



**COURSE STRUCTURE
&
SYLLABUS
FOR
UNDERGRADUATE PROGRAMME
IN
BIOCHEMISTRY 5th and 6th Semester
CORE COURSES
UNDER
CHOICE BASED CREDIT SEMESTER SYSTEM w.e.f
June, 2018.**

**COURSE STRUCTURE FOR UG PROGRAMME
BIOCHEMISTRY
SEMESTER 5**

| Semester | Course | Title | Hours /week | Credit | Exam hours | Internal marks | External Marks | Total Marks |
|-----------------------|--------|--|-------------|--------|------------|----------------|----------------|-------------|
| 5th | 501 | Enzymology | 6 | 4 | 3 | 30 | 70 | 100 |
| | 501 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |
| | 502 | Intermediary metabolism | 6 | 4 | 3 | 30 | 70 | 100 |
| | 502 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |
| | 503 | Molecular Biology & Recombinant DNA Technology | 6 | 4 | 3 | 30 | 70 | 100 |
| | 503 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |

Saurashtra University
Semester 5th Syllabus of Biochemistry (CBCS)
Biochemistry – 501
Paper No 501- ENZYMOLOGY

Credit: 4

Theory: 6 lectures/week

Total Lectures : 60

UNIT I: Introduction:

[12 hours]

- History, general characteristics, nomenclature, IUB enzyme classification (rationale, overview and specific examples), significance of numbering system.
- Definitions with examples of holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site (identification of groups excluded), metalloenzymes, units of enzyme activity, specific enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes and multi-enzyme complexes. Enzyme specificity.
- Historical perspective, nature of non-enzymatic and enzymatic catalysis. Measurement and expression of enzyme activity- enzyme assays. Definitions of IU, Katal enzyme turn over number and specific activity.
- Role of non-protein

Unit II: Enzyme catalysis: [12 hours]

- Role of cofactors in enzyme catalysis: NAD/NADP⁺, FMN/FAD, coenzyme A, biocytin, cobamide, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions.
- Mechanism of Enzyme action- Acid base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory.

Unit III: Enzyme Purification: [12 hours]

1. Methods for isolation, purification and characterization of enzymes.

Unit IV: Enzyme Kinetics: [12 hours]

- Factors affecting enzyme activity; enzyme concentration, substrate concentration, pH and temperature.
- Derivation of Michaelis-Menten equation for unisubstrate reactions. K_m and its significance. Lineweaver-Burk plot and its limitation.
- Bi-substrate reactions- brief introduction to sequential and ping-pong mechanisms with examples.
- Kinetics of zero and first order reactions. Significance of activation energy and free energy.
- Reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibitions. Allosteric enzymes.

Unit V: Industrial and clinical applications of enzymes: [12 hours]

- Immobilization of enzymes and their industrial applications.
- Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose-fructose syrup from sucrose; use of proteases in food, detergent and leather industry.
- Medical application of enzymes; use of glucose oxidase in enzyme electrodes.

Practicals:

- 1) An introduction to practicals in enzymology.
- 2) Assay of enzyme Acid Phosphatase.
- 3) Enzyme curve of Acid Phosphatase.
- 4) Substrate curve of Acid Phosphatase.
- 5) pH curve of Acid Phosphatase.
- 6) Temperature Curve of Acid Phosphatase.
- 7) Specific activity

8) Enzyme immobilization (Demonstration practical)

Reference Books :

1. Fundamentals of Enzymology (ii Ed) by Nicholas Price and Lewis Stevens, Oxford Univ Press.
2. Enzymes (3rd Ed) by Dixon & Webb, E.C.Longmans, London.
3. Enzymes BY Trevor Palmer, Horwood publishing Chichester.
4. Biochemistry (Ed 1995) by Geoffrey Zubay, McGraw Hill.
5. Enzyme biotechnology (1999) by G.Tripathi, Technoscience publications.
6. Biochemistry (2^{ed} 1995) by Donald Voet & JudithVoet, John Wiley & sons.inc,

Saurashtra University
Semester 5th Syllabus of Biochemistry (CBCS)
Biochemistry

Paper No 502-Intermediary Metabolism

Credit: 4

Theory: 6 lectures/week

Total Lectures : 60

UNIT I: Introduction to metabolism and Carbohydrate Metabolism:

[12 hours]

- General features of metabolism.
- Reactions, regulation and energetic of glycolysis. Alcoholic and lactic acid fermentations. Entry of fructose, galactose, mannose etc.
- Reactions, regulation and energetic of TCA cycle.
- Gluconeogenesis, glycogenesis and glycogenolysis.
- Reactions and physiological significance of pentose phosphate pathway.
- Photosynthesis, a brief review.
- Inborn errors of carbohydrate metabolism.

UNIT II: Electron Transport Chain and Oxidative Phosphorylation.

[12 hours]

- Structure of mitochondria, sequence of electron carriers, sites of ATP production, inhibitors of electron transport chain.
- Hypothesis of mitochondria oxidative phosphorylation (basic concepts). Inhibitors and uncouplers of oxidative phosphorylation.
- Transport of reducing potentials into mitochondria.

Unit III: Lipid metabolism:

[12 hours]

- Introduction, hydrolysis of triacylglycerols, transport of fatty acids into mitochondria, β oxidation of saturated fatty acids and its energetics.
- Oxidation of unsaturated and odd chain fatty acids.
- Biosynthesis of saturated and unsaturated fatty acids.
- Biosynthesis of triglycerides and important phospholipids, glycolipids, sphingolipids & cholesterol.
- Regulation of cholesterol metabolism.

- Metabolism of ketone bodies.
- Inborn errors of lipid metabolism.

Unit IV: Amino acid metabolism: [12 hours]

- General reactions of amino acid metabolism, transamination, oxidative deamination & decarboxylation.
- Biosynthesis of amino acids.
- Glycogenic and ketogenic amino acids.
- Urea cycle.
- Inborn errors of amino acid metabolism.

Unit V: Nucleotide metabolism: [12 hours]

- Sources of the atoms in the purine and pyrimidine molecules.
- Biosynthesis and degradation of purines and pyrimidines.
- Regulation of purine and pyrimidine biosynthesis.
- Inborn errors of nucleotide metabolism.

Practicals:

1. Estimation of blood glucose.
2. Estimation of Uric acid.
3. Estimation of Urea.
4. Estimation of Total protein and albumin globulin ratio.
5. Estimation of Triglycerides.
6. Estimation of cholesterol.
7. Estimation of HDL- cholesterol.

Reference Books:

1. Biochemistry (2^{ed} 1995) by Donald Voet & Judith Voet, John Wiley & sons.inc, NY.
2. Biochemistry (ed 1995) by Geoffrey Zubay, McGraw Hill.
3. Biochemistry by Lubert Stryer, WH Freeman & Co, San Francisco.
4. Text Book of Biochemistry by Thomas Devlin, John Wiley & Sons, NY.
5. Principles of biochemistry by Garrett & Grisham. Brooks Cole Publishers.

Saurashtra University
Semester 5th Syllabus of Biochemistry (CBCS)
Biochemistry

Paper No 503- Molecular Biology & Recombinant DNA Technology

Credit: 4

Theory: 6 lectures/week

Total Lectures : 60

Unit I: Sequencing of DNA and DNA Replication [12 hours]

- Sequencing of DNA.
- DNA replication in prokaryotes- conservative, semi conservative and dispersive types, experimental evidence for semi conservative replication.
 - Mechanism of DNA replication. DNA Polymerases, other enzymes
 - And protein factors involved in replication. inhibitors of DNA replication.
- Similarity and differences between replication in prokaryotes and eukaryotes.

Unit II: Transcription: [12 hours]

- Transcription in prokaryotes- RNA polymerase, promoters initiation elongation and termination of RNA synthesis, post transcriptional processing of RNA. Inhibitors of transcription.
- Reverse transcriptase and brief introduction to eukaryotic transcription.

Unit III: Translation and Regulation of Gene Expression [12 hours]

- Genetic code.
- Mechanism of translation in prokaryotes and brief introduction to eukaryotic translation.
- Regulation of gene expression in prokaryotes- lac operon, Trp operon.

Unit IV: Mutation and Repair: [12 hours]

- Mutation: Molecular basis of mutation, types of mutation. Mutagens.
- Mutagenicity testing: correlation of mutagenicity and carcinogenicity; Ames testing
- DNA Repair: UV repair systems in *E.coli*. Significance of thymine in DNA.

Unit V: Recombination & Recombinant DNA Technology: [12 hours]

- Recombination in bacteria- conjugation, transduction & transformation.
- Transposon.
- Modification & Restriction -DNA methylation, restriction endonucleases.
- Brief discussion of gene cloning in bacteria.
- Applications of Recombinant DNA technology.

Practicals:

1. Genomic DNA isolation from Bacteria.
2. Spectrophotometric estimation of isolated genomic DNA.
3. Plasmid isolation by CTAB method
4. Plasmid isolation by Alkaline lysis method.
5. Agarose gel electrophoresis of isolated plasmid.
6. Restriction endonuclease enzyme digestion of DNA.
7. Bacterial conjugation
8. Bacterial Transformation.
9. Gene cloning (Demonstration practical)
10. PCR (Demonstration practical)

Reference Books:

1. Molecular biology by Lodish scientific American books.
2. Biochemistry(2^{ed} 1995) by Donald Voet & Judith Voet, John Wiley & sons.inc, NY.
3. Molecular biology of the Gene by J D Watson, Hopkins, Roberts & et al WH Freeman, San Francisco.
4. Genes VII by Benjamin Lewin Oxford Univ Press. London.
5. Molecular biology by David Friefelder. WH Freeman NY.

**COURSE STRUCTURE FOR UG PROGRAMME
BIOCHEMISTRY - CBCS
SEMESTER 6**

| Semester | Course | Title | Hours /week | Credit | Exam hours | Internal marks | External Marks | Total Marks |
|-----------------------|--------|----------------------------------|-------------|--------|------------|----------------|----------------|-------------|
| 6th | 601 | Human Physiology | 6 | 4 | 3 | 30 | 70 | 100 |
| | 601 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |
| | 602 | Immunology | 6 | 4 | 3 | 30 | 70 | 100 |
| | 602 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |
| | 603 | Endocrinology and Cancer Biology | 6 | 4 | 3 | 30 | 70 | 100 |
| | 603 | Practicals | 6 | 3 | 6 | 15 | 35 | 50 |

Saurashtra University
Semester 6th Syllabus of Biochemistry (CBCS)
Biochemistry

Paper No 601- Human Physiology and Clinical Biochemistry

Credit: 4

Theory: 6 lectures/week

Total Lectures : 60

Unit I: Blood

[12 hours]

- Composition and functions of blood, plasma, erythrocytes and Hb, leucocytes and thrombocytes in health and diseases.
- Genesis of erythrocytes, different types of leucocytes and platelets.
- Blood groups, ABO system, rhesus (Rh) system, blood clotting factors. Intrinsic and extrinsic pathways for blood coagulation.
- Brief about various types of anemia.
- Hematological disorder & their diagnosis.

Unit II: Digestive system and process of digestion and absorption

[12 hours]

- Brief anatomy of digestive system.
- Chemical composition and functions of digestive juices (saliva, gastric juice, pancreatic juice, bile juice and intestinal juice).

- Absorption of digested food and absorption of minerals, hydrates, lipids and proteins.
- Regulation of secretion of digestive juices.
- Disorders related to digestive system & their diagnosis, Liver function tests.

Unit III: Excretory systems:

[12 hours]

- Structure and organization of kidney and urinary system. Nephron- the structural and functional unit of kidney.
- Mechanism of urine formation (filtration, selective reabsorption and secretion). Regulation of water and electrolyte balance, role of kidneys and hormones in their maintenance.
- Disorders of urinary system & Renal function tests.

UNIT IV: Nervous system

[12 hours]

- Organization of the nervous system. Structure of a typical neuron. Different types of neuronal and glial cells and their functions.
- Nerve impulse and neurotransmission.
- Synapses: chemical and electrical synapses.
- Neurotransmitter: properties, different types, action and inactivation.

UNIT V: Respiratory and Cardiovascular system

[12 hours]

- Components of respiratory system (nasal cavity, trachea, pharynx, larynx, lungs, bronchi, bronchioles and alveoli) and their functions.
- Diffusion of respiratory gases (oxygen and carbon dioxide), role of Hb in transport of oxygen. Control of respiration & Respiratory disorders.
- Overall design of circulatory system; pulmonary and systemic circulation.
- Cardiac cycle, ECG, disorders related to circulatory system.

Practicals:

1. Introduction to Hematology & Clinical Biochemistry.
2. Blood Grouping.
3. Haemoglobin Estimation.
4. Total Count.
5. Differential Count.
6. Packed cell volume.
7. ESR and Red Cell Indices.
8. Bleeding Time and Clotting Time.
9. Measurement of Blood Pressure.
10. Widal Test.
11. Urine Analysis.
12. Liver Function Test.
13. Kidney Function Test.
14. Cardiac Function Test.

Reference Books:

1. Text book of Medical Physiology by A.C.Guyton, Harcourt Asia.
2. Harper's Biochemistry by R.K.Murray and others. Appleton and Lange, Stanford.
3. Concise Medical Physiology by Sujit Chaudhuri Central publishers.
4. Anatomy and Physiology by Wilson and Waugh. Churchill Livingstone.

Saurashtra University
Semester 6th Syllabus of Biochemistry (CBCS)
Biochemistry
Paper No 602- Immunology

Credit: 4

Theory: 6 lectures/week

Total Lectures : 60

Unit I: Immunity and Immune Response [12 hours]

- Historical Perspective:-Early theories of immunity, discovery of humoral and cellular immunity
- Innate Immunity-Anatomic barrier, Physiologic barrier, Endocytic and Phagocytic barrier, Inflammatory barrier
- Acquired Immunity:- Characteristics of Specific Immune response, Functions of humoral and cell mediated immunity, Generation of cell mediated and Humoral response, Primary and Secondary immune Response, Clonal selection of lymphocytes.
- Major Histocompatibility Complex-Location and Functions of MHC regions, Structure of Class I and II molecules, Organization of class I and Class II genes.
- Polymorphism of Class I and Class II molecules, Peptide binding by MHC molecules

Unit II: Cells, Organs, Antigen and Antibody [12 hours]

- Cell and Organs Involved in the Immune System-Cells of immune system; Lymphoid cells, Mononuclear cells, Granulocytic cells, mast cells, Dendritic cells Primary Lymphoid organs; Bone Marrow, Thymus
- Secondary lymphoid organs; Spleen, Lymph nodes, MALT
- Antigen:-Immunogenicity, Antigenicity, Factors Influencing the Immunogenicity, Adjuvants, Epitopes, Haptens, Exotoxins, Endotoxins, Mitogens.
- Immunoglobulin:-Determination of Basic Structure of immunoglobulin, Introduction to the fine structure of Immunoglobulin, Isotypic, Allotypic and Idiotypic Determinants, Immunoglobulin Classes, Introduction to monoclonal antibodies and Immunoglobulin superfamily.

Unit III: Complement Fixation and Antigen Antibody Reactions [12 hours]

- Antigen-Antibody Reactions in vitro and in vivo-Concept of Antibody affinity and Avidity, Cross Reactivity, Precipitation reactions in fluids and gels

- Agglutination Reactions; hemagglutination, Bacterial Agglutination, Passive agglutination and agglutination inhibition
- Components of Complement System-, Classical and Alternative pathway of Complement Activation, Cell Lysis, Inflammatory Response, Opsonization, Viral neutralization, .
- Organization and Expression of Immunoglobulin Genes.-Multigene Organization of Ig Genes, variable Region gene Rearrangements.Introduction to generation of antibody diversity and Class Switching

Unit IV: Hypersensitive Reactions, Autoimmunity and Tumor Immunology

[12 hours]

- Hypersensitive Reaction-Ig E Mediated Hypersensitivity, Antibody Mediated Cytotoxic Hypersensitivity, Immune Complex mediated hypersensitivity and T_{DTH} mediated hypersensitivity
- Tumor immunology-Tumor specific antigens and tumor associated Antigens
- Immune Response to Tumors
- Autoimmune Diseases-Organ Specific Autoimmune Diseases; Hashimoto's Thyroiditis, Autoimmune Anaemia's, Goodpasture's Syndrome, Insulin Dependent Diabetes Mellitus, Graves Disease, Myasthenia Gravis
- Systemic Autoimmune Disease; SLE, Multiple Sclerosis, Rheumatoid Arthritis

Unit V: Processing and Presentation of Antigen, Vaccines and Immunodeficiency .

[12 hours]

- Antigen Processing and Presentation-The Cytosolic Pathway; proteasome mediated peptide generation, peptide transport from to cytosol to RER, Overview of the pathway
- The Endocytic Pathway; Peptide generation of endocytic vesicles, Transport of Class II MHC molecule to Endocytic Vesicles, Overview of the pathway
- Vaccines-Active and passive Immunization, Whole Organism vaccine, Introduction to Recombinant Vector vaccine, DNA Vaccine, Multivalent Subunit Vaccine.
- HIV and Immunodeficiency-Structure of HIV, Target cell of HIV and consequences of infection, Transmission of HIV, Diagnosis of HIV infection,
- Concept of HAART.

- Severely Combined Immuno Deficiency Disease and AIDS

Practicals:

- 1.Radial Immunodiffusion
2. Ouchterlony Technique
3. Rocket Immuno-electrophoresis
4. Determination of Antibody Titre
5. ELISA

Reference Books:

1. Immunology by Ivan Roitt, J Brostoff. Mosby Times mirror Int. pub ltd.
2. Immunology by Janis Kuby WH Freeman and USA.
3. Essential Immunology by Ivan Roitt Blackwell Science Ltd.
4. Veterinary Immunology by Ian Tizard. W.B. Saunders Company.

Saurashtra University
Semester 6th Syllabus of Biochemistry (CBCS)
Biochemistry

Paper No 603- Endocrinology and Cancer Biology

Credit: 4

Theory: 6 lectures/week

Total Lectures: 60

Unit I: Introduction to Endocrinology

[12 hours]

- Functions of hormones and their regulation.
- Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms.
- Chemical classification of hormones,
- Transport of hormones in the circulation and their half-lives.
- Hormone receptors - extracellular and intracellular.
- Receptor - hormone binding, Scatchard analysis.
- G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP₃, DAG, Ca²⁺, NO.
- Hormone therapy. General introduction to Endocrine methodology.

Unit II: Hypothalamic and Pituitary Hormones, Thyroid gland, Hormones regulating Ca²⁺ homeostasis

[12 hours]

- Hypothalamic - pituitary axis.
- Physiological and biochemical actions of hypothalamic hormones, pituitary hormones
- Feedback regulation cycle.
- Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.
- Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action.
- Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimoto's disease.
- PTH, Vitamin D and calcitonin.
- Mechanism of Ca²⁺ regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit III: Pancreatic and GI tract hormones, Adrenals and Reproductive hormones: [12 hours]

- Regulation of release of insulin, glucagon, adipoleptin, gastrin, secretin, CCK, GIP, leptin and ghrelin.
- Summary of hormone metabolite control of GI function.
- Physiological and biochemical action. Pathophysiology - diabetes type I and type II.
- Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response.
- Pathophysiology – Addison’s disease, Conn’s syndrome, Cushing syndrome.
- Male and female sex hormones.
- Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

Unit IV: Signal transduction [12 hours]

- General principles of signal transduction- Introduction, Signal transduction mechanisms, Protein–protein interactions in signal transduction
- Receptors and their ligands- Introduction, Receptor specificity, Receptor activation, Intracellular receptors.
- Intracellular signalling components- Trimeric G proteins, Lipid-modifying enzymes, Second messengers, Monomeric G proteins, Protein kinases and Activation of transcription factors

Unit V: Cancer Biology and Immunology [12 hours]

- General outline of cancer and outcomes of cancer research. Characteristics of cancerous cells. Differences between tumors and cancer and different types of cancers.
- Carcinogenesis and factors involved in carcinogenesis (physical and chemical carcinogenic agents, viruses, environmental factors, genetic factors). Role of dietary factors in prevention of cancer.
- Steps in the process of tumor metastasis and malignancies. Experimental strategies to block tumor metastasis
- Molecular Mechanisms of cancer. Concept of proto-oncogenes, tumor suppressor genes.
- Overview of cancer immunology.

Practicals:

1. Case Study related to Thyroid hormones.
2. Case Study related to Adrenal hormones
3. Case Study related to Pancreatic hormones
4. Case Study related to Type I and II Diabetes.
5. Significance of Glucose Tolerance Test (GTT) and its interpretation
6. Human chorionic gonadotropin (hCG) testing.

Reference Books:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (New York),.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. The Cell: A Molecular Approach (2009) 5th Ed.
4. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893- 300-6