

# BIOCHEMISTRY 6765: ADVANCED PHYSICAL BIOCHEMISTRY

BIOCHEM 6765.02 - AdvBiochm-Physical

TuTh 9:35-10:55 AM (14 weeks) – McPherson Lab 1021

Instructors:

Damien Wilburn, wilburn.120

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Office hours: Wednesday, 1:30 – 3:00 pm, or by appointment – via Video Conference

GTA:

Vaishnavi Sidharthan, sidharthan.1.

Office hours: Wednesday, 11:00 am – 12:00 pm.

## DESCRIPTION:

The course provides an advanced survey of quantitative biophysical methods to reveal macromolecular structure, mechanism and interactions in biochemical sciences. The goal of the course is to equip students with tools and knowledge to read, understand and critique the research literature, and to apply those concepts to their own research.

## COURSE STRUCTURE

Conventional lectures, interactive discussions, and problem solving, individually and in groups; asynchronous viewing of tutorials, recorded instructions; online quizzes; electronically submitted assignments and exams. Class sessions will feature a mixed lecture-discussion format, and engaged participation is essential for learning.

## TOPICS (ORDER MAY VARY)

- Introduction – Physical Measurements in Biology
- Design of Experiments, Measurements, Precision, Analysis, Error
- Computational tools: Data analysis (Python), molecular visualization (PyMOL)
- Molecular Modeling (Dynamics Simulations, Docking)
- NMR Spectroscopy (Basics, Structure Determination, Dynamics)
- Mass Spectrometry
- Single Molecule Methods (SM-FRET, AFM, Tweezers)
- Electronic Spectroscopy (UV-Vis, CD, Fluorescence)
- Thermodynamics (Equilibria, Calorimetry)
- Hydrodynamics (Diffusion, Sedimentation, Light Scattering)
- X-ray Scattering (Crystal Diffraction, Solution Scattering)
- Microscopy (Cryo-EM)

## CLASS MATERIALS

Materials will include assigned text readings, and materials available on-line via Carmen (<http://carmen.osu.edu>). Other sources of information will include the current research literature as well as structural databases.

## PRIMARY TEXT

*Methods in Molecular Biophysics*. Zaccai, Serdyuk & Zaccai. 2<sup>nd</sup> Ed. 2017. ISBN 978-1107056374.

<https://www.amazon.com/Methods-Molecular-Biophysics-Structure-Dynamics/dp/1107056373>

## SUPPLEMENTARY TEXTS:

*The Molecules of Life. Physical and Chemical Principles.* Kuryan, Konforti, Wemmer. 2013. ISBN 9780815341888

*Biophysical Chemistry: Part II: Techniques for the Study of Biological Structure and Function.* Cantor and Schimmel, 1980, ISBN 9780716711902

*Biophysical Techniques,* Iain Campbell, Oxford University Press, 2012. ISBN 9780199642144.  
<http://global.oup.com/uk/orc/biosciences/biochem/campbell/>

## GRADING

Homework assignments (~weekly; 25%), Quizzes (~weekly; 35%), Exams (midterm, final; 40%). Letter grades will be assigned on a curve, on a scale appropriate for an advanced graduate course.

## EXAMS

Exam I: *Take-home, open-book exam, due Thu 3/9*

Exam II: *Take-home, open-book exam. Due Thu 4/20*

## DATA ANALYSIS, PLOTTING, FITTING

We will use computer software (i.e., Python and Jupyter notebooks) to analyze data, perform model fitting using non-linear regression, and discuss how to assess the resulting fit parameters.

## COMPUTER-AIDED STRUCTURE ANALYSIS

We will use of molecular visualization software (e.g., [PyMol](#), [ChimeraX](#)) to learn about macromolecular structure and interactions; details will be posted on Carmen. The use of these software packages requires access to a reasonably modern computer; if you don't have access to such a system, please reach out to the course instructors.

## ASSIGNMENTS

Answers to problem sets should be typeset, not hand-written, and submitted electronically via Carmen as a single PDF. Chemical structures can be drawn using [ChemDraw](#), for which OSU has a [site license](#). Students should become familiar with tools for locating published literature, particularly [PubMed](#), and the use of [the OSU Library Proxy Service](#). Students are also encouraged to work in groups to solve the homework assignments; however, each student must submit their own work.

## QUIZZES

Online quizzes in Carmen will be used throughout the course to evaluate and assess progress and comprehension of the topics covered. Quizzes are NOT group assignments and must be completed individually.

## IN-CLASS ACTIVITIES

Interactive individual and small-group in-class activities will allow students to work in groups to learn, problem solve, and to apply concepts to example problems.

## ACADEMIC INTEGRITY

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term

“academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct <http://studentlife.osu.edu/csc/>.

## ACCESSIBILITY

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. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: [slds@osu.edu](mailto:slds@osu.edu); 614-292-3307; <http://slds.osu.edu>; 098 Baker Hall, 113 W. 12th Avenue.

## PANDEMIC RESPONSE

All students, faculty and staff are required to comply with and stay up to date on all university safety and health guidance (<https://safeandhealthy.osu.edu>).

## YOUR MENTAL HEALTH

As a student, you may experience a range of issues that can cause barriers to learning such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. No matter where you are engaged in distance learning, The Ohio State University's Student Life Counseling and Consultation Service (CCS) is here to support you. If you find yourself feeling isolated, anxious or overwhelmed, on-demand resources are available at [go.osu.edu/ccsondemand](http://go.osu.edu/ccsondemand). You can reach an on-call counselor when CCS is closed at 614-292-5766, and 24-hour emergency help is also available through the 24/7 National Prevention Hotline at 1-800-273-TALK or at [suicidepreventionlifeline.org](http://suicidepreventionlifeline.org). [The Ohio State: Wellness app](#) is also a great resource.

- Resources for students are included on the [Ohio State: Wellness app](#). The Ohio State: Wellness app is designed for students but offers tips and guidance useful for all members of our community. It is available for [Android](#) and [iOS](#) devices.
- The university has also created a site to assist students as they adapt to this new virtual environment: [Keep Learning](#).

The instructors and TAs are here to support your learning in this course; our goal is for you to be successful. Do read ahead, attend class meeting, and don't be discouraged if you find the material challenging.

## TITLE IX – ADDRESSING SEXUAL MISCONDUCT:

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by contacting the Ohio State Title IX Coordinator at [titleix@osu.edu](mailto:titleix@osu.edu)

Biochem 6765.02 – Syllabus

DRAFT LECTURE PLAN

(Subject to change)

Date	Day	Topic	Reading	Assignment
2023-01-10	Tue	Introduction		
2023-01-12	Thu	Sampling, statistics, error, uncertainty		Quiz 1
2023-01-17	Tue	Data fitting		Asg 1
2023-01-19	Thu	Python and Jupyter notebooks		Quiz 2
2023-01-24	Tue	Electronic Spectroscopy	ZSZ E	Asg 2
2023-01-26	Thu	Electronic Spectroscopy		Quiz 3
2023-01-31	Tue	Thermodynamics	ZSZ C, TMOL 10.25-29	Asg 3
2023-02-02	Thu	Thermodynamics		Quiz 4
2023-02-07	Tue	Thermodynamics		Asg 4
2023-02-09	Thu	Hydrodynamics — Diffusion & Sedimentation	ZSZ D, TMOL 17	Quiz 5
2023-02-14	Tue	Hydrodynamics — Diffusion & Sedimentation		Asg 5
2023-02-16	Thu	Solution Scattering (SAXS)	ZSZ G1-2	Quiz 6
2023-02-21	Tue	X-ray Crystallography	ZSZ G3	Asg 6
2023-02-23	Thu	X-ray Crystallography		Quiz 7
2023-02-28	Tue	X-ray Crystallography		Asg 7
2023-03-02	Thu	Electron Microscopy (Cryo-EM)	ZXZ H	Quiz 8
2023-03-07	Tue	Electron Microscopy (Cryo-EM)		Asg 8
2023-03-09	Thu	Electron Microscopy (Cryo-EM)	<b>Exam I due (take-home)</b>	Exam I
2023-03-14	Tue	<i>Spring Break</i>		-
2023-03-16	Thu	<i>Spring Break</i>		-
2023-03-21	Tue	Molecular visualization		Quiz 9
2023-03-23	Thu	Molecular modeling (MD, docking, prediction)		Asg 9
2023-03-28	Tue	NMR Fundamentals (FT, 1D)		Quiz 10
2023-03-30	Thu	NMR nD, heteronuclear, NOESY, HSQC		Asg 10
2023-04-04	Tue	NMR nD continued; assignments		Qui 11
2023-04-06	Thu	NMR relaxation, dynamics, and exchange		Asg 11
2023-04-11	Tue	NMR structure determination		Quiz 12
2023-04-13	Thu	NMR data processing		Asg 12
2023-04-18	Tue	Mass spectrometry		Quiz 13
2023-04-20	Thu	Single molecule methods	<b>Exam II (take-home)</b>	Exam II