

**Grove City College**  
**Fall Semester 2025**  
**CHEM 351: Biochemistry I**

**Instructor**

Instructor Kevin Shaw  
Email *klshaw@gcc.edu*  
Phone Office 724-450-4043  
Home 724-974-9381  
Campus Mail #3097  
Office STEM 340C  
Office Hours M, 12-2; T, 12:30-2; R, 10-11; F, 9-11, 12-1

**Meeting Hours**

Lecture Section A MWF 8:00-8:50, SHAL 110  
Laboratory Section L W 14:00-16:59, STEM 155  
Laboratory Section M R 14:00-16:59, STEM 155

**Course Objectives(●), Assessments(○) and (Biochemistry Program Outcomes)**

Upon completion of this course, the student will be able to:

- Discuss the basic areas, questions and methodologies of biochemical investigation.
  - Unit examinations, final examination and laboratory reports (1, 2, 3, 4 and 7)
- Identify and explain the non-covalent forces responsible for macromolecular structure and behavior.
  - Unit examinations, final examination and laboratory reports (1, 2, 3 and 4)
- Prepare dilute buffer solutions.
  - Unit examinations, final examination and laboratory reports (1, 2, 3 and 4)
- Predict the properties and behaviors of polyionic macromolecules.
  - Unit examinations, final examination and laboratory reports (1, 2 and 3)
- Identify and draw the structures of common biological molecules including amino acids, carbohydrates and small molecules.
  - Unit examinations and final examination (1 and 2)
- Design protein purification strategies using common purification methods based on the physical properties of a protein.
  - Unit examinations, final examination and laboratory reports (1, 2, 3 and 4)
- Describe the binding of macromolecules.
  - Unit examinations, final examination and laboratory reports (1, 2 and 3)
- Describe the general principles of enzymatic catalysis.
  - Unit examinations and final examination (1, 2 and 3)
- Derive and apply a formal treatment of steady-state enzyme kinetics including multiple substrates and reversible inhibition.
  - Unit examinations, final examination and laboratory reports (1, 2, 3, 4 and 5)
- Search, read and use the biochemical literature to write a review paper on an enzyme.
  - Research paper (1, 2, 5 and 6)
- Recognize common enzymatic reaction mechanisms by enzyme or cofactor type and draw enzyme reaction mechanisms at the electron level.
  - Unit examinations and final examination (1 and 2)
- Describe biochemical reactions as thermodynamic systems and apply thermodynamic methodologies to predict the behavior of biochemical systems.
  - Unit examinations, final examination and laboratory reports (1, 2 and 3)
- Draw common metabolic pathways including glycolysis, the citric acid cycle and the urea cycle.
  - Unit examinations and final examination (2)
- Apply knowledge of basic metabolic pathways to integrate connected metabolic pathways.
  - Unit examinations and final examination (2)
- Describe electron transport chains and ATP synthase.
  - Unit examinations and final examination (2)

- Describe the synthesis of common biochemical molecules such as amino acids and carbohydrates.
  - Unit examinations and final examination (2)
- Keep a laboratory notebook, electronic data and analysis.
  - Laboratory reports, laboratory notebook and electronic laboratory data/analysis (3, 4, 5 and 6)
- Perform basic experimental protocols such as micropipette measurements, solution preparation, titrations and the handling of small quantities of biochemical reagents.
  - Laboratory reports (3 and 4)
- Analyze data using nonlinear least-squares fitting methods.
  - Laboratory reports and electronic laboratory data/analysis (3 and 4)

### Required Materials

Nelson, D. L. and Cox, M. M., **Lehninger Principles of Biochemistry, 7<sup>th</sup> Edition**, W. H. Freeman and Company, New York, NY, 2017. ISBN 1-4641-2611-9

<https://biochemistry.prof/351/>

### Grading

#### Course Grade

Exam I	20%
Exam II	20%
Final Exam	25%
Laboratory	25%
Research Paper	5%
Seminar	5%

#### Grading Scale

The grading scale is ten percent to the letter grade with appropriate  $\pm$  distinctions. Thus, the lowest “A–” is ninety percent, the lowest “B–” is eighty percent, the lowest “C–” is seventy percent, and the lowest passing grade for the course is sixty percent.

### Laboratory

#### Laboratory Grading

Laboratory Reports	80%
Laboratory Notebook/Electronic Data	20%

#### Laboratory Reports

A lab report is required for each laboratory activity. Each laboratory is described on the course website; the details of the lab report are a feature of that description. Please follow those guidelines so that your laboratory report is complete and so that you do not spend time on unnecessary work. Along with the description of the laboratory activity is the due date for each laboratory report.

#### Laboratory Report Grading

A+	100%	Excellent presentation with correct analysis
A	95%	Good presentation with correct analysis
A–	90%	Good presentation with minor error in analysis
B+	85%	Poor presentation or major error in analysis
D–	60%	No laboratory report
F	0%	Failure to attend laboratory

#### Laboratory Notebook

Each student is required to keep a laboratory notebook that details their work in the laboratory portion of this course. The laboratory notebook is the sole written record of your work in the laboratory and should be used for *all* record keeping related to laboratory work. While there is some freedom in notebook choice and record keeping style, each laboratory notebook must conform to the following:

- The laboratory notebook must be kept in a bound notebook. Either a glued or stitched binding is acceptable; a three ring or spiral binding is not acceptable. The purpose of a permanent binding is to prevent the removal of pages and show evidence when that has happened.
- The pages of the notebook must be numbered, and the first several pages should be reserved for a table of contents created at the end of the semester. Either printed or hand written page numbers are acceptable.
- All writing in the notebook must be in ink.
- Each entry must be dated.

- Each new laboratory topic must be introduced with a very brief statement of the purpose of the experiments.
- All notes, calculations and data should be entered into the notebook as they are made. If some element is incorrect, strike it and correct it below.
- Analysis of data, even if completed outside of the scheduled laboratory time, should be done in the laboratory notebook.
- Calculations and plots prepared electronically may be printed and included in the lab notebook by staple, tape or glue. Alternately, electronic data files may be saved in the lab data folder (*see Electronic Data below*) and a reference to that analysis included in the laboratory notebook.

In laboratory, students will work in small groups. Individual tasks for an experiment may be completed by a subset of students. As a result, an individual notebook will not be a complete record of the work done. This is alright. Your notebook only needs to be a record of the work you completed; you do not need to copy information from others to “complete” your notebook.

Your laboratory notebook is due by 11 December, 2025.

#### *Electronic Data*

Much of the data collected in laboratory will be derived from instruments in electronic form and analyzed with spreadsheets. The course website has a link to a network folder where all electronic lab data for this course will be collected. Each lab group should create a folder to contain all their raw data and analysis files. There must be a correspondence between files in this folder and data mentioned in the laboratory notebook.

Also, the network folder will be used when each lab group collects only a subset of the data required for the analysis. Each lab summary will point to any “community” data files to be used for that experiment.

#### *Laboratory Safety*

While in the laboratory, long pants and closed-toe shoes are required; safety goggles must be worn in the laboratory. Eating or drinking is not permitted in the laboratory. Failure to comply with any safety directive may result in dismissal from laboratory.

### Laboratory Schedule<sup>†</sup>

Laboratory	Date	Topic
1	27, 28 August	Accuracy and Precision
2	3, 4 September	Measuring Transfer Free Energy
3	10, 11 September	Ionization, Titrations and pK Values
4	17, 18 September	Size-Exclusion Chromatography
5	24, 25 September	Ligand Binding
6	1, 2 October	Steady-State Enzyme Kinetics
–	8, 9 October	Exam I ( <i>STEM 155</i> )
–	15, 16 October	<i>No Laboratories—Fall Recess</i>
7	22, 23 October	pH Dependence of Enzyme Kinetics
8	29, 30 October	Enzyme Kinetics with Multiple Substrates
9	5, 6 November	SDS-PAGE
10	12, 13 November	Library Screening for Drug Discovery
–	19, 20 November	Exam II ( <i>STEM 155</i> )
–	26, 27 November	<i>No Laboratories—Thanksgiving Recess</i>
–	3, 4 December	<i>No Laboratories</i>
–	10, 11 December	<i>No Laboratories—Study Day</i>

<sup>†</sup> *The laboratory schedule may be changed at anytime to better meet the needs of the course.*

### Research Paper

#### *Description*

The research paper for this course will investigate the reaction(s), sequence, structure and biological role one enzyme. The research paper will involve the use of journal articles, databases of biochemical information and analytical tools—all common elements in the study of biochemistry. The course website has the complete assignment description, links to direct your work and a mechanism for enzyme selection.

#### *Due Date*

The research paper is due on or before 7 November, 2025.

## Seminar

### *Description*

The Department of Chemistry operates a seminar series during the fall semester. The seminar series draws speakers from professionals in the chemical industries, academic faculty and current graduate students. The series attempts to cover a wide variety of topics from scientific discovery through career advancement. Seminars are held at various times (afternoons and evenings) throughout the fall semester. Your attendance is required at two departmental seminars during the fall semester. Please see the course website for dates, times and other information about the seminar speakers and schedule.

### **Course Policies**

#### *Readings*

Readings from the text are listed on the lecture schedule which follows. The reading listed for a day is the background for the lecture content of that day. In addition to readings listed in the lecture schedule, some examples of the primary literature will be provided on the course website. These articles will typically highlight the theory or practice of an idea discussed in a lecture. These readings are supplements to connect discussion to the literature—they do not need to be memorized in detail.

#### *Suggested Problems*

Biochemistry is a problem-solving discipline; in order to fully learn biochemistry, you must solve problems. For many lecture topics, there will be a document of “suggested problems” on the course website. This document will contain a few problems or references to problems in the text related to that discussion. This document will also contain answers to problems not found in the text and, when necessary, more complete solutions for problems from the text. These problems will emphasize and extend lecture content; similar problems will be included on examinations.

#### *Examinations*

Examinations in this course will be given during the laboratory sessions. The primary reason for this is to eliminate the time constraint of a fifty minute period for examination. The examinations will be given in a room that can accommodate approximately forty students (see laboratory schedule for locations). Since seating room is not a issue, you may take the examinations with any laboratory section. The final examination for this course is comprehensive. Unit examinations are not permanently returned to students. You may review unit exams at any time during normally scheduled office hours.

#### *Final Examination*

Grove City College requires each faculty member to give a rigorous, comprehensive, faculty-proctored final examination in each course. It is the student's responsibility to review the final exam schedule (<http://www2.gcc.edu/registrar/>) at the beginning of the semester and make work and travel plans accordingly. See page 53–54 of the *2025-2026 Grove City College Bulletin* for the Grove City College final examination policy.

#### *Accessibility and Accommodation*

Any required learning accommodations will be provided in this course. See page 39 of the *2025-2026 Grove City College Bulletin* for information on requesting services from the Disability Services Coordinator.

#### *Attendance*

As adopted by the Grove City College faculty, three (3) unexcused lecture absences are permitted without grade penalty. Unexcused absences are not permitted for laboratories or examinations. If you must miss your scheduled laboratory section, you may attend another laboratory section during the same week. Make-up laboratories and examinations will be given for excused absences; formats and requirements may be different for make-up work. See pages 55–55 of the *2025-2026 Grove City College Bulletin* for Grove City College attendance expectations.

#### *Honesty in Learning*

All work submitted in this course must be the student's own scholarly work prepared originally for this course. See pages 56–59 of the *2025-2026 Grove City College Bulletin* for Grove City College policies and procedures related to honesty in learning.

Any use of artificial intelligence tools to generate content for an assignment, while crediting the output as your own work, constitutes an act of plagiarism and a violation of the colleges academic integrity policy.

## Lecture Schedule<sup>†</sup>

Lecture	Date	Topic	Reading
1	25 August	Course Introduction	–
2	27 August	What is Biochemistry?	–
3	29 August	Water	Chp. 2 p. 47–58
–	1 September	<i>No Class—Labor Day</i>	–
4	3 September	May the Forces Be with You	Chp. 2 p. 47–58
5	5 September	Data Analysis with Spreadsheets	–
6	8 September	Ionization and Buffers	Chp. 2 p. 58–69
7	10 September	The Amino Acids	Chp. 3 p. 75–85
8	12 September	Protein Purification	Chp. 3 p. 85–96
9	15 September	Protein Purification ( <i>continued</i> )	Chp. 3 p. 85–96
10	17 September	Protein Purification ( <i>continued</i> )	Chp. 3 p. 85–96
11	19 September	Peptide Structure	Chp. 4 p. 115–125
12	22 September	Protein Structure	Chp. 4 p. 125–142
13	24 September	Protein Structure ( <i>continued</i> )	Chp. 4 p. 125–142
14	26 September	Ligand Binding	Chp. 5 p. 157–174
15	29 September	Steady-State Enzyme Kinetics	Chp. 6 p. 198–204
16	1 October	Multiple Substrate/Reversible Inhibition Enzyme Kinetics	Chp. 6 p. 204–213
17	3 October	General Principles of Enzyme Catalysis <i>**final lecture in Unit I</i>	Chp. 6 p. 187–198
18	6 October	Enzyme Reaction Mechanisms	Chp. 6 p. 213–225
19	8 October	Enzyme Reaction Mechanisms ( <i>continued</i> )	Chp. 6 p. 213–225
20	10 October	Enzyme Regulation	Chp. 6 p. 225–236
21	13 October	Thermodynamics	Chp. 13 p. 495–501
22	15 October	Biochemical Reactions	Chp. 13 p. 501–527
–	17 October	<i>No Class—Fall Recess</i>	–
23	20 October	Glycolysis	Chp. 14 p. 533–553
24	22 October	Glycolysis ( <i>continued</i> )	Chp. 14 p. 533–553
25	24 October	Glycolysis ( <i>continued</i> )	Chp. 14 p. 533–553
26	27 October	Fermentation	Chp. 14 p. 553–558
27	29 October	Gluconeogenesis	Chp. 14 p. 558–565
28	31 October	Regulation of Glycolysis/Gluconeogenesis	Chp. 15 p. 575–600
29	3 November	Citric Acid Cycle	Chp. 16
30	5 November	Citric Acid Cycle ( <i>continued</i> )	Chp. 16
31	7 November	Citric Acid Cycle ( <i>continued</i> )	Chp. 16
32	10 November	Electron Transport Chain	Chp. 19 p. 711–728
33	12 November	ATP Synthesis <i>**final lecture in Unit II</i>	Chp. 19 p. 728–741
34	14 November	Photophosphorylation	Chp. 20 p. 755–774
35	17 November	Photophosphorylation ( <i>continued</i> )	Chp. 20 p. 755–774
36	19 November	Carbohydrate Biosynthesis	Chp. 20 p. 780–798
37	21 November	Carbohydrate Biosynthesis ( <i>continued</i> )	Chp. 20 p. 780–798
–	24 November	<i>No Class—Thanksgiving Recess</i>	–
–	26 November	<i>No Class—Thanksgiving Recess</i>	–
–	28 November	<i>No Class—Thanksgiving Recess</i>	–
38	1 December	Urea Cycle	Chp. 18 p. 675–690
39	3 December	Amino Acid Degradation Pathways	Chp. 18 p. 690–705
40	5 December	Amino Acid Degradation Pathway ( <i>continued</i> )	Chp. 18 p. 690–705
41	8 December	Amino Acid Biosynthesis	Chp. 22 p. 859–880
42	10 December	Amino Acid Biosynthesis ( <i>continued</i> )	Chp. 22 p. 859–880
–	13 December	Final Exam, Section A, 13:00	–

<sup>†</sup>The lecture schedule may be changed at anytime to better meet the needs of the course.