

Advanced Biochemistry - Enzymes Syllabus

Biochem 6762; Spring 2023

Course Information

- **Course times and location:** MWF 10:20 - 11:15 am in **McPherson Lab 1046**
- **Credit hours:** 1.5 (3 hours for 7 weeks)
- **Mode of delivery:** In-person

Instructor

- **Name:** Professor Dehua Pei
- **Email:** pei.3@osu.edu
- **Office location:** 578 Bioscience Building
- **Office hours:** Fridays 400-500 pm or by appointment
- **Preferred means of communication:**
 - My preferred method of communication for questions is **email**.
 - My class-wide communications will be sent through the Announcements tool in CarmenCanvas.

Teaching Assistant

- **Name:** Ms. Monica Pan
- **Email:** pan.1024@buckeyemail.osu.edu
- **Office Hours:** TBA

Course Prerequisites

Organic Chemistry 2510-2530 and 6440 (or their equivalent); Biochemistry 6761 (Macromolecular Structure-Function A) or undergraduate biochemistry.

Course Description

This course covers the chemical basis of enzymatic catalysis, the different types of catalytic strategies utilized by enzymes and cofactors, and how different catalytic strategies are integrated to achieve exceptional catalytic efficiency, specificity, and fidelity. The course also covers the basic experimental approaches to mechanistically investigating, inhibiting, and evaluating enzymatic reactions. Finally, this course will discuss the catalytic mechanisms of several key classes of enzymes frequently encountered in modern biomedical research and the applications of enzymes in research, medicine, and industry.



Learning Outcomes

There are thousands of enzymes. It is neither possible (certainly not in 7 weeks) nor necessary to learn the mechanism of every enzyme. Through studying a few representative (and arguably the most important) enzyme classes and learning how these enzymes achieve their impressive levels of catalytic proficiency, substrate specificity, and/or reaction fidelity, by the end of this course students should successfully be able to:

- Clearly understand the types and the chemical basis of all fundamental catalytic strategies.
- Understand why some enzymes require cofactors for catalysis and how some of the common enzyme cofactors catalyze chemical reactions.
- Be familiar with the enzyme classification system.
- Be able to draw and explain the catalytic mechanisms by which the major classes of peptidases and proteases catalyze the hydrolysis of amide bonds.
- Understand how the environment (e.g., pH, temperature, and the presence of inhibitors) affects enzymatic catalysis.
- Be able to perform simple kinetic analysis of enzymatic reactions (e.g., how to determine k_{cat} , K_M , k_{cat}/K_M , and microscopic rate constants for individual catalytic steps).
- Understand the different types of enzyme inhibition and how to design different types of enzyme inhibitors.
- Become familiar with some of the basic experimental techniques to study enzymatic catalysis (e.g., enzyme inhibition pattern, pH profile analysis, mutagenesis, steady-state and pre-steady-state kinetics, and kinetic isotope effects).
- Understand with the mechanism of DNA polymerases and how the polymerases use different strategies (e.g., proofreading activity) to achieve exceptional fidelity.
- Understand the catalytic mechanisms of major classes of redox enzymes and their biological function.
- Become familiar with how enzymes are used as tools/technologies in basic research, drug discovery, and other industries.

Credit Hours and Work Expectations

This is a 3 credit-hour course (for 7 weeks). According to [Ohio State bylaws on instruction](http://go.osu.edu/credithours) (go.osu.edu/credithours), students should expect around **3 hours** per week of time spent on direct instruction (instructor content and Carmen activities, for example) in addition to **10 hours** of homework (reading and assignment preparation, for example) to receive a grade of B or above.

Required Materials and/or Technologies

- There is no required textbook for this course.
- Assigned reading materials (typically original research articles and reviews) will be posted on CarmenCanvas.

Recommended/Optional Materials

The following reference books are useful:

- “Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis,” 2nd Edition, by R. A. Copeland. Wiley-VCH. Print ISBN: 9780471359296
- “Enzyme Reaction Mechanisms,” by P. A. Frey and A. D. Hegeman. Oxford University Press, 2007

Exams

Assignment Category	Points
Homework	50 pts
Midterm Exam (Tuesday 2/7/23, 6:00-7:45 pm)	100 pts
Final Exam (Tuesday 2/28/23, 6:00-7:45 pm; comprehensive)	150 pts

Grading Scale

You may expect a grade no worse than the following based on your total score. The class may be curved (up) at the end of the term, if deemed appropriate.

240–300: A	220–239: A-	200–219: B+	180–199: B
150–179: B-	120–149: C+	100–119: C	Below 100: E

Assigned Reading

These are typically original research papers or review articles that will help you understand the topics covered by lectures. They will be labeled as “required reading” and “recommended reading” categories and their PDF files will be posted on Carmen.

Homework

Approximately five homework problem sets will be posted on Carmen (and announced in class) and will be graded for credits (up to 50 points). They are typically due a week after the date of initial assignment and must be uploaded into Carmen as PDF files on or before the due date. Penalty for late turning in is 1 point/day.



Tentative Lecture Schedule:

Date	Topic
1/9/23	Part I: Fundamentals of Enzymatic Catalysis Lecture 1: Introduction to Catalysis – How Do Enzymes Accelerate the Rates of Chemical Reactions?
1/11/23	Lecture 2: Chemical Basis of Enzymatic Catalysis
1/13/23	Lecture 2: Chemical Basis of Enzymatic Catalysis
1/16/23	Martin Luther King Day (no class)
1/18/23	Lecture 2: Chemical Basis of Enzymatic Catalysis
1/20/23	Lecture 3: Mechanism of Coenzyme Catalysis-Part I
1/23/23	Lecture 4: Mechanism of Coenzyme Catalysis-Part II
1/25/23	Lecture 5: Enzyme Classification
1/27/23	Part II: Specific Enzyme Class I - Hydrolytic Enzymes Lecture 6: Serine Proteases – How Do Enzymes Achieve High Substrate Specificity?
1/30/23	Lecture 6: Serine Proteases
2/1/23	Lecture 7: Other Proteases and Peptidases
2/3/23	Lecture 8: The Proteasome – Regulated Protein Degradation
2/6/23	Part III: Enzyme Kinetics and Inhibition Lecture 9: Steady-State Kinetics and Enzyme Assays
2/7/23	Midterm Exam (Tuesday 600-745 pm)
2/8/23	Lecture 10: Enzyme Inhibition and pH Effect
2/10/23	Lecture 11: Pre-Steady-State Kinetics and Kinetic Isotope Effect
2/13/23	Lecture 12: Mechanism-Based Covalent Inhibitors
2/15/23	Part IV: Mechanisms of Biologically and Industrially Important Enzymes Lecture 13: DNA Polymerases – How Do Enzymes Achieve High Fidelity?
2/17/23	Lecture 14: Flavin-Dependent Enzymes
2/20/23	Lecture 15: Heme-Dependent Enzymes – Role in Drug Metabolism
2/22/23	Lecture 16: Non-Heme Iron Enzymes - Histone Modification
2/24/23	Lecture 17: Enzymes in Research, Medicine, and Industry
2/28/23	Final Exam (Tuesday 600-745 pm)

CarmenCanvas Access

You will need to use [BuckeyePass](https://buckeyepass.osu.edu) (buckeyepass.osu.edu) multi-factor authentication to access your courses in Carmen. To ensure that you are able to connect to Carmen at all times, it is recommended that you do each of the following:

- Register multiple devices in case something happens to your primary device. Visit the [BuckeyePass - Adding a Device](https://go.osu.edu/add-device) (go.osu.edu/add-device) help article for step-by-step instructions.
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- [Install the Duo Mobile application](https://go.osu.edu/install-duo) (go.osu.edu/install-duo) on all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.

If none of these options will meet the needs of your situation, you can contact the IT Service Desk at [614-688-4357 \(HELP\)](tel:614-688-4357) and IT support staff will work out a solution with you.

Instructor Feedback and Response Time

I am providing the following list to give you an idea of my intended availability throughout the course. Remember that you can call [614-688-4357 \(HELP\)](tel:614-688-4357) at any time if you have a technical problem.

- **Preferred contact method:** If you have a question, please contact me first through my Ohio State email address. I will try to reply to emails within 24 hours on days when class is in session at the university.
- **Class announcements:** I will send all important class-wide messages through the Announcements tool in CarmenCanvas. Please check [your notification preferences](https://go.osu.edu/canvas-notifications) (go.osu.edu/canvas-notifications) to ensure you receive these messages.
- **Discussion board:** I will check and reply to messages in the discussion boards once mid-week and once at the end of the week.
- **Grading and feedback:** For assignments submitted before the due date, we will try to provide feedback and grades within seven days. Assignments submitted after the due date may have reduced feedback, and grades may take longer to be posted.

Ohio State's Academic Integrity Policy

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's [Code of Student Conduct](https://studentconduct.osu.edu) (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's *Code of Student Conduct* and this syllabus may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's *Code of Student Conduct* is never considered an excuse for academic misconduct, so I recommend that you review the *Code of Student Conduct* and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If COAM determines that you have violated the university's Code of Student Conduct (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in this course and suspension or dismissal from the university. If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

Other sources of information on academic misconduct (integrity) to which you can refer include:

[Committee on Academic Misconduct](http://go.osu.edu/coam) (go.osu.edu/coam)

[Ten Suggestions for Preserving Academic Integrity](http://go.osu.edu/ten-suggestions) (go.osu.edu/ten-suggestions)

[Eight Cardinal Rules of Academic Integrity](http://go.osu.edu/cardinal-rules) (go.osu.edu/cardinal-rules)

Copyright for Instructional Materials

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Creating an Environment Free from Harassment, Discrimination, and Sexual Misconduct

The Ohio State University is committed to building and maintaining a community to reflect diversity and to improve opportunities for all. All Buckeyes have the right to be free from harassment, discrimination, and sexual misconduct. Ohio State does not discriminate on the basis of age, ancestry, color, disability, ethnicity, gender, gender identity or expression, genetic information, HIV/AIDS status, military status, national origin, pregnancy (childbirth, false pregnancy, termination of pregnancy, or recovery therefrom), race, religion, sex, sexual orientation, or protected veteran status, or any other bases under the law, in its activities, academic programs, admission, and employment. Members of the university community also have the right to be free from all forms of sexual misconduct: sexual harassment, sexual assault, relationship violence, stalking, and sexual exploitation.

To report harassment, discrimination, sexual misconduct, or retaliation and/or seek confidential and non-confidential resources and supportive measures, contact the Office of Institutional Equity:

Online reporting form at equity.osu.edu,

Call 614-247-5838 or TTY 614-688-8605,

Or email equity@osu.edu

The university is committed to stopping sexual misconduct, preventing its recurrence, eliminating any hostile environment, and remedying its discriminatory effects. All university employees have reporting responsibilities to the Office of Institutional Equity to ensure the university can take appropriate action:

All university employees, except those exempted by legal privilege of confidentiality or expressly identified as a confidential reporter, have an obligation to report incidents of sexual assault immediately.

The following employees have an obligation to report all other forms of sexual misconduct as soon as practicable but at most within five workdays of becoming aware of such information: 1. Any human resource professional (HRP); 2. Anyone who supervises faculty, staff, students, or volunteers; 3. Chair/director; and 4. Faculty member.

Accessibility Accommodations for Students with Disabilities

Requesting Accommodations

The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with [Student Life Disability Services \(SLDS\)](#). After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. **In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services.**

Disability Services Contact Information

- Phone: [614-292-3307](tel:614-292-3307)
- Website: slds.osu.edu
- Email: slds@osu.edu
- In person: [Baker Hall 098, 113 W. 12th Avenue](#)

Accessibility of Course Technology

This course requires use of CarmenCanvas (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations as early as possible.

[CarmenCanvas accessibility](http://go.osu.edu/canvas-accessibility) (go.osu.edu/canvas-accessibility)

Streaming audio and video

[CarmenZoom accessibility](http://go.osu.edu/zoom-accessibility) (go.osu.edu/zoom-accessibility)