General Course Information

Course Subject, Number and Title
BIOCHEM 719, From Atoms to Molecules

Credits
3

Course Designations and Attributes
Graduate level course

Course Description
Topics covered include protein structure and folding, protein dynamics, biological catalysis, membrane structure and assembly, nucleic acid structure and folding, and bioenergetics. Each topic includes discussion of the primary literature, hypothesis generation, experimental design, data, analysis and interpretation underlying the facts in the textbook. The goal is to help students transition from undergraduate consumers of knowledge to graduate students and future independent scientists who will discover and add new knowledge.

Requisites
Declared in Biochemistry PhD graduate program

Meeting Time and Location
Fall semester, MWF, 9:55am -10:45am, Biochemistry 1116

Instructional Mode
In-person

Specify how Credit Hours are met by the Course
The course involves three 50-minute class sessions every week. Assignments for the class include:

- Readings from the textbook
- Readings from the primary literature in biochemistry
- Homework problems requiring students to analyze and interpret biochemical data, design experiments to test hypotheses, or predict the outcome of experiments based on the material learned in class
- Three take-home exams
- Preparing a written summary and critique (individual), plus an oral presentation to the class (as a team) of a paper drawn from the primary scientific literature

It is expected that these assignments will require 6-8 hours per week outside of class.

Regular and Substantive Student-Instructor Interaction
Regular student-instructor interaction will occur during 3 in-person class periods each week. These classes will include direct instruction in course material and instructor-facilitated discussion of course material. Students will also receive instructor feedback and assessment on three take-home midterm exams and an in-class presentation of a paper from the literature on a topic relevant to the course content.

OTHER COURSE INFORMATION

INSTRUCTORS

Dr. Katherine A. Henzler-Wildman, Professor of Biochemistry

Dr. Ivan Rayment, Professor of Biochemistry

Dr. Sam Butcher, Professor of Biochemistry

Instructor Availability
Office hours for Dr. Henzler-Wildman Mon 11:00am-1:00pm or by appointment
Office hours for Dr. Rayment Monday and Tuesday 11:00am-12:00pm or by appointment

Instructor Email/Preferred Contact
henzlerwildm@wisc.edu
irayment@wisc.edu

COURSE LEARNING OUTCOMES

- Understand the chemical principles underlying the structure, dynamics, interaction, and function of biological molecules
- Design experiments to test a particular hypothesis using various techniques
- Analyze, interpret, test, and share experimental data
- Develop biochemical knowledge from experimental data

GRADING

The class is graded with A-F scale; F is not being used because C is a failing grade. This is graduate level course with multiple, difficult assignments throughout the semester that are graded rigorously. Following is the translation of percentage of points achieved in the course and how that corresponds to a letter grade. Note that IPiB students must achieve a minimum grade of BC in order for this program requirement to be fulfilled:

C	<73 (Must retake class)
BC	73-77
B	78-83
AB	83-88
A	88-100

REQUIRED TEXTBOOK, SOFTWARE & OTHER COURSE MATERIALS

The Molecules of Life: Physical and Chemical Principles, Kuriyan, Konforti & Wemmer, 2013

COURSE WEBSITE

https://canvas.wisc.edu/courses/272606

EXAMS, QUIZZES, PAPERS & OTHER MAJOR GRADED WORK

Paper presentation and written review (20%)
Three take-home midterm exams (20%, 20%, 20%)

HOMEWORK & OTHER ASSIGNMENTS

Problem sets and quizzes assigned by instructors (20%)

OTHER COURSE INFORMATION

Students are expected to attend the IPiB Retreat (held on 9/10) and Biochemistry Colloquia (3:30pm on Mondays in 1211 HF DeLuca Biochemical Sciences Building).

Schedule of Topics and Readings

See the Canvas course page for the schedule of topics and readings

Teaching & Learning Data Transparency Statement

The privacy and security of faculty, staff and students' personal information is a top priority for UW-Madison. The university carefully evaluates and vets all campus-supported digital tools used to support teaching and learning, to help support success through learning analytics, and to enable proctoring capabilities. View the university's full teaching and learning data transparency statement.

Privacy of Student Records & the Use of Audio Recorded Lectures Statement

See more information about privacy of student records and the usage of audio-recorded lectures.

Lecture materials and recordings for this course are protected intellectual property at UW-Madison. Students in this course may use the materials and recordings for their personal use related to participation in this class. Students may also take notes solely for their personal use. If a lecture is not already recorded, you are not authorized to record my lectures without my permission unless you are considered by the university to be a qualified student with a disability requiring accommodation. [Regent Policy Document 4-1] Students may not copy or have lecture materials and recordings outside of class, including posting on internet sites or selling to commercial entities. Students are also prohibited from providing or selling their personal notes to anyone else or being paid for taking notes by any person or commercial firm without the instructor's express written permission. Unauthorized use of these copyrighted lecture materials and recordings constitutes copyright infringement and may be addressed under the university's policies, UWS Chapters 14 and 17, governing student academic and non-academic misconduct.

How to Succeed in This Course

To succeed in the course, students should complete assigned readings, prepare early with their group for their in-class paper presentation, and seek assistance from the instructors if they are

having difficulty understanding any of the course material.

Digital Course Evaluation (AEFIS)
UW-Madison uses a digital course evaluation survey tool called AEFIS. For this course, you will receive an official email two weeks prior to the end of the semester, notifying you that your course evaluation is available. In the email you will receive a link to log into the course evaluation with your NetID. Evaluations are anonymous. Your participation is an integral component of this course, and your feedback is important to me. I strongly encourage you to participate in the course evaluation.

Students' Rules, Rights & Responsibilities

Diversity & Inclusion Statement
Diversity is a source of strength, creativity, and innovation for UW-Madison. We value the contributions of each person and respect the profound ways their identity, culture, background, experience, status, abilities, and opinion enrich the university community. We commit ourselves to the pursuit of excellence in teaching, research, outreach, and diversity as inextricably linked goals. The University of Wisconsin-Madison fulfills its public mission by creating a welcoming and inclusive community for people from every background – people who as students, faculty, and staff serve Wisconsin and the world.

Academic Integrity Statement
By virtue of enrollment, each student agrees to uphold the high academic standards of the University of Wisconsin-Madison; academic misconduct is behavior that negatively impacts the integrity of the institution. Cheating, fabrication, plagiarism, unauthorized collaboration, and helping others commit these previously listed acts are examples of misconduct which may result in disciplinary action. Examples of disciplinary action include, but is not limited to, failure on the assignment/course, written reprimand, disciplinary probation, suspension, or expulsion.

Accommodations for Students with Disabilities Statement
The University of Wisconsin-Madison supports the right of all enrolled students to a full and equal educational opportunity. The Americans with Disabilities Act (ADA), Wisconsin State Statute (36.12), and UW-Madison policy (UW-855) require the university to provide reasonable accommodations to students with disabilities to access and participate in its academic programs and educational services. Faculty and students share responsibility in the accommodation process. Students are expected to inform faculty [me] of their need for instructional accommodations during the beginning of the semester, or as soon as possible after being approved for accommodations. Faculty [I], will work either directly with the student [you] or in coordination with the McBurney Center to provide reasonable instructional and course-related accommodations. Disability information, including instructional accommodations as part of a student's educational record, is confidential and protected under FERPA. (See: McBurney Disability Resource Center)

Academic Calendar & Religious Observances

Protein Structure, Folding and Engineering

9/8 Structure Determination by X-ray Crystallography: Learning to use the PDB (Rayment)

9/10 IPIB Retreat

9/13 Assessing the quality of a crystal structure (Rayment)

9/15 Structure determination by CryoEM (Grant)

9/17 Comparison of X-ray and CryoEM (Kirchdoerfer)

9/20 Protein Folding (Henzler-Wildman)

9/22 Directed evolution of proteins (Romero)

9/24 NMR structure (Rienstra)

9/27 Protein Design (Raman)

Student Presentation 1

9/29 Kerner, *et al.* Proteome-wide analysis of chaperonin-dependent protein folding in Escherichia coli.

Protein Dynamics (Henzler-Wildman)

10/1 Time and length scales of motion

10/4 "Slow" timescale dynamics

10/6 Fast timescales - entropy

10/8 Single molecule versus ensemble measurements (CJ Lim)

Protein-Ligand Interaction (Henzler-Wildman)

10/11 Protein-ligand interaction

10/13 Thermodynamics of protein-ligand interaction

10/15 Kinetics of protein-ligand interaction

10/18 Drug design

10/20 Allostery

Student Presentation 2

10/22 Wilson *et al.* Using ancient protein kinases to unravel a modern cancer drug's mechanism.

Catalysis (Rayment)

10/25 Enzyme Kinetics: Michaelis Menten

10/27 Enzyme Inhibition

10/29 Catalysis Theory

11/1 Catalysis Chemistry

11/3 ATP and Kinases

11/5 Pre-steady state kinetics

11/8 Engineering enzymes (Weeks)

11/10 Dissecting signaling networks using biochemical tools (Coyle)

Student Presentation 3

11/12 Ferrall-Fairbanks, *et al.* Reassessing enzyme kinetics: Considering protease-as-substrate interactions in proteolytic networks

***Midterm 2* due 11/15**

Nucleic Acid Structure & Folding (Butcher)

11/15 DNA structure

11/17 RNA structure

11/19 RNA folding

11/22 Ribozymes

Student Presentation 4

11/24 Kappel, *et al.* Blind tests of RNA-protein binding affinity prediction.

Membrane Structure & Assembly (Henzler-Wildman)

11/29 Lipids & membranes

12/1 Cholesterol and biological membranes

12/3 Membrane protein structure and folding

Signaling & Transport (Henzler-Wildman)

12/6 Primary Active Transport

12/8 Secondary active transport

12/10 Electrical energy – action potentials and channels

12/13 Signaling at the membrane

Student Presentation 5

12/15 Carlson, *et al.* Profiling the *Escherichia coli* membrane protein interactome captured in Peptidisc libraries.

***Midterm 3* due 12/15**