straighterline

Syllabus

CHEM450 | **Biochemistry**

Course Texts

No need to track down a textbook; these texts are provided digitally as part of the course enrollment:

Nelson, David L., et al. *Lehninger Principles of Biochemistry*. 8th ed., Macmillan Learning, 2021.

Course Description

Biochemistry provides a comprehensive overview of the fundamental principles of biochemistry, from the structure and function of biomolecules to the regulation of cellular metabolism. The course starts with an introduction to the foundations of biochemistry, including the chemistry of life and the properties of water as the solvent of life. The structure, function, and regulation of amino acids, peptides, and proteins are then explored, including protein folding and enzyme catalysis. The course also covers the metabolism of carbohydrates, lipids, and nucleic acids, including glycolysis, the citric acid cycle, fatty acid catabolism, oxidative phosphorylation, and lipid biosynthesis. The biosynthesis of amino acids, nucleotides, and related molecules is also examined, as well as hormonal regulation and the integration of mammalian metabolism. Additionally, the course explores the structure and function of biological membranes, transport mechanisms, and biochemical signaling pathways. Finally, the course also covers the regulation of gene expression, including the structure and function of genes and chromosomes, DNA metabolism, RNA metabolism, and protein metabolism.

Learning Outcomes

After completing this course, students will be able to:

1. Explain how weak interactions, the properties of water, and acid–base equilibria (pH, pKa, buffering) govern the structure and reactivity of biomolecules in aqueous systems.
2. Analyze how the primary, secondary, tertiary, and quaternary structure of a protein determines its folding, ligand binding, and biological function.
3. Apply the principles of enzyme catalysis and enzyme kinetics to predict how substrates, inhibitors, and regulatory signals alter reaction rates.
4. Classify carbohydrates, nucleotides, and lipids by structural features and relate each class to its role as a fuel, structural component, information carrier, signal, cofactor, or pigment.
5. Explain how membrane composition and architecture produce membrane dynamics and determine the mechanism of solute transport across the bilayer.
6. Trace biochemical signaling pathways—including G protein–coupled receptors, gated ion channels, transcriptional regulation, and cell cycle control—from ligand binding to cellular response.
7. Apply bioenergetic and thermodynamic principles, including free-energy change, coupled reactions, and the central role of ATP, to evaluate whether a metabolic reaction is favorable and how it is regulated.
8. Compare the catabolic pathways of carbohydrates and fats—glycolysis, gluconeogenesis, the pentose phosphate pathway, glycogen metabolism, the citric acid cycle, fatty acid oxidation, and oxidative

phosphorylation—in terms of substrates, energy yield, and points of regulatory control.
9. Evaluate how anabolic pathways for fatty acids, triacylglycerols, membrane phospholipids, amino acids, and nucleotides are coordinated with catabolism through hormonal regulation across tissues in the fed, fasted, and dysregulated (diabetic) states.
10. Describe the flow of genetic information through the structure of genes and chromosomes, DNA replication and repair, RNA synthesis and processing, translation, and the regulation of gene expression.

Course Prerequisites

It is recommended that students complete Organic Chemistry I & II before enrolling in this course.

Academic Integrity Statement

Academic integrity is the pursuit of scholarly activity in an honest, truthful and responsible manner. Violations of academic integrity include, but are not limited to, plagiarism, cheating, fabrication and academic misconduct. Failure to comply with the Academic Integrity Policy can result in a failure and/or zero on the attempted assignment/examination, a removal from the course, disqualification to enroll in future courses, and/or revocation of an academic transcript.

Course Completion Policy

In order for a course to be considered complete, **all required coursework must be attempted, submitted, and graded.** Required coursework consists of graded assignments. Any Academic Integrity Policy violations may prevent a course from being considered complete.

Assessment Types

StraighterLine courses may include any combination of the assessment types described below. Review the descriptions to learn about each type, then review the Course Evaluation Criteria to understand how your learning will be measured in this course.

Benchmarks

Benchmarks test your mastery of course concepts. You have 3 attempts, and your highest score counts. **Note:** Cumulative Benchmarks (final exams) only allow 1 attempt and use a browser-based examination integrity tool.

Capstones

Capstones are project-based assessments that help you apply concepts to real-world scenarios. You have 2 attempts, and your highest score counts.

Checkpoints

Checkpoints are quick knowledge checks on important course concepts. All are open-book, and most have 1-3 attempts.

AI Use-Case Policies

StraighterLine Capstone assessments operate under one of three AI Use-Case Policies. These designations are selected intentionally to support learners in developing digital literacy, ethical reasoning, and authentic communication skills. Each model requires students to engage meaningfully with the course outcomes while adhering to academic standards.

Independent Work Requirement: Capstones with this designation must be completed independently without using AI tools. The goal is for learners to showcase their own understanding and skills without AI assistance. Students are expected to generate and submit original work developed solely through their own reasoning and effort.

AI-Assisted Planning Option: Capstones with this designation may allow AI tools to support brainstorming and assessment planning. If allowed, students will be asked to document any AI assistance by noting how it informed their work. Documentation must be included within the assignment or in a designated reflection field. Examples include describing how an AI tool helped organize an outline, generate ideas, or surface sources for further exploration.

AI-Integration Requirement: Capstones with this designation require AI tools as part of the learning process. Students will be asked to reflect upon their AI interactions and AI contributions to the assessment. Reflections must include which tools were used, how they were used, and what insights students gained from the process. This promotes transparency, ethical use, and metacognitive skill-building.

Course Evaluation Criteria

Your score provides a percentage score and letter grade for each course. A passing percentage is 70% or higher.

There are a total of 1000 points in the course:

Assessment	Points	Learning Outcomes
Checkpoint 1: The Foundations of Biochemistry	4	1
Checkpoint 2: Water, the Solvent of Life	4	1
Checkpoint 3: Amino Acids, Peptides, and Proteins	4	2
Checkpoint 4: The Three-Dimensional Structure of Proteins	4	2
Checkpoint 5: Protein Function	4	2
Checkpoint 6: Enzymes	4	3
Benchmark 1: Checkpoints 1-6	100	1-3
Checkpoint 7: Carbohydrates and Glycobiology	4	4
Checkpoint 8: Nucleotides and Nucleic Acids	4	4
Checkpoint 9: Lipids	4	4
Checkpoint 10: Biological Membranes and Transport	4	5
Checkpoint 11: Biochemical Signaling	4	6
Checkpoint 12: Introduction to Metabolism	4	7
Benchmark 2: Checkpoints 7-12	100	4-7
Benchmark 3: Checkpoints 1-12	200	1-7

Assessment	Points	Learning Outcomes
Checkpoint 13: Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway	4	8
Checkpoint 14: The Metabolism of Glycogen in Animals	4	8
Checkpoint 15: The Citric Acid Cycle	4	8
Checkpoint 16: Fatty Acid Catabolism	4	8
Checkpoint 17: Oxidative Phosphorylation	4	7, 8
Checkpoint 18: Lipid Biosynthesis	4	9
Benchmark 4: Checkpoints 13-18	100	7-9
Checkpoint 19: Biosynthesis of Amino Acids, Nucleotides, and Related Molecules	4	9
Checkpoint 20: Hormonal Regulation and Integration of Mammalian Metabolism	4	9
Checkpoint 21: Genes and Chromosomes	4	10
Checkpoint 22: DNA Metabolism	4	10
Checkpoint 23: RNA Metabolism	4	10
Checkpoint 24: Protein Metabolism	4	10
Checkpoint 25: Regulation of Gene Expression	4	10
Benchmark 5: Checkpoints 19-25	100	9, 10
Benchmark 6: Checkpoints 1-25	300	1-10
Total	1000	

Course Roadmap

This roadmap provides an overview of the checkpoints and lessons covered in this course.

Checkpoint 1: The Foundations of Biochemistry

- Textbook: Checkpoint 1 Reading Assignment: Chapter 1
- The Foundations of Biochemistry
- Flashcards: Chapter 1
- Concept Map Activity: Chapter 1

Checkpoint 2: Water, the Solvent of Life

- Textbook: Checkpoint 2 Reading Assignment: Chapter 2
- Water: The Solvent of Life
- Flashcards: Chapter 2
- Concept Map Activity: Chapter 2

Checkpoint 3: Amino Acids, Peptides, and Proteins

- Textbook: Checkpoint 3 Reading Assignment: Chapter 3
- Amino Acids, Peptides, and Proteins
- Checkpoint 3: Chapter 3 Video Playlist
- Flashcards: Chapter 3
- Concept Map Activity: Chapter 3

Checkpoint 4: The Three-Dimensional Structure of Proteins

- Textbook: Checkpoint 4 Reading Assignment: Chapter 4
- The Three Dimensional Structure of Proteins
- Checkpoint 4: Chapter 4: Video Playlist
- Flashcards: Chapter 4
- Concept Map Activity: Chapter 4

Checkpoint 5: Protein Function

- Textbook: Checkpoint 5 Reading Assignment: Chapter 5
- Protein Function
- Checkpoint 5: Chapter 5: Video Playlist
- Flashcards: Chapter 5
- Concept Map Activity: Chapter 5

Checkpoint 6: Enzymes

- Textbook: Checkpoint 6 Reading Assignment: Chapter 6
- Enzymes
- Checkpoint 6: Chapter 6: Video Playlist
- Flashcards: Chapter 6
- Concept Map Activity: Chapter 6

Checkpoint 7: Carbohydrates and Glycobiology

- Textbook: Checkpoint 7 Reading Assignment: Chapter 7
- Carbohydrates and Glycobiology
- Flashcards: Chapter 7
- Concept Map Activity: Chapter 7

Checkpoint 8: Nucleotides and Nucleic Acids

- Textbook: Checkpoint 8 Reading Assignment: Chapter 8
- Nucleotides and Nucleic Acids
- Checkpoint 8: Chapter 8: Video Playlist
- Flashcards: Chapter 8
- Concept Map Activity: Chapter 8

Checkpoint 9: Lipids

- Textbook: Checkpoint 9 Reading Assignment: Chapter 10
- Lipids
- Flashcards: Chapter 10

- Concept Map Activity: Chapter 10

Checkpoint 10: Biological Membranes and Transport

- Textbook: Checkpoint 10 Reading Assignment: Chapter 11
- Biological Membranes and Transport
- Checkpoint 10: Chapter 11: Video Playlist
- Flashcards: Chapter 11
- Concept Map Activity: Chapter 11

Checkpoint 11: Biochemical Signaling

- Textbook: Checkpoint 11 Reading Assignment: Chapter 12
- Biochemical Signaling
- Flashcards: Chapter 12
- Concept Map Activity: Chapter 12

Checkpoint 12: Introduction to Metabolism

- Textbook: Checkpoint 12 Reading Assignment: Chapter 13
- Introduction to Metabolism
- Checkpoint 12: Chapter 13: Video Playlist
- Flashcards: Chapter 13
- Concept Map Activity: Chapter 13

Checkpoint 13: Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway

- Textbook: Checkpoint 13 Reading Assignment: Chapter 14
- Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway
- Checkpoint 13: Chapter 14: Video Playlist
- Flashcards: Chapter 14
- Concept Map Activity: Chapter 14

Checkpoint 14: The Metabolism of Glycogen in Animals

- Textbook: Checkpoint 14 Reading Assignment: Chapter 15
- The Metabolism of Glycogen in Animals
- Checkpoint 14: Chapter 15: Video Playlist
- Flashcards: Chapter 15
- Concept Map Activity: Chapter 15

Checkpoint 15: The Citric Acid Cycle

- Textbook: Checkpoint 15 Reading Assignment: Chapter 16
- The Citric Acid Cycle
- Checkpoint 15: Chapter 16: Video Playlist
- Flashcards: Chapter 16
- Concept Map Activity: Chapter 16

Checkpoint 16: Fatty Acid Catabolism

- Textbook: Checkpoint 16 Reading Assignment: Chapter 17
- Fatty Acid Catabolism

- Checkpoint 16: Chapter 17: Video Playlist
- Flashcards: Chapter 17
- Concept Map Activity: Chapter 17

Checkpoint 17: Oxidative Phosphorylation

- Textbook: Checkpoint 17 Reading Assignment: Chapter 19
- Oxidative Phosphorylation
- Flashcards: Chapter 19
- Concept Map Activity: Chapter 19

Checkpoint 18: Lipid Biosynthesis

- Textbook: Checkpoint 18 Reading Assignment: Chapter 21
- Lipid Biosynthesis
- Flashcards: Chapter 21
- Concept Map Activity: Chapter 21

Checkpoint 19: Biosynthesis of Amino Acids, Nucleotides, and Related Molecules

- Textbook: Checkpoint 19 Reading Assignment: Chapter 22
- Biosynthesis of Amino Acids, Nucleotides, and Related Molecules
- Checkpoint 19: Chapter 22: Video Playlist
- Flashcards: Chapter 22
- Concept Map Activity: Chapter 22

Checkpoint 20: Hormonal Regulation and Integration of Mammalian Metabolism

- Textbook: Checkpoint 20 Reading Assignment: Chapter 23
- Hormonal Regulation and Integration of Mammalian Metabolism
- Flashcards: Chapter 23
- Concept Map Activity: Chapter 23

Checkpoint 21: Genes and Chromosomes

- Textbook: Checkpoint 21 Reading Assignment: Chapter 24
- Genes and Chromosomes
- Flashcards: Chapter 24
- Concept Map Activity: Chapter 24

Checkpoint 22: DNA Metabolism

- Textbook: Checkpoint 22 Reading Assignment: Chapter 25
- DNA Metabolism
- Flashcards: Chapter 25
- Concept Map Activity: Chapter 25

Checkpoint 23: RNA Metabolism

- Textbook: Checkpoint 23: Reading Assignment: Chapter 26
- RNA Metabolism
- Flashcards: Chapter 26

- Concept Map Activity: Chapter 26

Checkpoint 24: Protein Metabolism

- Textbook: Checkpoint 24 Reading Assignment: Chapter 27
- Protein Metabolism
- Flashcards: Chapter 27
- Concept Map Activity: Chapter 27

Checkpoint 25: Regulation of Gene Expression

- Textbook: Checkpoint 25 Reading Assignment: Chapter 28
- Regulation of Gene Expression
- Flashcards: Chapter 28
- Concept Map Activity: Chapter 28

Related Courses

CHEM450L
Biochemistry Lab
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PHY250
General Physics I
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PHY250L
General Physics I Lab
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