics of tumor cells; mechanism of transformation; angiogenesis; tumour suppressor genes.
- Cell signaling in development and differentiation; regulatory genes in the development of Drosophila;
- Stem cell, Regeneration, Autophagy and Cell Death.

P16BCDC01	DSE 1 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 propionoc 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.
- 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 bone 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.

P16BCDC02	DSE 2: Plant Biochemistry	4hrs/week	4 Credits

OBJECTIVES: To enable the students

- Understand biochemical basis of plant functions.
- Describe the defensive mechanism in plants
- Learn medicinal values of plants.

Unit 1 Photosynthesis : (9 hrs)

- Photosynthetic pigments – Structure and function. Light absorption and energy conversion, Organization of thylakoid membrane.
- Light reactions - Photo system I and II, Hill's reaction, Z-scheme, Q-cycle, Photophosphorylation -cyclic and non-cyclic.
- Dark reactions - calvin cycle and CAM plants, Carbon reaction in C4 plants - Hatch-Slack pathway.
- Comparison of mitochondrial and chloroplast electron transfer.
- Inhibitors of photosynthesis.
- Biochemical basis and role of Photorespiration.

Unit 2 Plant growth hormones: (9 hrs)

- Chemistry, biosynthesis, mode of action, distribution and physiological effects of Auxins, Gibberllins, Cytokinins, Absisic acid and Ethylene.
- Physiology and biochemistry of seed germination, glyoxalate cycle.
- Seed Dormancy - types of dormancy.
- Biochemistry of Senescence and Fruit ripening.

Unit 3 Nitrogen Fixation and Sulphate Assimilation: (10 hrs)

- Nitrogen cycle and Nitrogen Fixation: Symbiotic nitrogen fixation - Rhizobium, nodule formation, leg hemoglobin,
- Non-symbiotic nitrogen fixation.
- Biochemistry of N_2 fixation - Nitrogenase complex. Nitrate reduction, nitrite reduction and ammonia assimilation.
- Genetic manipulations for nitrogen fixation.
- Sulfur uptake and transport, reductive sulfate assimilation pathway.
- Biosynthesis of glutathione and its role as antioxidant and detoxifying agent.

Unit 4 Secondary Metabolites of Plants: **(10 hrs)**

- Structure and functions of terpenoids, alkaloids, lignins and flavonoids.
- Phytopharmaceuticals: Carbohydrates and derived products.
- Drugs containing glycosides, tannins, lipids, terpenoids. Peptide drugs. Alkaloidal drugs.
- Natural pesticides, Antibiotics and Allergenic Extracts -immunomodulators - Adaptogens.

Unit 5 Plant Biotechnology: (10 hrs)

- Plant Tissue culture: Types- Callus culture, Organ culture and suspension culture. Protoplast culture - isolation of protoplast.
- Somatic hybridization -mechanisms and applications.
- Production of haploid plants - androgenesis and gynogenesis. Applications of haploid plants.
- Somaclonal variations - isolation and applications of somaclonal variants.
- Micro propagation- Techniques and applications. Applications of PTC.

REFERENCE BOOKS:

1. Buchanan, B.B., Wilhelm Gruissem and Russell L. Jones. 2001. Biochemistry and Molecular Biology of Plants. IK International Pvt. Ltd., New Delhi.

2. Kokate, C.K., Purohit A.P. and Gokhale, S. B. 2008. Pharmacognosy. Nirali Prakashan .

3. Glick R. Bernard and Pasternak J. Jack. 2007. Molecular Biotechnology. [Third Edition]. ASM press, Washington D.C.

4. William G. Hopkins. 2004. Introduction to Plant Physiology. [Third Edition]. John Wiley & Sons, USA.

5. Peter B. Kaufmann. 1999. Natural Products from Plants. C.R.C. Press Boca Raton, Florida.

6.. Dey, P. M. and Harborne, J. B. 1997. Plant Biochemistry. [First Edition]. Academic Press, USA.

Semester II

16PBCCC05	**Core 4:** 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.
- 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 fattyacids.
- 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.

16PBCCC06	Core 5: Human Physiology and Endocrinology	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: Respiration, (9 hrs)

- Functional Anatomy of Respiratory System,
- Principles of Gas Exchange, Oxygen and carbon-Dioxide Transport
- Regulation of Respiration

Unit 2: Renal Physiology and Fluid Balance (9 hrs)

- Basic Anatomy of Kidney and Excretory sytem
- 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
- Blood Pressure and ionic Composition
- Regulation of Acid-Base Balance

Unit 3: 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 4: The Muscular System and Nervous System (10 hrs)

- Contraction and Excitation of Skeletal Muscles, Smooth Muscles and Cardiac Muscle
- Organization of the Nervous System
- Basic Functions of Synapses, Sensory Receptors
- Nerve Impulse Transmission, Neurotransmitters and their Receptors.

Unit 5: Endocrinology (10 hrs)

- Importance of Endocrinology, Pituitary Hormones and Their Control by the Hypothalamus
- Thyroid Hormones, Adrenocortical Hormones, Insulin, Glucagon, Parathyroid Hormone, Calcitonin. Reproductive Hormones of the Male and Female.
- Diseases related to pathphysiological

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. Harper's Biochemistry. [Twenty Fifth Edition]. Appleton and Lange Stanford, New York.
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.

16PBCCC07	Core 6: 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: (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.

16PBCDC03	**DSE.1 Nutritional Biochemistry**	**4hrs/week**	**4 Credits**

Objectives

To enable students to

- Understand nutritional aspects of the various classes of food
- Correlate metabolism and nutritional disorders
- Information on nutritional status in relation to physical activity and ageing, diet and disease, obesity and under-nutrition
- Understand role of diets & nutrition in the prevention and treatment of diseases

Unit 1. Composition of human body. (10 hrs)

- Energy content of foods. Measurement of energy
- expenditure: Direct & indirect calorimetry.
- Definition of BMR and SDA and factors affecting these.
- Thermogenic effects of foods.
- Energy requirements of man and woman and factors affecting energy requirements.

Unit 2. Dietary requirements of Human. (10 hrs)

- Physicochemical properties and physiological actions of un-available carbohydrates (dietary fibre).
- Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance.
- Essential amino acids for man and concept of protein quality.
- Cereal proteins and their limiting amino acids. Protein requirement at different stages of development.
- Major classes of dietary lipids. Properties and composition of plasma lipo-proteins.
- Dietary needs of lipids. Essential fatty acids and their physiological functions.

Unit 3. Nutritional significance Minerals and Vitamins (9 hrs)

- Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
- Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water-soluble vitamins.
- Hypervitaminosis symptoms of fat-soluble vitamins.
- Nutritional requirements during pregnancy, lactation and of infants and children.

Unit 4. Protein energy malnutrition (PEM): (10 hrs)

- Aetiology, clinical features, metabolic disorders and management of Marsmus and Kwashiorkar diseases.
- Techniques for the study of starvation. Protein metabolism in prolonged fasting. Protein sparing treatments during fasting.
- Basic concept of High protein, low caloric weight reduction diets.
- Definition and classification. Genetic and environmental factors leading to obesity. Obesity related

Unit 5. Role of diets & nutrition in the prevention and treatment of diseases: (9 hrs)

- Dental caries,Fluorosis, Hyperlipidemia, Atherosclerosis.

- Food allergy, Definition, Role of antigen, host and environment.

Reference Books:

1. Shils, M. E., & Shike, M. (Eds.). (2006). *Modern nutrition in health and disease*. Lippincott Williams & Wilkins
.2. S Davidson and J R Pasmore Human Nutrition and Dietics –ELBS, Zurich.
3. Swaminathan, M . (2004).Essentials of Food and Nutrition The Bangalore Printing and Publishing Co. Ltd., Bangalore.
4. Garrow, J. S. and James, W. P. T. [Tenth Edition] 2000. Human Nutrition and Dietetics. Churchill Livingstone Publishers, UK.
5. Wong, D. W. S. (1996).Mechanism and Theory in Food Chemistry.CBS, New Delhi.

16PBCDC04	DSE.2 Clinical Biochemistry	4hrs/week	4 Credits

Objectives:
To enable students to

- Discuss the biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory
- Identify and interpret common result patterns related to pathophysiology in relation to routine clinical biochemistry
- Describe the principles of the analytical instruments in use in the routine clinical laboratory
- Discuss the importance of quality control and assurance to diagnostic work.

Unit 1. Automation in clinical biochemistry (9 hrs)

- Automation in Clinical Biochemistry- Instrumental concept, Selection of Instrument,
- Quality assurance, Control of pre-analytical and analytical variables,
- External and internal quality control measurements.
- Good Clinical Practices: Basics and principles

Unit 2. Gastric and Blood Disorders (10 hrs)

- Gastric disorders: Disorders of gastric function, method of evaluation, pancreatic diseases, Steatorrhoea, Malabsorption syndrome test for their evaluation.
- Blood Disorder: Review of mechanism of coagulation and fibrinolysis, abnormalities in blood coagulation, variation of plasma proteins
- abnormalities of blood formation, anemia, haemoglobinopathies
- clinical significance of fecal and urine analysis.

Unit 3. Endocrinology I (10 hrs)

- Insulin and glucagon: Various types of hyperglycemia, Diabetes mellitus Ketonemia ,ketonuria , Experimental diabetes , Hypoglycemia, Polyurea, Glucose tolerance test.
- Thyroid: Iodine metabolism, Hypo and Hyper thyroidism, B.M.R.and other test for evaluation of thyroid function.
- Parathyroid: Calcium and phosphorus metabolism. Abnormalities of Parathyroid function and methods of evaluation.

Unit 4. Endocrinology II **(10 hrs)**

- Adrenal: Addison's disease and pheochromocytoma, Disorders of steroid metabolism, Test for evaluation of adrenal functions.
- Pituitary: Pituitary hormones, Clinical syndromes and their evaluation.

Unit 5. Liver disorders **(9 hrs)**

- Liver disorders: Jaundice, fatty liver and liver function tests. Renal function test
- Cerebrospinal fluid: Composition in health and disease .Lipid profile in health and disease.
- Elements of Clinical Enzymology: Isoenzymes in health and disease.
- Clinical significance of GOT, GPT, Creatine kinase, LDH etc.
- Biochemical diagnosis of disease by enzymatic evaluation.

Reference Books:

1.C. A. Burtis, Edward R. Ashwood and D. E. Bruns (2007) Tietz Fundamentals of Clinical Chemistry. 6th Edn., Saunders.

2. Marshall WJ, Bangert SK. (2008) Clinical Chemistry, 6th Edition. Edinburgh, London: Mosby Elsevier.

3.Kumar, V., Abbas, A. K., Fausto, N. & Aster, J. C. (2010) Robin & Cotron Pathologic basis of Disease. 8th Edn., Saunders-Elsevier.

4. Devlin, T. M. (1992). Textbook of Biochemistry with Clinical Correlations. A John Willey & Sons. Inc., Publication. New York.