

TELANGANA COUNCIL OF HIGHER EDUCATION (TGCHE)

HYDERABAD

PROPOSED COMMON CORE SYLLABUS

of

B.Sc. (Biochemistry)

Three Year Degree Under

Choice Based Credit System (CBCS) Frame Work

With effect from Academic Year 2026-2027

B. Sc. Biochemistry
Semester I -VI
COURSE STRUCTURE (w.e.f. 2026-27)

FIRST YEAR SEMESTER I				
Code	Course Title	Course Type	HPW	Credits
BS101	Major - I Chemistry of Biomolecules	DSC1A	4T+2P=6	4+1=5
BS102	Major - II	DSC2A	4T+2P=6	4+1=5
BS103	Minor	DSC3A	4T+2P=6	4+1=5
BS104	English	AEC1A	4	4
BS105	Second Language	AEC2A	4	4
	Total		26	23
FIRST YEAR SEMESTER II				
BS201	Major - I Chemistry of Nucleic acids and Biochemical Techniques	DSC1B	4T+2P=6	4+1=5
BS202	Major - II	DSC2B	4T+2P=6	4+1=5
BS203	Minor	DSC3B	4T+2P=6	4+1=5
BS204	English	AEC1B	4	4
BS205	Second Language	AEC2B	4	4
	Total		26	23
SECOND YEAR SEMESTER III				
BS301	Major - I Enzymology and Bioenergetics	DSC1C	4T+2P=6	4+1=5
BS302	Major - II	DSC2C	4T+2P=6	4+1=5
BS303	Minor	DSC3C	4T+2P=6	4+1=5
BS304	English	AEC1C	4	4
BS305	Second Language	AEC2C	4	4
	Total		26	23
SECOND YEAR SEMESTER IV				
BS401	Major - I Intermediary Metabolism	DSC1D	4T+2P=6	4+1=5
BS402	Major - II	DSC2D	4T+2P=6	4+1=5
BS403	Minor	DSC3D	4T+2P=6	4+1=5
BS404	English	AEC1D	4	4
BS405	Second Language	AEC2D	4	4
	Total		26	23

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THIRD YEAR SEMESTER V				
Code	Course Title	Course Type	HPW	Credits
BS501	Major – I A. Physiology, Nutrition & Clinical biochemistry (OR) B. Cell Biology, Genetics & Microbiology	DSC1E	4T+2P=6	4+1=5
BS502	Major – II A/B	DSC2E	4T+2P=6	4+1=5
BS503	Basics of Biochemistry	MDC	4	4
BS504	Skill Enhancement Course - I	SEC-I	2	2
BS505	Skill Enhancement Course – II Bioinformatics & Biostatistics (OR) Enzyme technology and Applications	SEC-II	2	2
BS506	Value Added Course – I Medical Laboratory Technology	VAC-I	1+1 *	1+1 *
	Total		22	20
THIRD YEAR SEMESTER VI				
BS601	Major – I A) Molecular Biology and Immunology (OR) B) r-DNA technology and Biotechnology	DSC1F	4+2=6	4+1=5
BS602	Major – II A/B	DSC2F	4+2=6	4+1=5
BS603	Skill Enhancement Course - III	SEC-III	2	2
BS604	Skill Enhancement Course – IV Vaccine Production and Quality Control (OR) Entrepreneurship in Biochemical Sciences	SEC-IV	2	2
BS605	Value Added Course – II Quality Control in food & Biopharmaceutical Industries	VAC-II	1+1 *	1+1 *
BS606	Internship/Project Work		4	4
	Total		22	20
	Grand Total			132

* Represents- Community Outreach/ Summer Internship/ Apprenticeship/ etc., as per UGC guidelines

Credits under Non-CGPA (Community Engagement & Service)				
1	NSS/NCC/Sports/Extra curricular	Upto 3 Credits (2 in each year)	Major - I	30
2	IKS	Upto 4 Credits (2 in each, after I & II years)	Major - II	30
			Minor	20
			AEC (Ability Enhancement Course) - English	16
			Second Language – Telugu/Hindi/Urdu etc.	16
			MDC (Multi-Disciplinary Course)	4
			SEC (Skill Enhancement Course)	8
			VAC (Value Added Course)	4
			Internship/ Project Work	4
			Total	132

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Programme Outcomes

The course would enable the students to utilize the knowledge gained with in-depth critical analytical thinking to identify, formulate & design process related to Biochemistry, industry, pharma, medical organizations & academia. Develop skills, attitude and values required for self-directed, lifelong learning and professional development.

Programme Specific Outcomes

- **PSO1.** Students will demonstrate an understanding of fundamental biochemical principles such as structure and function of biomolecules.
- **PSO2.** Students will demonstrate an understanding of biomolecules and equip knowledge on biochemical techniques
- **PSO3.** The student will acquire basic knowledge on biochemical calculations, biostatistics, Bioenergetics, biological oxidation and enzymology
- **PSO4.** The student equip knowledge on applied and computational biochemistry and intermediary metabolism
- **PSO5.** The student will acquire basic knowledge on fundamentals of microbiology, physiology, clinical biochemistry, cell biology and Genetics.
- **PSO6.** The students will develop analytical thinking in execution of biochemical experiments and data interpretation, immunology, molecular biology, endocrinology and genetic engineering and biochemistry in health and diseases


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SEMESTER –I: BS101 (Theory): Paper - I

CHEMISTRY OF BIOMOLECULES

4 Credits; 4 hrs./ week

Course Outcomes:

- CO1: Remembering:** Recall the fundamental principles governing the structure and function of biomolecules such as carbohydrates, lipids, proteins, and nucleic acids. Memorize the nomenclature, classifications, and key properties of biomolecules as outlined in biochemical literature and research.
- CO2: Understanding:** Explain the interrelationship between biomolecular structures and their respective functions in living organisms. Interpret experimental data and scientific literature to comprehend the mechanisms underlying biomolecular interactions and reactions.
- CO3: Applying:** Apply biochemical concepts and principles to analyze real-world scenarios, such as metabolic pathways, enzymatic reactions, and molecular interactions in biological systems.
- CO4: Analyzing:** Evaluate the impact of environmental factors, genetic variations, and chemical modifications on biomolecular structure, stability, and activity.
- CO5: Creating:** Synthesize and propose hypotheses regarding the molecular mechanisms underlying biological processes, biomolecular structure, function



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SEMESTER –I: BS101 (Theory): Paper - I

CHEMISTRY OF BIOMOLECULES

4 Credits; 4 hrs./ week

Unit 1: Introduction

1. Scope of Biochemistry
2. Water as biological solvent
3. Weak acids and bases
4. pH and concept of Buffers
5. Biological buffers and their physiological importance
6. Henderson- Hassel Balch equation (Simple numerical problems)
7. Common functional groups in biomolecules

Unit 2: Amino acids & proteins

1. Classification, structure, stereochemistry and chemical reactions of amino acids.
2. Titration curve of glycine & pk values.
3. Essential, nonessential amino acids and non-protein amino acids.
4. Peptide bond formation, Naturally occurring peptides –Glutathione and Enkephalin
5. Outlines of protein classification, structural organization of proteins: primary, secondary, tertiary and quaternary structures (ex. hemoglobin & myoglobin)
6. General properties of proteins, denaturation and renaturation of proteins.
7. Determination of amino acid composition of proteins, Sequencing of amino acids.

Unit 3: Carbohydrates

1. Classification of carbohydrates
2. Monosaccharides: Structures, Fisher and Haworth projections
3. Reactions of monosaccharides, Mutarotation
4. Derivatives of Monosaccharides: Amino sugars and Glycosides
5. Glycosidic bond formation, Disaccharides, Oligosaccharides
6. Polysaccharides, Storage and Structural Polysaccharides
7. Bacterial cell wall polysaccharides.

Unit 4: Lipids

1. Classification of lipids, Reactions & properties of lipids
2. Saturated, Unsaturated and Essential fatty acids
3. Structure and functions of Neutral fats, waxes, phospholipids, sphingolipids,
4. Structure and functions of cholesterol and glycolipids.
5. Prostaglandins and lipoproteins.
6. Bio membranes, behavior of amphipathic lipids in water, formation of micelles, bilayers, vesicles, Liposomes
7. Membrane composition and fluid mosaic model.


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References:

1. Lehninger's Principles of Biochemistry – Nelson.D.L. and Cox.M.M., Freeman & Co.
2. Biochemistry – Berg.J.M., Tymoczko.J.L. and Stryer.L., Freeman & Co.
3. Biochemistry – Voet.D and Voet., J.G., John Wiley & Sons .
4. Textbook of Biochemistry – West.E.S., Todd.W.R, Mason.H.S..and. Bruggen, J.T.V., Oxford & IBH Publishers. 5. Outlines of Biochemistry – Conn.E.E., Stumpf.P.K., Bruening, G and Doi.R.H., John Wiley & Sons .
6. Harper's Illustrated Biochemistry – Murray, R.K., Granner.D.K. & Rodwell, V.W., McGraw-Hill
7. Biochemistry-Lippincott's Illustrated Reviews. Champe, P.C. and Harvey, R. A. Lippincott
8. Fundamentals of Biochemistry –Jain, J.L., Jain, S., Jain, N. S. Chand & Co.
9. Biochemistry – Satyanarayana. U and Chakrapani. U, Books & Allied Pvt. Ltd.


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SEMESTER –I: BS101 (Practical): Paper - I
QUALITATIVE ANALYSIS OF BIOMOLECULES

1 Credit; 2 Hrs./week

1. Laboratory general safety procedures
2. Preparation of standard solutions (Molar, Normal and percent solutions)
3. Determination of pKa values of amino acids by titration (Glycine)
4. Preparation of buffers (Acetate and Phosphate buffers)
5. Qualitative identification of Carbohydrates
6. Qualitative identification of Amino acids
7. Qualitative identification of Lipids

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern


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SEMESTER –II: BS201 (Theory): Paper - II
CHEMISTRY OF NUCLEIC ACIDS & BIOCHEMICAL TECHNIQUES

4 Credits; 4 hrs./ week

Course Outcomes:

- CO1: Remembering:** Recall the structure, composition, and functions of nucleic acids, including DNA and RNA, and their roles in genetic information transfer and regulation. Memorize the principles and methodologies of biochemical techniques commonly used in nucleic acid analysis and manipulation, such as chromatography, gel electrophoresis.
- CO2: Understanding:** Explain the chemical and physical properties of nucleic acids and their implications for the storage, transmission, and expression of genetic information. Interpret the mechanisms underlying various biochemical techniques employed for nucleic acid isolation, purification, amplification, and analysis.
- CO3: Applying:** Apply biochemical techniques, to investigate gene expression. Utilize computational tools and software for sequence analysis, primer design analysis of nucleic acid sequences.
- CO4: Analyzing:** Analyze experimental data obtained from biochemical techniques to identify genetic mutations, sequence variations, and gene expression patterns in biological samples. Evaluate the reliability, sensitivity, and specificity of nucleic acid-based assays and technologies for biomedical research, clinical diagnostics, and forensic analysis.
- CO5: Creating:** Design experiments and research protocols to address specific questions related to nucleic acid structure, function, and regulation. Develop novel biochemical techniques or assay protocols for nucleic acid analysis and manipulation, considering factors such as sensitivity, specificity, and practical applicability.


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SEMESTER –II: BS201 (Theory): Paper - II
CHEMISTRY OF NUCLEIC ACIDS & BIOCHEMICAL TECHNIQUES

4 Credits;4 hrs./ week

Unit 1: Composition of Nucleic acids

1. Organization of DNA in the cell, Mitochondria and Chloroplasts.
2. Composition of nucleic acids (DNA & RNA).
3. Structure of purines and pyrimidines.
4. Nucleosides and Nucleotides
5. Stability and formation of phosphodiester linkages
6. Effect of acids, alkali and nucleases and phosphodiester linkages
7. Photochemical and Spectral characteristics of Nucleic acid.

Unit 2: Structure of Nucleic acids

1. Watson& Crick DNA double helix structure.
2. Introduction to circular DNA, supercoiling, helix to random coil transition.
3. Denaturation of nucleic acids.
4. Hyperchromic effect
5. T_m values and their significance.
6. Reassociation kinetics, cot curves and their significance.
7. Different types of RNA and their biological functions.

Unit3: Spectrophotometric and Centrifugation Techniques

1. Concept of absorbance, Electromagnetic spectrum.
2. Beer-Lamberts law and its limitations.
3. Principle of Colorimetry and spectrophotometry
4. UV and Visible spectra, Molar extinction coefficient.
5. Principle of Fluorimetry and applications
6. Principle of Centrifugation, Sedimentation coefficient
7. Types of centrifugations and their applications

Unit 4: Chromatography and Electrophoresis techniques

1. Introduction and principles of chromatographic techniques
2. Paper chromatography and applications
3. Thin layer chromatography and applications
4. Gel filtration (molecular sieve) chromatography
5. Ion exchange Chromatography
6. Affinity chromatography
7. Electrophoresis: Principle and applications: Native, SDS-PAGE and Agarose gel electrophoresis


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3. Outlines of Biochemistry – Conn.E.E., Stumpf.P.K., Bruening, G and Doi.R.H., John Wiley & Sons
4. Principles and Techniques of Practical Biochemistry- Wilson, K. and Walker, J. Cambridge Press.
5. The Tools of Biochemistry- Cooper, T. G. John Wiley & Sons Press.
6. Physical Biochemistry- Friefelder, D. W.H. Freeman Press.
7. Analytical Biochemistry – Holme.D.J. and Peck.H., Longman.
8. Biophysical Chemistry: Principle and techniques- Upadhyay A, Upadhyay K and Nath. N. Himalaya Publishing House.
9. Experimental Biochemistry- Clark Jr. J.M and Switzer, R. L. Freeman & Co.


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SEMESTER –II: BS201 (Practical): Paper - II
QUANTITATIVE ANALYSIS OF BIOMOLECULES

1 Credit; 2 Hrs./week

1. Amino acid Estimation by Ninhydrin method
2. Protein Estimation by Biuret method
3. Protein estimation by Folin's Method
4. Estimation of Total Sugars by Anthrone Method
5. Estimation of Reducing Sugars by Dinitrosalicylate method
6. Estimation of Keto sugar by Roe's resorcinol Method
7. Estimation of total Sugars by Phenol- Sulphuric acid method.

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
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SEMESTER –III: BS301 (Theory): Paper - III
ENZYMOLGY AND BIOENERGETICS

(4 Credits; 4 Hrs./week)

Course Outcomes:

- CO1: Remembering:** Recall the fundamental principles of bioenergetics, including the laws of thermodynamics and the concept of Gibbs free energy, and their relevance to biological systems. Memorize the structures, mechanisms, and coenzymes involved in biological oxidation-reduction reactions, such as NADH/NAD⁺, FADH₂/FAD, and ATP/ADP.
- CO2: Understanding:** Explain the pathways and mechanisms of energy production and utilization in living organisms, including glycolysis, the citric acid cycle, oxidative phosphorylation, and photosynthesis. Interpret the role of enzymes and cofactors in catalyzing biochemical reactions and regulating metabolic pathways to maintain cellular homeostasis.
- CO3: Applying:** Apply biochemical principles to analyze energy transformations and metabolic pathways in various biological contexts, such as cellular respiration, fermentation, and metabolic disorders. Utilize kinetic and thermodynamic principles to analyze enzyme-catalyzed reactions, calculate reaction rates, and predict the effects of temperature, pH, and substrate concentration on enzyme activity.
- CO4: Analyzing:** Analyze experimental data from enzyme kinetics experiments to determine kinetic parameters, such as Michaelis-Menten constants (K_m) and maximum reaction rates (V_{max}), and to evaluate enzyme inhibition mechanisms. Evaluate the mechanisms of enzyme regulation and allosteric control in metabolic pathways and their significance in cellular signaling and metabolic adaptation.
- CO5: Creating:** Design experiments to investigate the kinetics and mechanisms of enzyme-catalyzed reactions, considering factors such as enzyme purification, substrate specificity, and assay conditions. Develop models or simulations to illustrate the dynamics of metabolic pathways and enzyme regulation, integrating biochemical principles with computational methods for data analysis and visualization.


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SEMESTER –III: BS301 (Theory): Paper - III
ENZYMOLGY AND BIOENERGETICS

(4 Credits; 4 Hrs./week)

Unit I: Introduction to Enzymology

1. Introduction to biocatalysis, differences between chemical and biological catalysis.
2. Principles of energy of activation, transition state.
3. Nomenclature and classification of enzymes.
4. Definition of holo-enzyme, apo-enzyme, coenzyme, cofactor, Fundamentals of enzyme assay, enzyme units.
5. Enzyme specificity. Active site.
6. Interaction between enzyme and substrate- lock and key, induced fit models.
7. Enzyme Engineering

Unit II: Enzyme Kinetics and Enzyme action

1. Rate of a Reaction – Law of Mass action, Factors affecting the catalysis- substrate concentration, pH, temperature, Time, Enzyme concentration and Product concentration
2. Michaelis - Menten equation for single substrate reaction, significance of K_M and V_{max} .
3. Enzyme inhibition- irreversible and reversible, types of reversible inhibitions- competitive and non-competitive.
4. Outline of mechanism of enzyme action- acid-base catalysis, covalent catalysis, electrostatic catalysis, and metal ion catalysis.
5. Regulation of enzyme activity- allosterism and cooperativity, ATCase as an allosteric enzyme.
6. Zymogen activation- activation of trypsinogen and chymotrypsinogen.
7. Isoenzymes (LDH) and Multienzyme complexes (PDH), Ribozyme.

Unit III: Bioenergetics

1. Laws of thermodynamics
2. Energy transformations in the living system
3. Free energy, Enthalpy and Entropy concepts.
4. Exergonic and endergonic reactions.
5. High energy compounds, Substrate level phosphorylation.
6. Phosphate group transfer potential.
7. Cytochromes-structure, types and their functions

Unit IV: Biological Oxidations

1. Biological oxidations: Definition, enzymes involved- oxidases, dehydrogenases and oxygenases.
2. Redox reactions. Redox couplers. Reduction potential (E , E_0 , E'_0). Standard reduction potential (E'_0) of some biochemically important half reactions.
3. Ultrastructure of mitochondria, Electron transport chain and carriers involved.
4. Oxidative phosphorylation, theories of oxidative phosphorylation- Mitchell's chemiosmotic theory. Fo F1- ATPase, Inhibitors of respiratory chain and oxidative phosphorylation, uncouplers.
5. Formation of reactive oxygen species and their disposal through enzymatic reactions.
6. Ultrastructure of chloroplast
7. Cyclic and non-cyclic photophosphorylation.


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4. Outlines of Biochemistry – Conn.E.E., Stumpf.P.K., Bruening, G and Doi.R.H., John Wiley & Sons.
5. Harper's Illustrated Biochemistry – Murray, R.K., Granner.D.K. & Rodwell,V.W., McGraw-Hill
6. Biochemistry – Satyanarayana. U and Chakrapani. U, Books & Allied Pvt. Ltd.
7. Fundamentals of Enzymology – Price.N.C.and Stevens.L., Oxford University Press.
8. Understanding Enzymes – Palmer.T., Ellis Harwood.
9. Enzymes – Biochemistry, Biotechnology, Clinical Chemistry – Palmer.T., Affiliated East-West Press


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SEMESTER –III: BS301 (Practical): Paper - III

ENZYMOLGY

(1 Credit; 2 Hrs./week)

1. Assay of salivary α -amylase
2. Assay of β -amylase from sweet potatoes
3. Assay of urease
4. Assay of phosphatase
5. Determination of optimum temperature for amylase
6. Determination of optimum pH for amylase
7. Effect of Substrate concentration of amylase activity

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Enzyme Assays- A practical Approach: Eisenthal, R and Dawson,M.I., IRL Press.
4. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers.


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SEMESTER –IV: BS401 (Theory): Paper - IV
INTERMEDIARY METABOLISM

(4 Credits; 4 Hrs./week)

Course Outcomes:

- CO1: Remembering:** Recall the major metabolic pathways involved in the conversion of macronutrients (carbohydrates, lipids, and proteins) into energy and biomolecules. Memorize the structures, substrates, intermediates, and products of key metabolic pathways, including glycolysis, gluconeogenesis, fatty acid oxidation.
- CO2: Understanding:** Explain the regulation and coordination of metabolic pathways in response to cellular energy demands, nutrient availability, and hormonal signals. Interpret the biochemical mechanisms underlying metabolic disorders and diseases, such as diabetes mellitus, metabolic syndrome, and fatty liver disease.
- CO3: Applying:** Apply knowledge of intermediary metabolism to analyze metabolic fluxes, energy production, and substrate utilization in different physiological and pathological conditions. Utilize metabolic pathway maps and metabolic network models to predict the metabolic consequences of genetic mutations, dietary interventions, and drug treatments.
- CO4: Analyzing:** Analyze experimental data from metabolic studies to assess metabolic rates, substrate preferences, and metabolic adaptations in response to environmental stimuli or cellular stress. Evaluate the interplay between metabolic pathways and other cellular processes, such as signal transduction, gene expression, and cellular differentiation.
- CO5: Creating:** Design experiments to investigate the regulation and metabolic fluxes of specific metabolic pathways using biochemical, molecular, and systems biology approaches. Develop metabolic engineering strategies to manipulate metabolic pathways for biotechnological applications.

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SEMESTER –IV: BS401 (Theory): Paper - IV

INTERMEDIARY METABOLISM

(4 Credits; 4 Hrs./week)

Unit I: Amino acid Metabolism

1. General reactions of amino acid metabolism- transamination, decarboxylation and deamination
2. Urea cycle and regulation
3. Catabolism of carbon skeleton of amino acids- glycogenic and ketogenic amino acids.
4. Metabolism of glycine, serine, aspartic acid, methionine, phenylalanine and leucine.
5. Biosynthesis of creatine.
6. Inborn errors of aromatic amino acids
7. Inborn errors of branched chain amino acid metabolism.

Unit II: Carbohydrate Metabolism

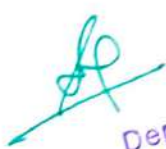
1. Glycolysis, energy yield. Fate of pyruvate- formation of lactate and ethanol.
2. Citric acid cycle, regulation, energy yield, amphipathic role. Anaplerotic reactions.
3. Glycogenolysis and glycogenesis.
4. Pentose phosphate pathway.
5. Gluconeogenesis.
6. Photosynthesis- Light and Dark reactions, Calvin cycle and C4 Pathway, CAM Pathway
7. Metabolic disorders of carbohydrates – Galactosemia and Pentosuria

Unit III: Lipid Metabolism

1. Catabolism of fatty acids (β - oxidation) with even and odd number of carbon atoms, Ketogenesis
2. *de novo* synthesis of fatty acids
3. Elongation of fatty acids in mitochondria and microsomes
4. Biosynthesis and degradation of triacylglycerol
5. Biosynthesis of lecithin.
6. Biosynthesis of cholesterol.
7. Metabolic disorders of lipid metabolism – Nieman-pick disease and Fabry's disease

Unit IV: Nucleic acid Metabolism

1. Biosynthesis of purine and pyrimidine nucleotides, *de novo* and salvage pathways.
2. Regulation of purine and pyrimidine nucleotides
3. Catabolism of purines and pyrimidines.
4. Biosynthesis of deoxyribonucleotides- ribonucleotide reductase and thymidylate synthase and their significance.
5. Disorders of nucleotide metabolism- Gout, Lesch- Nyhan syndrome.
6. Biosynthesis of heme
7. Degradation of heme

  
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References

1. Lehninger's Principles of Biochemistry – Nelson.D.L. and Cox.M.M., Freeman & Co.
2. Biochemistry – Berg.J.M., Tymoczko.J.L. and Stryer.L., Freeman & Co.
3. Biochemistry – Voet.D and Voet., J.G., John Wiley & Sons.
4. Textbook of Biochemistry – West.E.S., Todd.W.R., Mason.H.S. and Bruggen, J.T.V., Oxford & IBH Publishers.
5. Principles of Biochemistry: General Aspects-Smith, E. L., Hill, R.L. Lehman, I. R. Lefkowitz, R.J. Handler, P., and White, A. McGraw-Hill
6. Outlines of Biochemistry – Conn.E.E., Stumpf.P.K., Bruening, G and Doi.R.H., John Wiley & Sons
7. Harper's Illustrated Biochemistry – Murray, R.K., Granner.D.K. & Rodwell,V.W., McGrawHill
8. Biochemistry-Lippincott's Illustrated Reviews. Champe, P.C. and Harvey, R. A. Lippincott
8. Fundamentals of Biochemistry –Jain, J.L., Jain, S., Jain, N. S. Chand & Co.
9. Biochemistry – Satyanarayana. U and Chakrapani. U, Books & Allied Pvt. Ltd.
10. Biochemistry – Rama Rao. A and Ratna Kumari. D, Kalyani Publishers.
11. Biochemistry- The Molecular Basis of Life – McKee. T and McKee, J. R, McGraw-Hill.

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SEMESTER –IV: BS401 (Practical): Paper - IV
BIOCHEMICAL PREPARATIONS AND SEPARATIONS

(1 Credit; 2 Hrs./week)

1. Isolation of egg albumin from egg white.
2. Isolation of cholesterol from egg yolk.
3. Isolation of starch from potatoes.
4. Isolation of casein from milk.
5. Separation of amino acids by Paper chromatography
6. Separation of Plant pigments by TLC
7. Absorption maxima of colored substances- *p*-Nitrophenol, Methyl orange, BSA and DNA.

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern


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SEMESTER –V: BS501 (Theory): Paper – V (A)
PHYSIOLOGY, NUTRITION AND CLINICAL BIOCHEMISTRY
(4 Credits; 4 Hrs./week)

Course outcomes:

- CO1: Remembering:** Recall the physiological principles underlying organ systems, including the cardiovascular, respiratory, and digestive systems, and their regulation. Memorize essential nutrients, their functions, dietary sources, and metabolic pathways involved in nutrient absorption, utilization, and storage.
- CO2: Understanding:** Explain the interrelationships between physiology, nutrition, and clinical biochemistry in maintaining homeostasis and supporting optimal health. Interpret the biochemical mechanisms underlying metabolic disorders, nutrient deficiencies, and the pathophysiology of common diseases.
- CO3: Applying:** Apply knowledge of physiological and biochemical principles to evaluate dietary patterns, nutritional requirements, and dietary interventions for promoting health and preventing disease. Utilize clinical laboratory tests and biochemical markers to assess nutritional status, metabolic health, and disease risk in diverse patient populations.
- CO4: Analyzing:** Analyze case studies and clinical scenarios to integrate physiological concepts, nutritional assessments, and biochemical data in diagnosing and managing health conditions. Evaluate the impact of lifestyle factors, dietary habits, and environmental exposures on metabolic health and disease outcomes.
- CO5: Creating:** Design personalized nutrition and lifestyle interventions based on individualized assessments of physiological parameters, nutritional needs, and biochemical markers. Develop research proposals or public health initiatives aimed at addressing nutritional deficiencies and metabolic disorders.


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SEMESTER –V: BS501 (Theory): Paper – V (A)

PHYSIOLOGY, NUTRITION AND CLINICAL BIOCHEMISTRY

(4 Credits; 4 Hrs./week)

Unit I: Physiology

1. Digestion and absorption of carbohydrates, lipids and proteins
2. Composition of blood and coagulation of blood
3. Hemoglobin and transport of gases in blood (oxygen and CO₂)
4. Heart- structure of the heart, Cardiac cycle, cardiac factors controlling blood pressure
5. Physiology of Vision
6. Muscle- kinds of muscles, structure of myofibril, organization of contractile proteins and mechanism of muscle contraction.
7. Structure of Neuron and propagation of nerve impulse

Unit II: Endocrinology

1. Endocrinology- organization of endocrine system. Classification of hormones.
2. Mechanism of hormonal action- Steroid and peptide hormones such as adrenaline, glucocorticoids and insulin.
3. Chemistry, physiological role and disorders of hormones of Pituitary, Hypothalamus and Thyroid
4. Chemistry, physiological role and disorders of hormones of Pancreas
5. Chemistry, physiological role and disorders of hormones of Parathyroid
6. Chemistry, physiological role and disorders of hormones of Gonads, Placenta and Adrenals
7. Gastrointestinal hormones and their physiological role

Unit III: Nutrition

1. Balanced diet. Calorific values of foods and their determination by bomb calorimeter.
2. BMR and factors affecting BMR. Specific dynamic action of foods.
3. Energy requirements and recommended dietary allowance (RDA) for children, adults, pregnant and lactating women.
4. Sources of complete and incomplete proteins. Biological value of proteins. Role of essential fatty acids in human nutrition.
5. Malnutrition- Kwashiorkor, Marasmus and PEM.
6. Vitamins- sources, structure, biochemical roles, deficiency disorders of water- and fat-soluble vitamins; Bulk and trace elements-Ca, Mg, Fe, I, Cu, Mo, Zn, Se and F.
7. Nutraceuticals; Obesity and starvation.

Unit IV: Clinical Biochemistry and Organ Function Tests

1. Structure and functions of the liver, Liver function tests- conjugated and total bilirubin in serum, albumin: globulin ratio, hippuric acid and bromsulphthalein tests. Serum enzymes in liver diseases- SGPT, GGT and alkaline phosphatase.
2. Kidneys-structure of nephron and Mechanism of urine formation. Normal and abnormal constituents of urine.
3. Biological buffers. Role of kidneys in maintaining acid-base and electrolyte balance in the body.
4. Renal function tests- creatinine and urea clearance tests, phenol red test.
5. Biochemical tests for the diagnosis of heart diseases- HDL/LDL cholesterol, SGOT, LDH, CK, C-reactive protein, cardiac troponins.
6. Brain function test- EEG
7. GI tract test- Endoscopy


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1. Textbook of Biochemistry and Human Biology – Talwar, G.P. and Srivastava. L.M., Printice Hall of India
2. Review of Medical Physiology-Ganong. McGraw-Hill.
3. Human Physiology – Chatterjee.C.C, Medical Allied Agency
4. Textbook of Medical Physiology – Guyton.A.G and Hall.J.E., Saunders
5. William's Textbook of Endocrinology – Larsen, R. P. Korenberg, H. N. Melmed, S. and Polensky
6. Mammalian Biochemistry- White, A. Handler, P. and Smith, E. L. McGraw-Hill.
7. Textbook of Human Nutrition- Bamji, Pralhad Rao and Reddy V. Oxford & IBH Publishers.
8. Foods: Facts & Principle- Shakuntala and Shadaksharaswamy. Wiley Ester Press.
9. Essentials of Food and Nutrition – Swaminathan.M. Bangalore Press.
10. Human Nutrition and Dietetics. Davidson, S. and Passmore, J. R. ELBS.
11. A Textbook of Biochemistry: Molecular and Clinical Aspects. Nagini, S. Scitech Publishers.
12. Tietz Fundamentals of Clinical Chemistry- Burtis, A. A. and Ashwood, E. R. Saundersimprint Elsevier Pub

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SEMESTER –V: BS501 (Practical): Paper – V (A)
PHYSIOLOGY, NUTRITION AND CLINICAL BIOCHEMISTRY

(1 Credit; 2 Hrs./week)

1. Estimation of hemoglobin, total count - RBC and WBC, differential count.
2. Urine analysis for albumin, sugars and ketone bodies.
3. Estimation of urinary creatinine.
4. Estimation of serum total cholesterol.
5. Estimation of Vitamin C by 2,6 – DCPIP method.
6. Determination of iodine value of oil.
7. Determination of peroxide value of oil.

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers



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SEMESTER –V: BS501 (Theory): Paper – V (B)
CELL BIOLOGY, GENETICS & MICROBIOLOGY

(4 Credits; 4 Hrs./week)

Course outcomes:

- CO1: Remembering:** Recall the fundamental concepts, terminology, structure, and functions of cells, biomolecules, microorganisms, chromosomes, genes, and principles of heredity.
- CO2: Understanding:** Explain the organization and functions of cellular organelles, cell division, microbial classification, Mendelian genetics, and the molecular basis of inheritance.
- CO3: Applying:** Apply the principles of cell biology, genetics, and microbiology to solve biological problems, interpret experimental observations, and perform basic laboratory techniques such as staining, microscopy, and microbial culture methods.
- CO4: Analyzing:** Analyze patterns of inheritance, chromosomal abnormalities, microbial growth characteristics, and cellular processes by interpreting genetic crosses, experimental data, and microbiological results.
- CO5: Creating:** Design simple experiments and propose appropriate strategies for studying cellular functions, genetic traits, and microbial applications in healthcare, agriculture, biotechnology, and environmental sciences while evaluating their scientific significance and ethical implications.


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SEMESTER –V: BS501 (Theory): Paper – V (B)
CELL BIOLOGY, GENETICS & MICROBIOLOGY
(4 Credits; 4 Hrs./week)

Unit I: Cell Biology

1. Cell as basic unit of living organisms, Ultra-structure of prokaryotic cell and eukaryotic cells
2. Composition & functions of cell organelles
3. Cytoskeleton- Microfilaments, Microtubules & Intermediate filaments
4. Chromosome organization in Prokaryotes and Eukaryotes and structure of chromosomes (Polytene and Lamp Brush)
5. Cell Cycle
6. Mitosis and Meiosis
7. Cell Death-Apoptosis & Necrosis

Unit II: Genetics

1. Basic concepts of Genetics- Mendel's laws
2. Non- Mendelian inheritance: Extra chromosomal inheritance (*Paramoecium* & *Drosophila*).
3. Partial or incomplete dominance and Co-dominance
4. Maternal inheritance (Coiling in snails, Leber's hereditary optic neuropathy (LHON)).
5. Polygenic inheritance (Introduction to quantitative traits).
6. Sex linked inheritance. X-linked recessive inheritance (colour blindness & Hemophilia). Concept of Autosomal recessive and dominant inheritance
7. Linkage and recombination

Unit III: Mutations and Mutagens

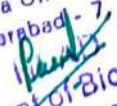
1. Mutations (spontaneous / induced, somatic / germinal, forward / reverse, transition / transversions)
2. Mutations (Silent, missense, nonsense, and frame shift mutations, conditional, leaky)
3. Detection, selection & isolation of microbial mutants
4. Estimation of mutation rates
5. Reversion and suppression of mutations
6. Mutagens – physical, chemical
7. Transposon mutagenesis, site-directed mutagenesis

Unit IV: Microbiology

1. Introduction to brief history of microbiology. Classification of microorganisms, Mycoplasma.
2. Motility and sporulation
3. Isolation and cultivation of bacteria. Selective media and enriched media. Gram's staining
4. Bacterial growth curve and kinetics of growth. Batch, continuous and synchronous cultures.
5. Industrial uses of *Aspergillus niger*, yeast and Spirulina.
6. Structure and composition of viruses. One-step growth and determination of plaque forming units (PFU).
7. Viral life cycles – T4 (Lytic), λ phage (lytic and lysogenic), TMV, Retro viruses- HIV.


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References

1. Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley
2. Modern Genetic Analysis Anthony JF Griffiths, William M Gilbert, Jeffrey H Miller, and Richard C Lewontin. Pub. W. H. Freeman
3. Lewin B. (Ed) (1996) Genes, VII edition, John Wiley and Sons, New York.
4. Cell and Molecular Biology, De Robertis and De Robertis, Lippincott & Wilkins
5. Cell Biology by C. B. Pawar
6. Principles of Genetics by R.H. Tamarin McGrawhill
7. Theory & problems in Genetics by Stansfield, Schaum out line series McGrawhill
8. Textbook of Microbiology – Ananthanarayan, R and Jayaram Paniker, C.K., Orient Longman.
9. Microbiology – Prescott.L.M., Harley.J.P. & Klein.D.A, McGraw-Hill.
10. Microbiology – Pelczar Jr., M.J., Chan.E.C.S. and Krieg.N.R., Tata McGraw-Hill.
11. Textbook of Microbiology- Dubey, R. C. and Maheshwari, D. K. S. Chand & Co.


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SEMESTER –V: BS501 (Practical): Paper – V (B)
CELL BIOLOGY, GENETICS & MICROBIOLOGY

(1 Credit; 2 Hrs./week)

1. Preparation of different stages of Mitosis & Meiosis
2. Problems on Monohybrid cross, Problems on dihybrid ratio in *Drosophila*/maize, Linkage & Recombination, Sex linked inheritance and X-linked recessive inheritance
3. Sterilization methods and Preparation of culture media, Isolation of pure cultures: (i) Streak plate method (ii) Serial dilution method.
4. Gram staining.
5. Motility of bacteria by hanging drop method.
6. Bacterial growth curve.
7. Antibiotic sensitivity by paper disc method.

References

1. Essential practical handbook of Cell Biology & Genetics, Biometry and Microbiology: A Laboratory Manual by Debarati Das, Academic Publishers.
2. Molecular Cloning (Lab manual) by Maniatis T, Fritsch EF, Sambrook J, Volume –I, CSH
3. 2. Microbiology – A Laboratory manual by Cappuccino and Sherman, Pearson Publications LPE.
4. 3. Experiments in Microbiology, Plant Pathology and Biotechnology by Aneja A. R., New Age Publications



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SEMESTER –V: BS503
MULTI- DISCIPLINARY COURSE (MDC)
BASICS OF BIOCHEMISTRY

(4 Credits; 4 Hrs./week)

Course Outcomes:

- CO1: Remembering:** Recall the fundamental biochemical principles underlying physiological processes such as cellular respiration, muscle contraction, and nerve transmission. Memorize the structures and functions of biomolecules including carbohydrates, lipids, proteins, and nucleic acids, and their roles in cellular physiology.
- CO2: Understanding:** Explain the biochemical basis of physiological functions, including the generation of ATP through oxidative phosphorylation, hormone signaling, and neurotransmitter release. Interpret the molecular mechanisms underlying physiological phenomena such as enzyme kinetics, membrane transport, and signal transduction pathways.
- CO3: Applying:** Apply knowledge of biochemistry to analyze physiological responses to environmental stimuli, stressors, and disease conditions. Utilize biochemical principles to understand the mechanisms of action of drugs, hormones, and therapeutic interventions in the context of physiological regulation.
- CO4: Analyzing:** Analyze experimental data from biochemical and physiological studies to elucidate the molecular basis of health and disease states. Evaluate the integration of biochemical pathways and physiological systems in maintaining homeostasis and responding to metabolic challenges.
- CO5: Creating:** Design experiments to investigate the biochemical and physiological mechanisms underlying specific physiological processes or disease conditions. Develop interdisciplinary approaches that integrate biochemical and physiological concepts to address complex research questions in health and medicine.


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SEMESTER –V: BS503
MULTI-DISCIPLINARY COURSE (MDC)
BASICS OF BIOCHEMISTRY

(4 Credits; 4 Hrs./week)

Unit I: Biomolecules- Carbohydrates and Proteins

1. Water properties, pH and Biological Buffers
2. Carbohydrates- Classification (mono, di, oligo and poly), properties and importance.
3. Glycosidic bond formation, Disaccharides, Oligosaccharides
4. Polysaccharides, Storage and Structural Polysaccharides
5. Amino acids – Classification, properties and importance
6. Essential, nonessential amino acids and non-protein amino acids.
7. Peptide bond, Outlines of protein classification, structural organization of proteins

Unit II: Biomolecules- Lipids and Nucleic Acids

1. Lipids – Classification, properties and importance.
2. Saturated, Unsaturated and Essential fatty acids
3. Structure and functions of Neutral fats, waxes, phospholipids, sphingolipids,
4. Structure and functions of cholesterol and glycolipids.
5. Nucleic acids – Purines, Pyrimidines, Nucleosides, Nucleotides.
6. Structure and types of DNA and RNA
7. Denaturation and Renaturation of DNA

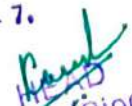
Unit III: Physiology

1. Physiology of digestion
2. Physiology of vision
3. Physiology of muscle
4. Physiology of nerve and mechanism of nerve impulse transmission
5. Composition of blood and blood coagulation
6. Structure of heart and cardiac cycle
7. Factors controlling blood pressure

Unit IV: Endocrinology

1. Introduction to Endocrinology and organization of endocrine system.
2. Hormones of Hypothalamus
3. Hormones of Pituitary
4. Hormones of Thyroid and Clinical Relevance
5. Hormones of Pancreas and Clinical Relevance
6. Hormones of Adrenal gland
7. Hormones of Gonads


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2. Biochemistry – Berg.J.M., Tymoczko.J.L. and Stryer.L., Freeman & Co.
3. Biochemistry – Voet.D and Voet., J.G., John Wiley & Sons .
4. Textbook of Biochemistry – West.E.S., Todd.W.R., Mason.H.S. and. Bruggen, J.T.V., Oxford & IBH Publishers. 5. Outlines of Biochemistry – Conn.E.E., Stumpf.P.K., Bruening, G and Doi.R.H., John Wiley & Sons .
6. Harper's Illustrated Biochemistry – Murray, R.K., Granner.D.K. & Rodwell,V.W., McGraw-Hill
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SEMESTER –V: BS505
SKILL ENHANCEMENT COURSE (SEC-II)
BIOINFORMATICS AND BIOSTATISTICS

(2 Credit; 2 Hrs./week)

Course Objective

To introduce students to **basic bioinformatics resources and statistical tools** used for analysing biological data.

Course Outcomes

After completing the course, students will be able to:

- Understand biological databases and sequence analysis tools.
- Apply basic statistical methods for biological data analysis.
- Interpret experimental data using graphical and statistical techniques.

Syllabus:

Unit I: Fundamentals of Bioinformatics

1. Introduction to bioinformatics and its applications in life sciences
2. Biological databases: GenBank, NCBI, Protein Data Bank (PDB)
3. Retrieval of biological data from online databases
4. Sequence alignment and analysis (BLAST)
5. Applications of bioinformatics in drug discovery and biotechnology

Unit II: Fundamentals of Biostatistics

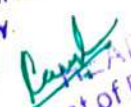
1. Introduction to biostatistics and types of data and methods of data collection
2. Measures of central tendency: mean, median, and mode
3. Measures of dispersion: variance and standard deviation
4. Correlation and regression analysis (basic concepts)
5. Graphical representation of biological data (charts, graphs, and tables)

References:

1. **P. S. S. Sundar Rao & J. Richard**, *An Introduction to Biostatistics: A Manual for Students in Health Sciences*, PHI Learning Pvt. Ltd., New Delhi.
2. **Indranil Banerjee**, *Medical Biostatistics*, S. Chand Publishing, New Delhi.
3. **T. K. Attwood & D. J. Parry-Smith**, *Introduction to Bioinformatics*, Pearson Education India.
4. **S. C. Rastogi, Namita Mendiratta & Parag Rastogi**, *Bioinformatics: Methods and Applications*, PHI Learning Pvt. Ltd., New Delhi.
5. **B. D. Singh**, *Biotechnology: Expanding Horizons*, Kalyani Publishers, New Delhi.


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SEMESTER –V: BS505
SKILL ENHANCEMENT COURSE (SEC-II)
ENZYME TECHNOLOGY AND APPLICATIONS

(2 Credit; 2 Hrs./week)

Course Objective

To provide students with an understanding of the production, immobilization, and industrial applications of enzymes, and to introduce their role in biotechnology, pharmaceutical, food, and environmental industries.

Course Outcomes (COs)

After successful completion of the course, students will be able to:

1. Explain the sources, production, and purification of industrial enzymes.
2. To enable the students for the industry to produce biosimilars.
3. Describe different methods of enzyme immobilization and their advantages.
4. Understand the role of enzymes in industrial processes.
5. Identify applications of enzymes in food, pharmaceutical, and environmental industries.
6. Recognize the importance of enzymes in clinical diagnostics and biosensor technologies.

Syllabus:

Unit I: Enzyme Production, Purification and Immobilization

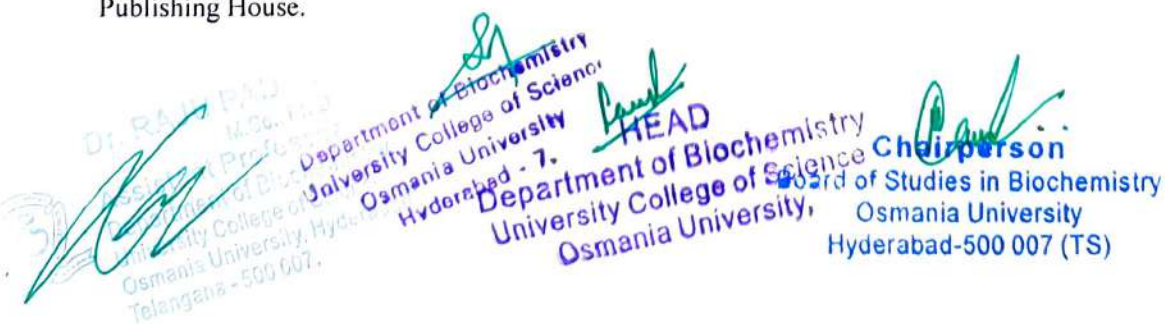
1. Sources of industrial enzymes (plant, animal, and microbial sources)
2. Microbial production of enzymes and fermentation processes
3. Industrial methods for enzyme extraction and purification
4. Methods of enzyme immobilization and its applications
5. Stability and storage of industrial enzymes

Unit II: Industrial and Biomedical Applications of Enzymes

1. Enzymes in food and dairy industries (amylase, protease, lactase)
2. Enzymes in pharmaceutical industries and drug production
3. Enzymes in clinical diagnostics and biosensors
4. Enzymes in detergent, textile, and leather industries
5. Emerging industrial applications of enzymes.

Reference Books (Indian Authors)

1. **B. D. Singh** – *Biotechnology: Expanding Horizons*, Kalyani Publishers.
2. **Purohit S. S.** – *Biotechnology: Fundamentals and Applications*, Agrobios (India).
3. **U. Satyanarayana & U. Chakrapani** – *Biochemistry*, Elsevier India.
4. **H. K. Das** – *Textbook of Biotechnology*, Wiley India.
5. **S. Shanmugam & T. Sathishkumar** – *Industrial Biotechnology*, IK International Publishing House.



SEMESTER –V: BS506
VALUE ADDED COURSE (VAC)
MEDICAL LABORATORY TECHNOLOGY

(2 Credit; 2 Hrs./week)

Course Objective

To introduce students to the **principles, techniques, and interpretation of common clinical laboratory tests** used in medical diagnostics.

Course Outcomes

After completing the course, students will be able to:

- Understand the organization and functioning of clinical laboratories.
- Explain biochemical and haematological diagnostic tests.
- Interpret common laboratory reports used in disease diagnosis.

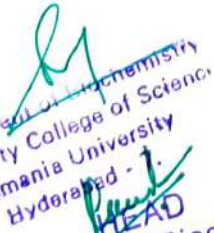
Unit I: Fundamentals of Medical Laboratory Technology

1. Introduction to clinical laboratory diagnostics and its importance in healthcare
2. Sample collection methods (blood, urine, saliva, and other specimens)
3. Sample handling, preservation, and transportation
4. Laboratory safety, biosafety levels, and waste disposal
5. Good Laboratory Practices (GLP) and quality control in laboratories

References:

1. U. Satyanarayana & U. Chakrapani, *Biochemistry*, Elsevier India.
2. D. M. Vasudevan, S. Sreekumari & Kannan Vaidyanathan, *Textbook of Biochemistry for Medical Students*. Jaypee Brothers Medical Publishers.
3. Harbans Lal, *Biochemistry for Medical Laboratory Technology Students*, CBS Publishers & Distributors, New Delhi.
4. S. P. Singh, *Practical Manual of Biochemistry*, CBS Publishers & Distributors.
- N. Murugesh & Dinesh Kumar Shukla, *Lab Tech Clinical Biochemistry*, Sathya Publishers.


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SEMESTER –VI: BS601 (Theory): Paper – VI (A)

MOLECULAR BIOLOGY & IMMUNOLOGY

(4 Credits; 4 Hrs./week)

Course Outcomes:

- CO1: **Remembering:** Recall the fundamental principles of molecular biology, including DNA replication, transcription, translation, and gene regulation. Memorize the structures and functions of key molecules involved in immune responses, such as antibodies, antigens, cytokines, and major histocompatibility complex (MHC) molecules.
- CO2: **Understanding:** Explain the molecular mechanisms underlying cellular processes in molecular biology, including DNA repair, RNA processing, protein synthesis, and signal transduction pathways. Interpret the principles of immunology, including antigen recognition, immune cell activation, antibody diversity, and immune tolerance.
- CO3: **Applying:** Apply molecular biology techniques, such as PCR, cloning, gel electrophoresis, and gene expression analysis, to investigate gene function, regulation, and expression patterns. Utilize immunological assays, including ELISA, flow cytometry, and immunoblotting, to analyze immune responses, detect antigens, and quantify immune cells.
- CO4: **Analyzing:** Analyze experimental data from molecular biology and immunology studies to elucidate molecular mechanisms underlying disease pathogenesis, immune dysregulation, and host-pathogen interactions. Evaluate the molecular basis of immune disorders, autoimmune diseases, infectious diseases, and cancer immunotherapy strategies.
- CO5: **Creating:** Design experiments to investigate the molecular mechanisms of immune responses, immune cell signalling pathways, and the development of immune memory. Develop research proposals or innovative approaches for targeting molecular pathways in immunotherapy, vaccine development.


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SEMESTER –VI: BS601 (Theory): Paper – VI (A)

MOLECULAR BIOLOGY & IMMUNOLOGY

(4 Credits; 4 Hrs./week)

Unit I: DNA Replication

1. Organization of genome in prokaryotes and eukaryotes.
2. Experimental evidences to prove nucleic acids as genetic material.
3. Nature and structure of the gene.
4. DNA replication- models of replication, Meselson-Stahl's experimental proof for semi-conservative model.
5. DNA polymerases I, II and III of *E. coli*, helicase, topoisomerases, primase, ligase.
6. Bidirectional replication model. Okazaki fragments, leading and lagging strands of DNA synthesis.
7. Inhibitors of DNA replication.

Unit II: Transcription & Translation

1. Transcription - RNA synthesis, RNA polymerases of prokaryotes & eukaryotes
2. Initiation, Elongation and Termination- rho dependent and rho independent.
3. Post-transcriptional modifications and Inhibitors of RNA synthesis.
4. Genetic code, Deciphering of genetic code, Nirenberg's and Khorana's experiments, wobble hypothesis, degeneracy of genetic code.
5. Protein synthesis, structure of t-RNA, activation of amino acids (aminoacyl t-RNA synthetases), Ribosome structure.
6. Initiation, elongation and termination of protein synthesis. Post- translational modifications and Inhibitors of protein synthesis.
7. Regulation of prokaryotic gene expression- induction and repression. Lac operon.

Unit III: Immunology

1. Organization of immune system.
2. Organs and cells of immune system.
3. Innate and acquired immunity.
4. Cell mediated and humoral immunity (T- and B- cells).
5. Classification of immunoglobulins, structure of IgG. Theories of antibody formation- clonal selection theory.
6. Epitopes / antigenic determinants. Concept of haptens. Adjuvants.
7. Monoclonal antibodies and their applications

Unit IV: Immunotechnology

1. Antigen-antibody reactions- agglutination, immunoprecipitation, immunodiffusion.
2. Blood group antigens.
3. Immunodiagnostics-RIA, ELISA.
4. Vaccines and their classification. Traditional vaccines-live and attenuated, toxoids.
5. Modern vaccines- recombinant and peptide vaccines.
6. Outlines of hypersensitivity reactions.
7. Fundamentals of graft rejection and MHC proteins.


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1. Molecular Biology of Cell- Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J. D. Garland Publishing.
2. Recombinant DNA and Biotechnology: A Guide for teachers- Helen and Massey. ASM Press.
3. Genes VIII – Lewin. B, Oxford University Press .
4. Molecular Biology- Freifelder. D. Naroasa Pub. House
5. Molecular Biology of the Gene- Watson. J.D., Baker, T.A, Bell, S.P., Gann.A, Levine, M and Losick.R, Pearson Education.
6. Molecular Biotechnology- Glick, B. R. and Pasternak, J. J. ASM Press
7. Principles of Gene Manipulation: An Introduction to GE- Old, R. V. and Primrose, S. B. Blackwell Sci. Pub.
8. Molecular Cell Biology- Lodish, H., Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M. Scott M P., Zipursky, S. L. and Darnell, J. Freeman & Co.
9. Immunology. Tizard, I. R. Thomson Press.
10. Kuby Immunology – Kindt.T.J., Goldsby.R.A. and Osborne.B.A., Freeman & Co.
11. Roitt's Essential Immunology – Roitt.I.M. and Delves.P.J., Blackwell Science


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SEMESTER –VI: BS601 (Practical): Paper – VI (A)

MOLECULAR BIOLOGY & IMMUNOLOGY

(1 Credit; 2 Hrs./week)

1. Isolation of DNA from onion/plasmids
2. Determination of purity of nucleic acids by UV-spectrophotometric method
3. Estimation of DNA by diphenylamine method.
4. Estimation of RNA by orcinol method.
5. Electrophoresis of nucleic acids and visualization by ethidium bromide staining.
6. Agglutination: A, B, AB & O blood groups and Rh.
7. ODD and Sandwich ELISA

References

1. Experimental Biochemistry-A student companion-Beedu Sashidhar Rao and VijayDeshpande.
2. Laboratory Manual in Biochemistry- Jayaraman, J. Wiley Eastern
3. Biochemical Methods- Sadasivam,S and Manickyam,A. New Age International Publishers


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SEMESTER –VI: BS601 (Theory): Paper – VI (B)

r-DNA TECHNOLOGY & BIOTECHNOLOGY

(4 Credits; 4 Hrs./week)

Course Outcomes:

- CO1: Remembering:** Recall the fundamental concepts, terminology, principles, and tools of recombinant DNA technology, genetic engineering, molecular cloning, and biotechnology.
- CO2: Understanding:** Explain the mechanisms of DNA manipulation, gene cloning, vector systems, polymerase chain reaction (PCR), gene expression, and the applications of biotechnology in agriculture, medicine, industry, and environmental management.
- CO3: Applying:** Apply recombinant DNA techniques, molecular biology tools, and biotechnological methods for gene transfer, nucleic acid analysis, recombinant protein production, and molecular diagnostics.
- CO4: Analyzing:** Analyze experimental data related to recombinant DNA technology, evaluate cloning strategies, interpret molecular biology techniques, and assess the applications and limitations of biotechnology in various fields.
- CO5: Creating:** Design simple recombinant DNA experiments and propose innovative biotechnological solutions for healthcare, agriculture, environmental sustainability, and industrial applications while considering biosafety, bioethics, and regulatory aspects.


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SEMESTER –VI: BS601 (Theory): Paper – VI (B)

r-DNA TECHNOLOGY & BIOTECHNOLOGY

(4 Credits; 4 Hrs./week)

Unit I: r-DNA technology I

1. Cloning strategies.
2. Tools of r-DNA technology: Enzymes- Restriction endonucleases and ligases
3. Restriction mapping.
4. Polymerase chain reaction- principle and applications.
5. Outlines of blotting techniques-Southern, Northern and Western.
6. Molecular markers-RFLP, AFLP and RAPD
7. DNA sequencing- Maxam Gilbert and Sanger's methods.

Unit II: r-DNA technology II

1. Construction of c-DNA libraries.
2. Cloning vectors- Plasmids, Cosmids, and λ phages
3. Hosts- *E.coli*
4. Applications of gene cloning- production of insulin
5. Production of human growth hormone
6. Production of Bt cotton
7. Edible vaccines.

Unit III: Plant & Animal Biotechnology

1. Plant tissue culture and its applications
2. Plants as bioreactors and valuable chemical factories (production of bioactive compounds)
3. Transgenic plants, Crop improvement, Production of herbicide and insect resistant plants
4. Genetically modified crops – Arabidopsis, Golden rice, soybeans, Bt cotton, tobacco, potato, papaya, jatropha.
5. Animal cell cultures and its applications
6. Animal cells as bioreactors, Molecular pharming, Production of vaccines, pharmaceutical proteins, recombinant hemoglobin and blood substitutes.
7. Transgenic Animals

Unit IV: Microbial & Environmental Biotechnology

1. Microbes as biocontrol agents, Microbial insecticides (*Baculoviruses*, *Bacillus thuringiensis* and *Bacillus sphaericus*)
2. Bioremediation, Biodegradation of cellulose and lignocellulose, biosurfactants and bioemulsifiers
3. Microbial ore leaching and production of microbial fuels (hydrogen, methane)
4. Renewable and Non-renewable energy sources
5. Strategies involved in Municipal solid waste treatment, Treatment of industrial and domestic effluent (aerobic and anaerobic)
6. Biomaterials as an alternative to non-degradable materials, Heavy Metal Accumulation. Biosorption
7. Heavy metal tolerance (including mechanism) and its impact on environment

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References:

1. Principles of Gene Manipulation: An introduction to GE – Old, R. and Primrose, S.B. Blackwell Sci. Pub
2. Molecular Biotechnology Glick, BR and Paternak, JJ. Publish ASM Press
3. Introduction to Biotechnology, William J. Thieman, Michael A. Palladino, Benjamin Cummings Publ
4. Biotechnology- Arora, Himalaya pub. House
5. Introduction to Environmental Biotechnology by A. K. Chatterji, PHI Learning Pvt. Ltd.
6. Animal Cells as Bioreactors - By Terence Gatoright, Cambridge Univ Press
7. Text Book of Biotechnology - By H.K. Das (Wiley Publications)
8. Introduction to Plant Tissue Culture - By M.K. Razdan (Oxford and IBH Publishing Company, New Delhi)
9. Industrial Microbiology by L.E. Casida


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SEMESTER –VI: BS601 (Practical): Paper – VI (B)

r-DNA TECHNOLOGY & BIOTECHNOLOGY

(1 Credit; 2 Hrs./week)

1. Restriction mapping: λ - DNA with any two restriction enzymes, strategies of gene cloning.
2. Preparation and transformation of competent cells.
3. Preparation of MS medium and initiation of callus, Micropropagation of plants
4. Isolation of microbes from environment (any source soil, water, skin, bread, milk)
5. Efficacy testing for biofertilizers (nodulation test for rhizobia) and efficacy testing for biopesticides.
6. Microbial degradation of organic matter, Municipal solid waste treatment and Waste water treatment
7. Production of hydrogen and methane

References

1. Microbial Biotechnology – A Laboratory Manual for bacterial systems by Das, Surajit, Dash, Hirak Ranjan, Springer-Verlag
2. Plant Tissue Culture by Kalyan Kumar De
3. Biogas Technology by B.T. Nijaguna
4. Biotechnology procedures and experiments handbook by S. Harisha, Infinity Science Press LLC.


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SEMESTER –VI: BS604
SKILL ENHANCEMENT COURSE (SEC-IV)
VACCINE PRODUCTION AND QUALITY CONTROL

(2 Credit; 2 Hrs./week)

Course Objective

To provide knowledge about **vaccine development, production methods, and quality control procedures** used in the biopharmaceutical industry.

Course Outcomes

After completing the course, students will be able to:

1. Understand different types of vaccines and their production processes.
2. Explain industrial methods of vaccine manufacturing.
3. Describe quality control and regulatory standards for vaccines.

Unit I: Vaccine Development and Production

1. Introduction to vaccines types of vaccines
2. Antigen selection and vaccine design
3. Microbial and cell culture systems for vaccine production
4. Upstream and Downstream processing in vaccine manufacturing
5. Formulation, stabilization, and storage of vaccines

Unit II: Quality Control and Regulatory Aspects of Vaccines

1. Quality control tests for vaccines
2. Potency and efficacy testing of vaccines
3. Stability studies and shelf-life determination
4. Good Manufacturing Practices (GMP) in vaccine production
5. Regulatory authorities and approval process (WHO, FDA)

References:

1. **B. D. Singh**, *Biotechnology: Expanding Horizons*, Kalyani Publishers, New Delhi.
2. **Purohit S. S.**, *Biotechnology: Fundamentals and Applications*, Agrobios (India), Jodhpur.
3. **U. Satyanarayana & U. Chakrapani**, *Biochemistry*, Elsevier India.
4. **H. K. Das**, *Textbook of Biotechnology*, Wiley India.
5. **A. K. Gupta**, *Biotechnology and Genomics*, Rastogi Publications, Meerut.


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SEMESTER –VI: BS604
SKILL ENHANCEMENT COURSE (SEC-IV)
ENTREPRENEURSHIP IN BIOCHEMICAL SCIENCES

(2 Credit; 2 Hrs./week)

Course Objective

To introduce students to **entrepreneurial opportunities in biochemical sciences**, including start-ups in biotechnology, diagnostics, pharmaceuticals, and food industries.

Course Outcomes

After completing the course, students will be able to:

1. Understand the concept and scope of entrepreneurship in life sciences.
2. Identify business opportunities in biochemical and biotechnology sectors.
3. Develop basic knowledge of business planning, funding, and regulatory requirements.

Syllabus:

Unit I: Fundamentals of Entrepreneurship

1. Concept, importance, and characteristics of entrepreneurship
2. Types of entrepreneurship and entrepreneurial skills
3. Government initiatives supporting start-ups (Start-up India, MSME schemes)
4. Opportunities for entrepreneurs in biochemical sciences
5. Case studies of successful biopharma start-ups

Unit II: Biochemical and Biotech-Based Enterprises

1. Diagnostic laboratories and clinical testing centers
2. Nutraceutical and functional food industries
3. Biopharmaceutical production and vaccine industries
4. Enzyme production and their industrial applications
5. Agricultural biotechnology and biofertilizer production

References:

1. **Dr. G. Chelladurai, Dr. Sr. S. Iruthaya Kalai Selvam & Dr. Priya Sundarrajan**
Bio-Entrepreneurship Authors Click Publishing.
2. **Sagarika Devi, Gokul Shankar Sabesan & Sultan Ahmed Ismail (Editors)**
Opportunities for Biotechnology Research and Entrepreneurship Bentham Science Publishers.
3. **B. D. Singh**
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4. **Purohit S. S.**
Biotechnology: Fundamentals and Applications Agrobios (India).
5. **Satyanarayana U. & Chakrapani U.**
Biochemistry Elsevier India.

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SEMESTER –VI: BS605
VALUE ADDED COURSE (VAC)
QUALITY CONTROL IN FOOD AND BIOPHARMACEUTICAL INDUSTRIES
(2 Credit; 2 Hrs./week)

Course Objective

To provide knowledge about quality control principles, regulatory standards, and analytical methods used in food and biopharmaceutical industries.

Course Outcomes

After completing the course, students will be able to:

- Understand quality assurance and quality control systems.
- Identify analytical techniques used in food and pharmaceutical quality testing.
- Explain regulatory standards and safety requirements in industry.

Unit I: Fundamentals of Quality Control

1. Concept and importance of quality control and quality assurance
2. Quality management systems in food and pharmaceutical industries
3. Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), Standard Operating Procedures (SOP)
4. Physical and chemical analysis of food products and quality standards
5. Regulatory agencies and food safety standards (FSSAI), Regulatory guidelines (WHO, FDA)

Reference:

1. **Rajeev Kumar & Shailendra Saraf**, *Pharmaceutical Quality Assurance*, Vallabh Prakashan, New Delhi.
2. **Anusuya R. & Bindu Sukumaran**, *Pharmaceutical Quality Assurance*, Nirali Prakashan, **K. R. Dhiman (Ed.)**, *Quality Control for Value Addition in Food Processing*, New India Publishing Agency.
3. **R. K. Trivedi & A. K. Goyal**, *Pharmaceutical Quality Assurance and Regulatory Affairs* CBS Publishers & Distributors, New Delhi.
4. **S. H. Ansari**, *Pharmaceutical Quality Assurance*, Birla Publications Pvt. Ltd., New Delhi.


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