SHRI GNANAMBICA DEGREE COLLEGE: MADANAPALLE

(AUTONOMOUS)

BIOTECHNOLOGY

COURSE-2: BIOLOGICAL CHEMISTRY

SEMESTER I

(W.E.F. 2025-2026)

Program: B.Sc. Biotechnology Honors

Hours per week: 4 **Credits: 3**

Course Outcomes:

Unit I – Nucleic Acids

Understand the chemical structure, base composition, and various forms of DNA and RNA, including the forces stabilizing nucleic acid structures and deviations from the Watson-Crick model.

Unit II – Carbohydrates and Lipids

Explain the classification, structure, and functions of carbohydrates and lipids, including fatty acids, triglycerides, phospholipids, porphyrins, heme, chlorophylls, and the process of β-oxidation.

Unit III – Amino Acids and Proteins

Describe the structure, classification, and properties of amino acids and proteins, and understand the levels of protein organization and the significance of the Ramachandran plot.

Unit IV – Enzymes

Analyze enzyme structure, classification, specificity, kinetics, and inhibition mechanisms, including concepts like active sites, coenzymes, and enzyme immobilization.

Unit V – Bioenergetics

Understand the principles of bioenergetics including energy transformations, redox reactions, and metabolic pathways such as glycolysis, Kreb's cycle, gluconeogenesis, and oxidative phosphorylation.

Learning Outcomes:

After completing this course, students will be able to:

- Describe the chemical structure and structural variations of nucleic acids.
- Classify and explain the structures and functions of carbohydrates, lipids, and porphyrins.
- Explain the properties and structural organization of proteins using the Ramachandran plot.
- Analyze enzyme kinetics, substrate specificity, and different types of enzyme inhibition.
- Understand the principles of bioenergetics and summarize major energy-yielding metabolic pathways.

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Syllabus

UNIT I

Nucleic Acids: Chemical structure and base composition of nucleic acids (DNA and RNA). **Nucleotide and Nucleoside**. Chargaff's rules. Watson Crick Model (B-DNA), deviations from Watson-Crick model. Alternative forms of DNA (A-DNA and Z-DNA). Forces stabilizing nucleic acid structures, (hydrogen bonds and hydrophobic associations).

UNIT II

Carbohydrates: Definition, classification, nomenclature of carbohydrates, structures of monosaccharides, disaccharides and polysaccharides. Concept and examples of heteropolysaccharides.

Lipid: Structure of saturated and unsaturated fatty acids, triglycerides, phospholipids, Chemistry of Porphyrines, Heme and Chlorophylls, **β – Oxidation**.

UNIT III

Amino acids and Proteins: Structure of amino acids occurring in proteins, classification of amino acids (pH based, polarity based and nutrition based) physico-chemical properties of amino acids. Primary, Secondary, Tertiary & Quaternary structure of proteins. Ramachandran Plot.

UNIT IV

Enzymes: Terminology: Active site, allosteric site, Holoenzyme, apoenzyme, coenzyme, substrate, inhibitor, activator, modulator etc. Classification and nomenclature of enzymes. Substrate Specificity (bond specificity, group specificity, absolute specificity, stereospecificity), lock and key and induced fit models. Enzyme kinetics: Michaelis-Menten equation, effect of substrate concentration, effect of enzyme concentration, effect of pH and temperature, temperature. Enzyme inhibition (reversible inhibition types – competitive, uncompetitive and non-competitive), brief idea of irreversible inhibition. **Immobilized Enzymes.**

UNIT V

Bioenergetics: Concept of free energy, Entropy, Enthalpy & Redox Potential. Concept of high energy bonds (structure of ATP). Glycolysis, Kreb's cycle, Gluconeogenesis: Bypass reactions., Electron transport chain, Oxidative phosphorylation.

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Reference books:

- Lehninger, A.L., Nelson, D.L. and Cox, M.M. – *Principles of Biochemistry* – W.H. Freeman and Company.
- Voet, D. and Voet, J.G. – *Biochemistry* – John Wiley & Sons.
- Stryer, L. – *Biochemistry* – W.H. Freeman and Company.
- Satyanarayana, U. and Chakrapani, U. – *Biochemistry* – Elsevier / Books and Allied (Indian edition).
- Zubay, G. – *Biochemistry* – Wm. C. Brown Publishers.
- Garrett, R.H. and Grisham, C.M. – *Biochemistry* – Brooks/Cole, Cengage Learning.
- Conn, E.E. and Stumpf, P.K. – *Outlines of Biochemistry* – John Wiley & Sons.

Extracurricular / Practical Activities

1. **DNA/RNA Model Making (3D or Clay Models)**
   Objective: Visualize the structure of nucleic acids, including base pairing, double helix, and alternative DNA forms (A-DNA, B-DNA, Z-DNA).
2. **Carbohydrate and Lipid Identification Tests (Lab Demonstration)**
   Objective: Perform qualitative tests like Benedict's test, Barfoed's test, Seliwanoff's test, and Sudan III stain to distinguish different types of carbohydrates and lipids.
3. **Amino Acid Spotting and pH-Based Classification Activity**
   Objective: Use pH papers and charting to classify amino acids as acidic, basic, or neutral based on their properties.
4. **Protein Structure Visualization Using Software (e.g., PyMOL or RCSB PDB)**
   Objective: Explore real protein structures online and identify primary to quaternary levels; interpret Ramachandran plots.
5. **Enzyme Kinetics Simulation (Using Software or Spreadsheet Models)**
   Objective: Simulate Michaelis-Menten kinetics and understand effects of pH, temperature, and inhibitors on enzyme activity.
6. **Energy Molecule Models and ATP Hydrolysis Demonstration**
   Objective: Create molecular models of ATP and demonstrate high-energy bond hydrolysis using visual aids or animations.
7. **Metabolic Pathway Mapping (Glycolysis, Krebs Cycle, ETC)**
   Objective: Design colorful wall charts or digital mind maps to interconnect key biochemical pathways and their energy outputs.

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SEMESTER - I

COURSE 2: BIOLOGICAL CHEMISTRY

Practical **Credits: 1** **2 hrs/week**

Practical Component:

1. Introduction to basic instruments (Principle standard operation procedure) demonstration and record
2. Calculation of molarity, normality, and molecular weight of compounds.
3. Qualitative analysis of carbohydrates (sugars)
4. Quantitative analysis of carbohydrates
5. Quantitative estimation of protein - Lowery method
6. Estimation of DNA by diphenylamine reagent
7. Estimation of RNA by orcinol reagent
8. Assay of protease activity
9. Preparation of starch from potato and its hydrolyzation by salivary amylase

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SEMESTER I

(W.E.F. 2025-2026)

Program: B.Sc. Biotechnology Honors

Question Paper Blue Print

Time : 3 Hrs **Max Marks: 70**

(Draw diagrams wherever necessary)

I. Answer any Four Questions 4 X 5 =20

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....

II. Answer all the questions 5 X 10 = 50

1. **(A).....**

   Or

   (B).....
2. **(A).....**

   Or

   (B).....
3. **(A).....**

   Or

   (B).....
4. **(A).....**

   Or

   (B).....
5. **(A).....**

   Or

   (B).....

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BIOTECHNOLOGY

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SEMESTER I

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Program: B.Sc. Biotechnology Honors

Model Question Paper

Time : 3 Hrs **Max Marks: 70**

(Draw diagrams wherever necessary)

I. **Answer any Four questions from the following 4 × 5 = 20 Marks**

1. Differentiate between nucleotide and nucleoside with examples.
2. State Chargaff's rules and explain their significance.
3. Classify carbohydrates with suitable examples.
4. Write a short note on saturated and unsaturated fatty acids.
5. Explain the primary and secondary structure of proteins.
6. Define the terms: holoenzyme, apoenzyme, coenzyme, and active site.
7. What is Michaelis-Menten equation? Mention its significance.
8. Define ATP and explain the concept of high-energy phosphate bonds.

II. **Answer ALL questions. 5 × 10 = 50 Marks**

9. a) Describe the Watson-Crick model of B-DNA.

OR

b) Write an essay on the chemical structure and alternative forms of DNA (A-DNA and Z-DNA).

10. a) Explain the structure and classification of carbohydrates with examples.

OR

b) Describe the structure and function of phospholipids. Add a note on β-oxidation of fatty acids.

11. a) Classify amino acids based on pH, polarity, and nutrition.

OR

b) Discuss the four levels of protein structure. Add a note on the Ramachandran plot.

12. a) Explain the lock-and-key and induced-fit models of enzyme action.

OR

b) Describe the types of reversible enzyme inhibition and their biological relevance.

13. a) Describe glycolysis with steps, enzymes, and energy yield.

OR

b) Write an account of the electron transport chain and oxidative phosphorylation.

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