

# Physics 205 – Cell and Molecular Biophysics

Spring 2024

Welcome to Cell and Molecular Biophysics. This course will hopefully be useful, informative, and a lot of fun.

*Basic Question of the course: In a world where everything naturally tends towards disorder, if you drop a teacup and it breaks it will never spontaneously reassemble itself, how is order created in living systems?*

## COURSE DESCRIPTION:

This course draws on concepts and tools from physics, biology, and chemistry to understand how energy is transformed into order in living systems. This will require students to consider the roles evolution, polymer physics, and chemistry have played in shaping the machinery of life. This course is aimed at students from physics, biology, and chemistry who are interested in stretching themselves beyond disciplinary boundaries. **This course is approved as both an interdisciplinary (“I”) and speaking emphasis (“SE”) course in WCU’s general education program.**

## PREREQUISITES:

As an interdisciplinary course, we need to know something about the disciplines involved. This course therefore has the following prerequisites: CHE 103, PHY 130 **or** PHY 170, any **one of** MAT 161 or MAT 145 or MAT 143.

## COREQUISITES:

Second Semester Physics: PHY 140 or PHY 180

## GENERAL EDUCATION INFORMATION:

This course is an approved interdisciplinary (“I”) and speaking emphasis (“S”) course in the West Chester University general education program.

The general education goals for this course are:

- (WCUPA Gen Ed. Goal #1) Communicate Effectively. In this course the student learning outcomes associated with this goal are:
  - Express oneself effectively in presentations. (This will be assessed through your final project presentation, and your presentation at the mock poster-session. See assignment list below.)
  - Demonstrate comprehension of and ability to explain information and ideas accessed through reading. (This will be primarily assessed through your final project presentation, and your presentation at the mock poster-session. See assignment list below.)

*AS a speaking emphasis course we will be working explicitly on your ability to present scientific information in a public setting. Please see the rubrics and project description at the end of this syllabus.*

(WCUPA Gen. Ed. Goal #2) Think critically and analytically. In this course the student learning outcomes associated with this goal are:

- Use relevant evidence gathered through accepted scholarly methods, and properly acknowledge sources of information, to support an idea. (This will be assessed through homework assignments,

exams, your final project presentation, and your poster for the mock poster-session. See assignment list below.)

- Reach sound conclusions based on a logical analysis of evidence. (This will be assessed through homework assignments, exams, your final project presentation, and your poster for the mock poster-session. See assignment list below.)
- (WCUPA Gen. Ed. Goal #4, for interdisciplinary courses) demonstrate the ability to think across and about disciplinary boundaries. The student learning outcomes for this goal are:
  - Synthesize and/or integrate information, and/or approaches from multiple disciplines in the investigation of a concept or problem. (This will be assessed through homework assignments, exams, your final project presentation, and your poster for the mock poster-session. See assignment list below.)
- Demonstrate the ability to appreciate how a given topic is informed and/or influenced by multiple disciplines simultaneously. (This will primarily be assessed via the final project.)

**COURSE MEETING TIME AND PLACE:**

Meeting Time	Location
M/W/F 9:00-9:50 am	SECC 208

**INSTRUCTOR INFORMATION:**

Dr. Shawn H. Pfeil  
 e-mail: [spfeil@wcupa.edu](mailto:spfeil@wcupa.edu) (please include course in subject line)  
 phone: (610) 430-4084  
 office: SECC 363

**OFFICE HOURS:**

My office hours as of the first day of class are....

	Monday	Tuesday	Wednesday	Thursday	Friday
SECC 363 (my office)	10-11 am	10-11 am	11 am – 1 pm	10-11 am	Research Day <b>NO OFFICE HOURS</b>

*Office hours are available by appointment for students with an ongoing conflict with my scheduled hours.*

**REQUIRED TEXT:**

- **Biological Physics Student Edition: Energy, Information, Life**, Philip Nelson, Chiliagon Science.
  - Please see Prof. Nelson’s website <https://www.physics.upenn.edu/biophys/BPse/> for ISBN information, errata. A paperback version of the text is available for ~\$30.00 and an e-book version is available for approximately ~\$10.

**OTHER TEXTS (BIBLIOGRAPHY):**

- **Designing Science Presentations: A Visual Guide to Figures, Papers, Slides, Posters, and More 1st Edition**, Matt Carter. *This is the text the physics department uses in PHY 310 and PHY 455 as a guide to scientific presentations. If you are planning on taking that class, you might want to pick a copy up early. Otherwise, we’ll pull some excerpts from it.*

- **Physical Biology of the Cell 2<sup>nd</sup> Edition**, R. Phillips, J. Kondev, J. Theriot and H.G. Garcia, Garland Science (2013) *I'll often pull material from this text. It was a close runner up to use for the course, but is both more expensive and a little too high level for a 200-level course.*
- **Molecular Biology of the Cell**, Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Water, Garland Science. *This or another cell biology book would be a good reference. If you have a Cell Bio textbook from a previous course...it would be useful to keep it handy.*
- **Biochemistry 7<sup>th</sup> Edition**, Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, W.H. Freeman Company
- **Random Walks in Biology**, Howard C. Berg.

### **GRADING:**

- **Problem Sets:** (20%) Most every Monday we will have a problem set due on D2L under assignments. Please scan your work to a single PDF and upload it. Occasionally you will be asked to use software such as Chimera to visualize molecules. Directions on how to upload the results to D2L will be provided. *Late homework will receive a 25% penalty.*
- **Exams:** (50%) This course will have three regular exams each worth 18% of the final course grade.
- **Final Project** (30%), Please see attached guidelines. Component due dates are on the course schedule.

**We will be using the official WCU scale for grades, see the undergraduate catalog.** However, I reserve the right to adjust the weights of individual components, or the scale to account for unforeseen circumstances.

Date (mm/dd)	Day	Topic	Lecture #	Reading	Due Dates
01/22	M	Course Introduction	0	None	
Week 1	W	Metaphors and Models	1	1.1-1.2	
	F	Ideas from Chemistry and Physics, Interdisciplinarity	2	1.3-1.5	
01/29	M	What is inside cells Part I	3	2.1-2.2	HW 1: CH 1
Week 2	W1	What is inside cells Part II	4	2.2-2.3	
	F	Probability Distributions	5	3.1-3.2	
02/05	M	Probability and Heredity	6	3.3-3.4	HW 2: CH 2
Week 3	W	Random Walk	7	4.1-4.2	
	F	Other Random Walks (Polymers and Stocks)	8	4.3	
02/12	M	Fick's Law and Diffusion, Application	9	4.4	HW 3: CH 3
Week 4	W	Biological Applications of Diffusion	10	Excerpts from Berg.	
	F	Friction in Fluids	11	5.1-5.2	
02/19	M	Applications of Fluid Friction in Biology	12	5.3-5.4	HW 4: CH 4
Week 5	W	<i>Review/Makeup/Flex Day</i>			
	F	<b>Exam 1: Chapters 1-4</b>			
02/26	M	How to Measure Disorder, Entropy	13	6.1-6.2	HW 5: CH5
Week 6	W	Temperature and the 2 <sup>nd</sup> Law	14	6.3-6.4	
	F	Open Systems and Free-Energy	15	6.5-6.6	
3/04 Week 7	M	Microscopic Systems, Partition Functions	16	6.6	HW 6: CH 6
	W	RNA Folding and other Two-State Systems	17	6.7	
	F	<a href="#">Speaking in Science: Story and Design</a>			Project Topics Due
03/11		<b>SPRING BREAK</b>			
Week 8					
03/18	M	Entropic Forces and Osmotic Pressure	18	7.1-7.2	NO HW Project Approvals Returned
Week 9	W	Osmotic Flow	19	7.3	
	F	Electrostatics in Salty Water	20	7.4	
03/25	M	Special Properties of Water and the Hydrophobic Effect	21	7.5/Excerpt	Project Slides Due
Week 10	W	Road to Self-Assembly: Chemical Potential	22	8.1	
	F	<i>Review/Makeup/Flex Day</i>			
04/01	M	Road to Self-Assembly: Chemical Reactions	23	8.2	HW 7: CH 7 Slide Critique Returned
Week 11	W	Dissociation/Gel Electrophoresis	24	8.3	
	F	<b>Exam 2: CH 5-7</b>			
04/08	M	Self-Assembly and Lipid Bilayers	25	8.4-8.6	Draft Talk Video Due
Week 12	W	Polymer Elasticity	26	9.1	
	F	Stretching Single Macromolecules	27	9.2	

4/15	M	Linear Algebra Reminder/Cooperativity	28	9.3-9.4	HW 8 Due: CH 8
Week 13	W	Thermal, Chemical, and Mechanical Switching	29	9.5	
	F	Allostery, Hemoglobin, Sharp Switches	30	9.6	
4/22	M	Effective Posters/Talk Conferences		None	HW 9 Due: CH 9 Draft Video Returned
Week 14	W	Enzymes and Molecular Machines a Survey	31	10.1	
	F	<b>Exam 3: CH 8-9</b>			
4/29	M	Flex Day/Presentation Office Hours			
Week 15	W	<b>Presentations</b>			
	F	<b>Presentations</b>			Draft Poster Due
05/08 Finals Period	W	<b>8:00-10:00 AM, Moch Poster Session</b>			Poster Presentation Due

## COURSE SPECIFIC POLICY STATEMENTS

### ATTENDANCE POLICY:

You are required to attend your fellow students' presentations. Failure to do so will result in your own final presentation grade being penalized, with a maximum penalty of 5% of the overall course grade. (Excused absences will not incur a penalty.) I do not grade on attendance for the regular lecture portion of the course, but failure to attend is strongly linked to poor performance on homework and exams.

### INTELLECTUAL PROPERTY STATEMENT:

I, the instructor, utilize copyrighted materials under the "Freedom and Innovation Revitalizing the United States Entrepreneurship Act of 2007" (Fair Use Act). Apart from such copyrighted materials, all other intellectual property associated with this course is owned and copyrighted by the instructor, including, but not limited to, lectures, course discussions, course notes, slides, assessment instruments such as exams, and supplementary materials posted or provided to students authored by the instructor. No recording, copying, storage in a retrieval system, or dissemination in any form by any means of the intellectual property of the instructor, in whole or in part, is permitted without prior written permission of the instructor. When such permission is granted, it must specify the utilization of the intellectual property and all such permissions and waivers shall terminate on the last day of finals of the semester in which this course is held.

### ACADEMIC & PERSONAL INTEGRITY

It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your own work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your own work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Undergraduate Handbook, the Undergraduate Catalog, the Ram's Eye View, and the University website at [www.wcupa.edu](http://www.wcupa.edu).

### ONLINE RESOURCES AND ACADEMIC INTEGRITY:

Posting of any of the homework or exam questions from this course to Chegg, Course Hero, or any other site where solutions are made available for a fee is a violation of the academic integrity policy. Copying solutions to problems from these websites is a form of plagiarism since any student that does so passes off others' work as their own. Solutions from any website which charges fees counts as buying solutions. Posting any materials which I have written, i.e., any exam questions in the course, is a violation of both academic integrity and a misuse of my intellectual property. Posting or accessing any exam course exam questions on these sites, at any time, will result in sanctions up to and including an F in the course.

## **ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES**

West Chester University is committed to providing equitable access to the full WCU experience for Golden Rams of all abilities. Students should contact the Office of Educational Accessibility (OEA) to establish accommodations if they have had accommodations in the past or if they believe they may be eligible for accommodations due to a disability, whether or not it may be readily apparent. There is no deadline for disclosing to OEA or for requesting to use approved accommodations in a given course. However, accommodations can only be applied to future assignments or exams; that is, they can't be applied retroactively. Please share your letter from OEA as soon as possible so that we can discuss accommodations. If you have concerns related to disability discrimination, please contact the university's ADA Coordinator in the Office of Diversity, Equity, and Inclusion: <https://www.wcupa.edu/admin/diversityEquityInclusion/> or 610-436-2433.

## **EXCUSED ABSENCES POLICY**

Students are advised to carefully read and comply with the excused absences policy, including absences for university-sanctioned events, contained in the WCU Undergraduate Catalog. In particular, please note that the "responsibility for meeting academic requirements rests with the student," that this policy does not excuse students from completing required academic work, and that professors can require a "fair alternative" to attendance on those days that students must be absent from class in order to participate in a University-Sanctioned Event.

## **REPORTING INCIDENTS OF SEXUAL VIOLENCE**

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to comply with the requirements of Title IX of the Education Amendments of 1972 and the University's commitment to offering supportive measures in accordance with the new regulations issued under Title IX, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. **Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University Protection of Minors Policy.** Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at: <https://www.wcupa.edu/admin/diversityEquityInclusion/sexualMisconduct/default.aspx>

## **INCLUSIVE LEARNING ENVIRONMENT AND ANTI-RACIST STATEMENT**

Diversity, equity, and inclusion are central to West Chester University's mission as reflected in our [Mission Statement](#), [Values Statement](#), [Vision Statement](#) and [Strategic Plan: Pathways to Student Success](#). We disavow racism and all actions that silence, threaten, or degrade historically marginalized groups in the U.S. We acknowledge that all members of this learning community may experience harm stemming from forms of oppression including but not limited to classism, ableism, heterosexism, sexism, Islamophobia, anti-Semitism, and xenophobia, and recognize that these forms of oppression are compounded by racism.

Our core commitment as an institution of higher education shapes our expectation for behavior within this learning community, which represents diverse individual beliefs, backgrounds, and experiences. Courteous and respectful behavior, interactions, and responses are expected from all members of the University. We must work together to make this a safe and productive learning environment for everyone. Part of this work is recognizing how race and other aspects of who we are shape our beliefs and our experiences as individuals. It is not enough to condemn acts of racism. For real, sustainable change, we must stand together as a diverse coalition against racism and oppression of any form, anywhere, at any time.

Resources for education and action are available through WCU's [Office for Diversity, Equity, and Inclusion](#) (ODEI), DEI committees within departments or colleges, the student [ombudsperson](#), and centers on campus committed to doing this work (e.g., [Dowdy Multicultural Center](#), [Center for Women and Gender Equity](#), and the [Center for Trans and Queer Advocacy](#)).

Guidance on how to report incidents of discrimination and harassment is available at the University's [Office of Diversity, Equity and Inclusion](#).

## **EMERGENCY PREPAREDNESS**

All students are encouraged to sign up for the University's free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit [www.wcupa.edu/wcualert](http://www.wcupa.edu/wcualert). To report an emergency, call the Department of Public Safety at 610-436-3311.

## **ELECTRONIC MAIL POLICY**

It is expected that faculty, staff, and students activate and maintain regular access to University provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.

## **ALL OTHER ACADEMIC POLICIES**

For any university wide academic policy not explicitly covered in this document, such as No Grade policies. Please consult your major advising handbook, the Undergraduate Catalog, the Ram's Eye View, or the University Website.

## **PHY 205: Molecular Biophysics Final Projects**

In lieu of a final exam, you will be responsible for investigating and presenting a brief introduction to a topic in biophysics we have not covered or diving deeper into a topic we have covered. You may either choose from a list of possible topics I will provide or propose your own topic. The first component of your project which is due is the:

- ***Project Proposal (2% of final project grade).*** You will provide a one-page written proposal for your final project.
  - A one paragraph description of what you are proposing to discuss.
  - A one paragraph description of how you will integrate biology, chemistry and physics to address the topic.
  - A list of references.
  - *I will not accept any other components of the project until you submit a project proposal and get it approved. Late project proposals will suffer a 50% penalty.*

The next component due is:

- **Project Talk: Slide Draft (3% of final project grade).** You will turn in a draft of your slides for a 10-minute presentation (about 5 slides). Feedback will be given on slide design and appropriateness. *A late penalty of 50% will be assessed for late slides. Please see the schedule. I will not accept the next component until this one has been returned.*
- **Video Draft (15% of final project grade).** You will turn in a draft of a 10-minute presentation on your topic to the class. This will include the following components:
  - The slides you will be presenting as a PDF or PowerPoint file (turned in on D2L).
  - A video recording of you presenting these slides (turned in on D2L).Your talk must include:
  1. A description of the phenomena being modeled.
  2. A description of the physical, chemical, and biological aspects of the phenomena.
  3. A summary of the results of the model and how they agree or disagree with experiments.
  4. A brief description of how the model can be extended.
  5. A bibliography slide.

I will provide you with feedback on both the scientific content of your talk, and on your scientific public speaking. Please see the rubric at the end of this document.

You will revise your presentation based on the feedback you receive. Then you will present to the class (see course schedule)

- **In Class Talk (30% of final project grade.)** On your assigned class meeting during the last two weeks, you will present your 10-minute presentation. You will also be responsible for fielding several minutes of questions. *I will record these presentations to upload to your e-portfolio.* In addition to presenting in class you must also:
  - Turn in a copy of your final slides on D2L.
  - Upload a copy of your final slides to your e-portfolio.

I will provide you with written feedback on your presentation prior to the mock poster session.

Finally, during the final exam period you will present a research poster formatted version of your presentation.

- **Poster Draft (5% of final project grade).** You will provide a draft of the poster you will be presenting as a PowerPoint or PDF file for feedback. Feedback will be provided prior to the final exam period. The rough draft must be complete (all figures and text).
- **Poster Presentation (45% of final project grade.)** You will create a research style poster to present your topic. For this portion of the final project, you will be graded on.
  - The scientific content of your poster. This is the final revision for content.
  - Effectively incorporating feedback from the rough draft of the poster.
  - Your public speaking skills at our mock poster session. You will be both graded on and receive feedback on your ability to communicate effectively in the semi-formal/informal environment of a poster session.

I will provide you with written feedback about the mock poster session via e-mail during finals week.