



ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

(A Statutory body of the Government of Andhra Pradesh)

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REVISED SYLLABUS OF B.Sc. BIOCHEMISTRY UNDER CBCS FRAMEWORK WITH EFFECT FROM 2020-2021

PROGRAMME: THREE-YEAR B.Sc. BIOCHEMISTRY

*(With Learning Outcomes, Unit-wise Syllabus, References, Co-curricular Activities &
Model Q.P.) For Fifteen Courses of 1, 2, 3 & 4 Semesters)*

(To be Implemented from 2020-21 Academic Year)

**A.P. STATE COUNCIL OF HIGHER EDUCATION B.Sc. BIOCHEMISTRY
REVISED SYLLABUS FOR CORE COURSES**

CBCS/ SEMESTER SYSTEM (w.e.f. 2020-21 Admitted Batch)

CORE COURSES STRUCTURE (Sem-I to Sem-IV)

Year	Semester	Paper	Subject	Hours /week	Credits	IA	EA	Total
1	I	Course-1	Biomolecules	4	3	25	75	100
		Course-1 Practical	Biomolecules	3	2	Max. Marks-50 Internal assessment at Semester end		50
	II	Course-2	Analytical techniques	4	3	25	75	100
		Course-2 Practical	Analytical techniques	3	2	Max. Marks-50 External assessment at Semester end		50
2	III	Course-3	Enzymology, Bioenergetics and Intermediary Metabolism	4	3	25	75	100
		Course-3 Practical	Enzymology, Bioenergetics and Intermediary Metabolism	3	2	Max. Marks-50 Internal assessment at Semester end		50
	IV	Course-4	Physiology, Nutritional and Clinical Biochemistry	4	3	25	75	100
		Course-4 Practical	Physiology, Nutritional and Clinical Biochemistry	3	2	Max. Marks-50 External assessment at Semester end		
		Course-5	Microbiology, Immunology and Molecular biology	4	3	25	75	100
		Course-5 Practical	Microbiology, Immunology and Molecular biology	3	2	Max. Marks-50 External assessment at Semester end		50

Expected out comes of the course BCH-1:

1. The student gains knowledge in the chemistry of biomolecules such as water, carbohydrates, lipids, proteins and nucleic acids which make up all the living organisms including humans.
2. This will enable the student to understand the importance of these biomolecules in living organisms and effects of their alterations in diseases occurring in plants, animals and humans.
3. The practicals will give the expertise to the student for analysis of any biological or non biological sample for identification of its chemical composition

BIO-CHEMISTRY

SEMESTER-I

Paper - 1: BIOMOLECULES

Code: BCH-1

**60 HRS
(5 periods/week)**

Unit - I: Biophysical Concepts

12 hours

Water as biological solvent, Buffers, measurement of pH, electrodes, Biological relevance of pH, pKa value, analysis of drinking water and pond water, Total dissolved salts (TDS), BOD, COD, soil analysis (texture, organic matter, elements), Electrical conductivity.

Unit - II: Carbohydrates

12 hours

Carbohydrates: Classification, monosaccharides, D and L designation, open chain and cyclic structures, epimers and anomers, mutarotation, reactions of carbohydrates (due to functional groups - hydroxyl, aldehyde and ketone. Amino sugars, Glycosides. Structure and biological importance of disaccharides (sucrose, lactose, maltose, isomaltose, trehalose), trisaccharides (raffinose, melezitose), structural polysaccharides (cellulose, chitin, pectin) and storage polysaccharides (starch, inulin, glycogen). Glycosaminoglycans, Bacterial cell wall polysaccharides. Outlines of glycoproteins, glycolipids and blood group substances.

Unit - III: Lipids

12 hours

Lipids: Classification, saturated and unsaturated fatty acids, structure and properties of fats and oils (acid, saponification and iodine values, rancidity). General properties and structures of phospholipids. Prostaglandins- structure, types and biological role. Lipoproteins- types and functions, Biomembranes: Membrane composition and organization - Fluid mosaic model.

Unit-IV: Amino Acids and Proteins

12 hours

Amino Acids: Classification, structure, stereochemistry, chemical reactions of amino acids due to carbonyl and amino groups. Titration curve of glycine and pK values. Essential and nonessential amino acids, non-protein amino acids. Peptide bond - nature and conformation. Naturally occurring peptides - glutathione, enkephalin. Proteins: Classification based on solubility, shape and function. Determination of

amino acid composition of proteins. General properties of proteins, denaturation and renaturation of proteins. Structural organization of proteins- primary, secondary, tertiary and quaternary structures (Eg. Hemoglobin and Myoglobin).

Unit-V: Nucleic acids and porphyrins

12 hours

Types of RNA and DNA. Structure of purines and pyrimidines, nucleosides, nucleotides. Stability and formation of phosphodiester linkages. Effect of acids, alkali and nucleases on DNA and RNA. Structure of Nucleic acids- Watson-Crick DNA double helix structure, denaturation and renaturation kinetics of nucleic acids-, T_m -values and their significance, cot curves and their significance, Introduction to porphyrins with examples.

Semester – I: Practical – I : Qualitative Analysis

1. Preparation of buffers (acidic, neutral and alkaline) and determination of pH.
2. Qualitative identification of carbohydrates- glucose, fructose, ribose/xylose, maltose, sucrose, lactose, starch/glycogen.
3. Preparation of Osazones and their identification.
4. Qualitative identification of amino acids- histidine, tyrosine, tryptophan, cysteine, arginine.
5. Qualitative identification of lipids- solubility, saponification, acrolein test, Salkowski test, Lieberman-Burchard test.
6. Isolation of casein from milk
7. Isolation of egg albumin from egg white.

Recommended books:

1. Biochemistry - Zubay C, Addison – Wesley, 1986.
2. Biochemistry, A problem Approach, 2nd Edn. Wood, W.B. Addison Wesley 1981.
3. Biochemistry, Lehninger A.H.
4. Textbook of Biochemistry West, E.S., Todd, Mason & Vanbruggen, Macmillan & Co.
5. Principles of Biochemistry White-A, Handler, Pand Smith E.L. Mc Graw Hill.
6. Organic chemistry, I.L. Finar, ELBS. (1985).
7. Organic Chemistry by Morrison and Boyd (2000) Prentice Hall.
8. Fundamentals of Biochemistry by Donald Voet (1999).
9. Biochemistry by U Satyanarayana

Expected outcomes of the course BCH- II

1. The student will learn the various analytical techniques and their applications in separation and isolation of cells and tissues for studying their functional abnormalities
2. The knowledge in the analytical techniques will enable the student for isolation ,purification and chemical characterization of compounds from plants and microbes which will have medical or commercial importance.
3. The practicals will provide the expertise to the student for quantification of electrolytes and other metal ions, hormones and identification of bacteria.
4. The expertise gained by the student in this course can be useful in food industries ,pharma industries, clinical and microbiological labs.

BIO-CHEMISTRY SEMESTER-II

Paper -2 : Analytical techniques Code: BCH-II

**60 HRS
(5 periods/week)**

Unit-I: Cell homogenization and centrifugation

12 hours

Methods of tissue homogenization: (Potter-Elvehjem, mechanical blender, sonicator and enzymatic). Centrifugation techniques, principles and applications- differential, density gradient. Ultra-centrifugation- preparative and analytical.

Unit-II: Chromatographic techniques

12 hours

Types of chromatographic techniques, Principle and applications - Paper chromatography- solvents, R_f value, applications; Thin layer chromatography- principle, choice of adsorbent and solvent, R_f value, applications; Gel filtration, Ion- exchange- principle, resins, action of resins, experimental techniques, applications, separation of metal ions; Affinity chromatography.

Unit-III: Spectroscopy and tracer techniques

12 hours

Electromagnetic radiation, Beer-Lambert's law. Colorimetry and Spectrophotometry, spectrofluorimetry, flame photometry. Tracer techniques: Radio isotopes, units of radio activity, half life, β and γ - emitters, use of radioactive isotopes in biology, ELISA, RIA.

Unit-IV: Electrophoresis**12 hours**

Electrophoresis- principles and applications of paper, polyacrylamide (native and SDS) and agarose gel electrophoresis, isoelectric focusing, immuno-electrophoresis-types and applications.

Unit-V: Microbial techniques:**12 hours**

Microscopy: Basic principles of light microscopy, phase contrast, electron microscope and fluorescent microscope and their applications. Preparation of different growth media, isolation and culturing and preservation of microbes, Gram's staining- Gram positive and Gram negative bacteria, motility and sporulation, Sterilization techniques-Physical methods, chemical methods.

Semester –II : Practical – II : BIOCHEMICAL TECHNIQUES**List of Experiments:**

1. Qualitative Identification of DNA,RNA and Nitrogen Bases
2. Isolation of cholesterol from egg yolk.
3. Isolation of starch from potatoes.
4. Separation of amino acids by paper chromatography.
5. Determination of exchange capacity of resin by titrimetry.
6. Separation of serum proteins by paper electrophoresis.
7. Absorption maxima of coloured substances (p-Nitrophenol and Methyl Orange)
8. Absorption maxima of proteins (BSA) and nucleic acids.

Recommended books:

1. Principles and Techniques of practical Biochemistry. Eds. Williams and Wilson.
2. Techniques in Molecular biology Ed. Walker & Gastra, Croom Helm, 1983.
3. Principles of instrumental analysis, 2nd Ed, Holt-Sanders, 1980.
4. An introduction to spectroscopy for Biochemistry. Ed. Brown S.N., Academic press
5. Analytical Biochemistry, Holmes and Hazel peck, Longman, 1983.
6. An introduction to practical biochemistry. David T. Plummer, Tata Mac Grew-Hill.
7. Biophysical chemistry, Edshall & Wyman, Academic press Vol. II & I.
8. A textbook of quantitative inorganic analysis including elementary instrumental analysis, Vogel ELBS.
9. Biochemical calculations Seigel, IH, 2nd Edit, John Wiley & sons Inc., 1983.
10. Analytical Biochemistry by Friefelder David

Outcomes of the course BCH-III

1. The student will get knowledge in enzymes, their physiological importance and other applications.
2. The student will know how the nutrients such as carbohydrates, lipids and proteins get metabolized for the purpose of energy and other physiological functions in the body. This will enable the student to understand the pathophysiology of metabolic diseases such as diabetes, atherosclerosis etc. which occur due to alterations in metabolisms.
3. The practicals will provide the expertise for quantification of enzymes' activities, glucose, proteins and lipid levels in blood which will have clinical applications.

BIO-CHEMISTRY

Semester-III

Paper -III : ENZYMOLOGY, BIOENERGETICS AND INTERMEDIARY METABOLISM

Code: BCH-III

60 HRS

(5 periods/week)

Unit-I: Enzymology

12 hours

Introduction to Biocatalysis, differences between chemical and biological catalysis. Nomenclature and classification of enzymes. Definition of holo-enzyme, apo-enzyme, coenzyme, cofactor. Active site, Enzyme specificity. Principles of energy of activation, transition state. Interaction between enzyme and substrate-lock and key, induced fit models. Fundamentals of enzyme assay, enzyme units. Outlines of mechanism of enzyme action, factors affecting enzyme activity. Commercial application of enzymes.

Unit- II: Bioenergetics and Biological oxidation

12 hours

Bioenergetics: Thermodynamic principles – Chemical equilibria; free energy, enthalpy (H), entropy (S). Free energy change in biological transformations in living systems; High energy compounds. Energy, change, oxidation-reduction reactions. Organization of electron carriers and enzymes in mitochondria. Classes of electron-transferring enzymes, inhibitors of electron transport. Oxidative phosphorylation. Uncouplers and inhibitors of oxidative phosphorylation. Mechanism of oxidative phosphorylation.

Unit-III: Carbohydrate Metabolism.

12 hours

Concept of anabolism and catabolism. Glycolytic pathway, energy yield. Fate of pyruvate-formation of lactate and ethanol, Citric acid cycle, regulation, energy yield, amphipathic role. Anaplerotic reactions. Glycogenolysis and glycogenesis. Pentose phosphate pathway. Gluconeogenesis. Photosynthesis- Light and Dark reactions, Calvin cycle, C₄ Pathway. Disorders of carbohydrate metabolism- Diabetes Mellitus.

Unit-IV: Lipid Metabolism

12 hours

Catabolism of fatty acids (β - oxidation) with even and odd number of carbon atoms, Ketogenesis, *DE NOVO* synthesis of fatty acids, elongation of fatty acids in mitochondria

and microsomes, Biosynthesis and degradation of triacylglycerol and lecithin. Biosynthesis of cholesterol. Disorders of lipid metabolism.

Unit-V: Metabolism of Amino acids

12 hours

General reactions of amino acid metabolism- transamination, decarboxylation and deamination, Urea cycle and regulation, Catabolism of carbon skeleton of amino acids- glycolytic and ketogenic amino acids. Metabolism of glycine, serine, aspartic acid, methionine, phenylalanine and leucine. Biosynthesis of creatine. Inborn errors of aromatic and branched chain amino acid metabolism.

Practical – BCP-301: Quantitative analysis

1. Assay of amylase.
2. Assay of urease.
3. Assay of catalase
4. Effect of pH, temperature and substrate concentration on enzyme activity.
5. Estimation of glucose by DNS method.
6. Estimation of glucose by Benedict's titrimetric method.
7. Estimation of total carbohydrates by Anthrone method.
8. Tests for lipids- Salkowski test, Lieberman-Burchard test.
9. Estimation of amino acid by Ninhydrin method.
10. Estimation of protein by Biuret method.

Recommended books:

1. Understanding enzymes: Palmer T., Ellis Harwood ltd., 2001.
2. Enzyme structure and mechanism. Alan Fersht, Freeman & Co. 1997
3. Principles of enzymology for food sciences: Whitaker Marc Dekker 1972.
4. Principles of Biochemistry, White. A, Handler, P and Smith.
5. Biochemistry, Lehninger A.L.
6. Biochemistry, Lubert Stryer.
7. Review of physiological chemistry, Harold A. Harper.
8. Text of Biochemistry, West and Todd.
9. Metabolic pathways – Greenberg.
10. Mitochondria, Munn.
11. Biochemistry, 2nd Edition, G. Zubay.

Expected out comes of course BCH-IV

1. The student will get knowledge in the different physiological systems and their functions in the human body. By studying blood, its composition and its functions the student will understand the importance of blood.
2. This course will also provide knowledge in hormones, their functions and the diseases occurring due to alterations in the levels of hormones.
3. By studying this course the student will know the nutritional importance of proteins, carbohydrates, lipids, vitamins and minerals.
4. Clinical biochemistry unit along with practicals will enable the student to do diagnostic tests for liver diseases, Gastro intestinal diseases, renal diseases and nutritional deficiencies.

BIO-CHEMISTRY SEMESTER-IV

Paper - IV : PHYSIOLOGY, NUTRITIONAL AND CLINICAL BIOCHEMISTRY

Code: BCH-1V

**60 HRS
(5 periods/week)**

Unit-I: Digestion and Blood

12hours

Digestion and absorption of carbohydrates, lipids and proteins. Role of enzymes and gastrointestinal hormones in digestion. Composition of blood, Blood groups, coagulation of blood and disorders of blood coagulation (haemophilia). Hemoglobin and transport of gases in blood (oxygen and CO₂). Types of anemias, haemoglobinopathies- sickle cell anemia.

Unit-II: Nervous system and excretory system

12hours

Introduction to nervous system, general organization of nervous system, Neurons- structure, types, properties and functions; Neurotransmitters, Cerebrospinal fluid- composition and functions, Reflex-types and properties. Introduction to excretory system. Organisation of kidney, Structure and functions of nephron, Urine formation, Role of kidneys in maintaining acid-base and electrolyte balance in the body.

Unit III: Endocrinology

12 hours

Endocrinology- organization of endocrine system. Classification of hormones. Outlines of chemistry, physiological role and disorders of hormones of thyroid, parathyroid, pituitary and hypothalamus. Introduction of gastrointestinal hormones. Mechanism of hormonal action- signal transduction pathways for glucocorticoids and insulin. Adrenalin, estrogen and progesterone.

Unit- IV: Nutritional Biochemistry

12hours

Balanced diet. Calorific values of foods and their determination by bomb calorimeter. BMR and factors affecting it. Specific dynamic action of foods. Energy requirements and recommended dietary allowance (RDA) for children, adults, pregnant and lactating

women. Sources of complete and incomplete proteins. Biological value of proteins. Malnutrition- Kwashiorkar, Marasmus and PEM.

Vitamins- sources, structure, biochemical roles, deficiency disorders of water and fat soluble vitamins. Introduction to nutraceutical and functional foods. Bulk and trace elements-Ca, Mg, Fe, I, Cu, Mo, Zn, Se and F.

Unit- V: Clinical Biochemistry

12hours

Plasma proteins in health and disease. Liver diseases-jaundice. Liver function tests-conjugated and total bilirubin in serum, albumin: globulin ratio, Serum enzymes in liver diseases-SGOT, SGPT, GGT,CPK, Acid and alkaline phosphatases. Serum lipids and lipoproteins. Normal and abnormal constituents of urine. Renal function tests-Blood urea, creatinine, GFR, creatinine clearance. GTT and gastric and pancreatic function tests.

Semester – IV : Practical -IV : NUTRITIONAL AND CLINICAL BIOCHEMISTRY

45 HRS

(3 periods/week)

List of Experiments:

1. Estimation of calcium by titrimetry
2. Estimation of iron by Wong's method.
3. Estimation of vitamin C by 2, 6 -dichlorophenol indophenol method.
4. Determination of iodine value of an oil.
5. Estimation of hemoglobin in blood.
6. Total count - RBC and WBC. Differential count.
7. Determination of blood group and Rh typing.
8. Visualization of antigen antibody reactions (Ouchterlony technique).
9. Urine analysis for albumin, sugars and ketone bodies.
10. Estimation of urinary creatinine.
11. Estimation of blood Glucose.
12. Estimation of serum total cholesterol.

Recommended books:

1. Essentials of Food and Nutrition, Vol. I & II, M.S. Swaminathan.
2. Text Book of Biochemistry with clinical correlations. Thomas M. Devlin (John Wiley).
3. Harper's Review of Biochemistry, Murray et al (Longman).
4. Biochemical aspects of human disease – R.S. Elkeles and A.S. Tavit. (Blackwell Scientific Publications).
5. Clinical chemistry in diagnosis and treatment–Joan F.Zilva and P.R.Pannall (Lloyd-Luke Medical Books, 1988).
6. Varley's Practical clinical Biochemistry – Ed. Alan W. Gowenlock (Heinemann Medical Books, London, 1988).
7. Clinical diagnosis and management by Lab methods (John Bernard Henry, W.B. Saunders Company, 1984).
8. Clinical Biochemistry – S.Ramakrishnan and Rajiswami.
9. Chemical Biochemistry (Metabolic and clinical aspects) by W.J.Marshall & S.K.Bangert.
10. Text book of clinical Biochemistry by Tietz et al.

Expected outcomes of the course BCH-V

1. This course will enable the student to know various microbes such as bacteria, fungi and viruses, their structures and other properties and diseases caused by them. The student will also get knowledge in their commercial applications by making use of their beneficial effects such as fermentation in alcohol production, nitrogen fixation in agriculture etc.
2. The student will also get knowledge in immune system, vaccines and also understand the pathogenesis of auto immune diseases and immune deficiency diseases.
3. This course will provide knowledge and expertise in molecular biology such as genes, their structure and importance. This will also enable the student to know the applications of PCR in cloning and diagnosis of genetic and viral diseases.
4. The practicals will provide the expertise to the student to work in microbiology laboratory, food and pharma industries, and biotech companies for production of vaccines and other life saving drugs.

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Semester - IV

Paper -V: Microbiology, Immunology and Molecular biology

Code: BCH-V

60 HRS

(5 periods/week)

Unit-I: Microbiology 12 hours

Introduction to microbiology and microbial diversity. Classification of microorganisms- prokaryotic and eukaryotic microorganisms. Bacterial structure, growth curve and kinetics of growth. Introduction to viruses- plant and animal viruses, structure, life cycle, Food and dairy microbiology.

Unit-II: Nitrogen Fixation

12 hours

Nitrogen cycle, Non-biological and biological nitrogen fixation, photosynthetic and non-photosynthetic systems, Nitrogenase system. Utilization of nitrate ion, Ammonia incorporation into organic compounds. Synthesis of glutamine and regulatory mechanism of glutamine synthase.

Unit-III: Applied Biochemistry 12 hours

Fermentation Technology: Batch, continuous culture techniques, principle types of fermentors. Pasteur effect. Industrial production of chemicals- alcohol, acids (citric acid), solvents (acetone), antibiotics (penicillin), Enzyme Technology: Immobilization of enzymes and cells, industrial applications, enzymes in Bioremediation.

Unit- IV: Immunology 12 hours

Organs and cells of immune system. Innate and acquired immunity, Cell mediated and humoral immunity (T-cells and B-cells). Classification of immunoglobulins, structure of IgG. Epitopes / antigenic determinants. Concept of haptens. Adjuvants. Monoclonal antibodies. Antigen-antibody reactions- agglutination, immunoprecipitation, immunodiffusion. Blood group antigens. Immunodiagnostics- ELISA. Vaccines and their

classification. Traditional vaccines-live and attenuated. Modern vaccines- recombinant and peptide vaccines. Outlines of hypersensitivity reactions.

Unit- V: Molecular biology

12 hours

Types of RNA and DNA, DNA replication-leading and lagging strands, okazaki fragments, inhibitors of DNA replication. Outlines of transcription, translation, inhibitors of protein synthesis. Introduction to Recombinant DNA Technology: vectors, restriction enzymes, PCR, applications of r-DNA Technology in agriculture, industry and medical fields.

Semester – IV : Practical –V: MICROBIOLOGY AND IMMUNOLOGY

45 HRS

(3 periods/week)

List of Practical Experiments

1. Biosafety and good laboratory practices (GLP) of Microbiology.
2. Sterilization of microbial media by autoclave.
3. Isolation of pure cultures: (i) Streak plate method. (ii) Serial dilution method.
4. Demonstration of alcohol fermentation.
5. Antibiotic sensitivity by paper disc method.
6. Effect of nitrogen sources on growth of *E. coli*
7. Gram Staining Techniques.
8. Identification of Bacteria based on shape.
9. Isolation of DNA from plant tissues.
10. Spotters.

Recommended books:

1. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T. Brown Publishers.
3. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
4. Fermentation Technology (2nd ed.) Standury (Pergman press)
5. Biotechnology: Textbook of Industrial microbiology 2nd Edit. By Crueger and Crueger (2000).
6. Principles of Biochemistry, White. A, Handler, P and Smith.
7. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
8. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.
9. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication.
10. Molecular biology by David Freifelder