Thomas C. Jenkins Department of

BIOPHYSICS

---Undergraduate Advising Manual---

I JHU Biophysics

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biophysics.jhu.edu

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1. Introduction

Welcome to the Department of Biophysics!

Johns Hopkins University was one of the first institutions in the country to establish Biophysics as an independent discipline and to have a department dedicated to studying biology using the tools and approaches of physics and physical chemistry.

The Thomas C. Jenkins Department of Biophysics has a long tradition of excellence in research and teaching, and of developing leaders in the scientific community. We are proud of the role the Jenkins Department has played in advancing biophysics and we invite you to learn more about us.

1.1 What is Biophysics?

Biophysics is the application of the laws of physics to biological phenomena. Biophysics uses the languages of math and computation in seeking to describe biology in quantitative terms. As such, biophysics has been referred to as a bridge between biology and physics.

Studies in the discipline of biophysics are particularly timely and important because biology is currently undergoing an incredible transformation. We now can determine know the entire DNA sequence of a person. For $99 anyone can have snippets of their genome sequence determined and their ancestry revealed or potential illnesses predicted from this information.[1] A complete catalog of all molecules is being assembled, ranging from the great to the small in millions of organisms, and from all kingdoms of life. The grand intellectual challenges in biology for the 21st century will be to understand how all the molecules in a cell interact to give rise to the living state, to envision how life emerges from the interactions among molecules, and to know how life originated and how it continues to evolve.

Because the field of biology is transforming from an observational and phenomenological science into a quantitative and physical one, Johns Hopkins is fortunate to have a Biophysics department and a strong, vibrant and active community of biophysicists already focused on the study of biology from the quantitative and physical perspectives.

2. Program Mission and Objectives

The Hopkins major in biophysics has always been a rigorous and challenging major that attracts students interested in biology who are not afraid of mathematics, physics, and computation. The goal of the major is to achieve true integration between biology, chemistry, physics, mathematics and computation, and our majors are required to become competent in all five areas.

However, interdisciplinary education is not just a matter of taking courses in different departments. The strength of our major is that we integrate all these scientific areas. This is accomplished through our courses in biophysics, in our advanced laboratory course, and through

[1] 23andme.com, whole genome SNP service

our independent research requirement. Key to our goal is the fact that our courses emphasize concepts and problem solving over memorization. We train our students to become thinkers who will have the quantitative skills and technical abilities to address any biological problem at hand.

Another unique aspect of Biophysics is the close contact between majors and the faculty in the Biophysics Department. As faculty we provide our majors with individualized and personal mentorship, rivaling that available at small, first-rate private liberal colleges. Our upper-level courses are small, and the intimate contact between faculty and students both inside and outside the classroom allows us to get to know the students well and *vice versa*.

2.1 Who are the Biophysics undergraduates?

Because the major attracts outstanding students who are interested in biology and comfortable with mathematics and physics, the undergraduate biophysics majors enjoy and appreciate the highly interdisciplinary training. It is usual for the average GPA of our graduating class to qualify for University Honors. A disproportionate number of Biophysics majors are elected to Phi Beta Kappa every year. They have a very high success rate of acceptance to medical and graduate schools.

Over and above their excellent academics, our majors are generally a happy and cohesive set of students. They form study groups and help each other master concepts from class and complete assignments. This sense of camaraderie and teamwork translates back into the classroom and into one-on-one interactions between majors and faculty; indeed, teaching and working with biophysics majors is a pleasure for the faculty.

2.2 What do the Biophysics undergraduate alumni do?

Biophysics majors typically go to medical (70%) or doctoral (15-20%) or combined MD/PhD (5%) programs after graduation. Medical schools that the recent graduates have attended include Albert Einstein, Columbia, Harvard, Johns Hopkins, Stanford, Univ. Chicago, Univ. Maryland, and Yale. Graduate schools that recent graduates have attended include Harvard, Yale, New York Univ., Stanford, UC Berkeley, UC San Francisco, Univ. of Chicago, and Washington Univ, in St. Louis.

3. Resources for Students

3.1 The Jenkins Faculty

The Jenkins faculty members are the main resources for prospective majors. We are a friendly department who love what we do, and we encourage you to email any of us if you have questions about the major or the classes we teach.

3.2 Current Biophysics Majors

In addition, our upperclassmen are always eager to share their enthusiasm for the biophysics major. Freshmen have opportunities to meet upper classmen as teaching assistants in our classes and at our biophysics parties or poster sessions. We also run an informal mentoring program whereby freshmen with specific questions who want to seek the opinions of upper classmen can be put in touch with them by simply emailing the DUS to ask for Biophysics senior contact information.

3.3 Undergraduate Newsletters

Prospective majors can obtain a sense for who our majors are from our undergraduate newsletters. The spring versions contain "senior profiles" and highlight the graduating class each year. The newsletters are printed and available in the main hall of Jenkins across from 110.

3.4 Our Undergraduate Alumni

Because they love their experience here so much, our alumni are happy to serve as a resource for our current majors. This can be especially helpful for our upper classmen as they contemplate graduate or medical schools. The DUS maintains a list of undergraduate alumni who have agreed to be contacted by current students.

3.5 Social Media

3.5.1 JHU BiPhi ϕϕ Facebook Page

Current majors take part in the undergraduate Facebook page, where you can play Biophysics Bingo, view Biophysics majors doing an interpretive dance modelling the helix coil transition, get a ride to the annual Biophysical Society meeting, or view the Fourier transform of a cat.

https://www.facebook.com/groups/220752411311415/

Many of our alumni are also members of this Facebook group, and this can be a good way to meet your cohorts and learn what they are doing after graduation.

4. Departmental Advising Procedures

4.1 Faculty Advisors

Once you declare biophysics as your major, a full-time faculty member in the Jenkins Department of Biophysics will serve as your academic advisor. We are genuinely interested in your success, and we want to help you find a set of course work that meets your interests.

4.1.1 Meetings with your faculty advisor

As current majors you will generally meet with your advisors at least once each semester to plan your courses for the upcoming semester and to discuss current courses. Before registration, the JHU registrar's office places a hold on all student accounts. This hold will be released by your faculty advisor upon completion of a meeting with them.

It is important that you email your faculty advisor in a timely manner to set up an appointment to meet with him or her. "Showing up" in a faculty member's office can sometimes result in a meeting, but the conversation will be much more productive if both of you have advanced notice for a meeting and can be prepared. Contact information for the faculty can be found in Section 10 or on the web site.

4.1.2 What to bring to an advisor meeting?

You will get the most out of your Hopkins experience if you learn to plan your schedule in advance. Therefore, the most important planning tool to accomplish this is to consult the degree audit for the major. Because degree audit is now exclusively online, it is helpful if you can bring your laptop with you to your advisor meeting.

The instructions for degree audit can be found on this site:

https://advising.jhu.edu/completing-your-degree/degree-auditing/

4.1.3 Obtaining a faculty advisor as a freshman

Although Johns Hopkins does not generally allow freshmen to declare a subject major, freshmen (pre-majors) interested in the major should feel free to email the Director of Undergraduate Studies (DUS) to set up a meeting to discuss their interests and current course plan and how the biophysics major can fit with their goals.

Many freshmen declare biophysics as their major during the spring. When this happens—usually in late April—the JHU Advising office forwards their names the Biophysics DUS, and they are assigned faculty advisors. The DUS then emails advisor's name and email address to the entering major. Upon receiving this email, entering majors should email their new advisors to arrange a meeting to discuss plans for sophomore year.

4.1.4 Switching into biophysics as an upperclassman

If you are currently an upperclassman and wish to major in biophysics, stop by the registrar's office to obtain a "change of major" form and email the biophysics DUS to set up an appointment to discuss your long-term goals and how your past course work fits the major requirements. The DUS will also assign you, a faculty advisor assignment and sign your change of major form at this meeting.

Students typically transfer to Biophysics from majors in Molecular & Cellular Biology, Chemical & Biomolecular Engineering, Chemistry, and Physics. Transfers are typically during the sophomore year, although transfers are still possible in the junior year depending on completed course work.

5. Examples of Paths for Completion of the Major

The following two sections (5.1 and 5.2) show examples for completion of the biophysics major for incoming students without AP credits. Section 5.3 lists Biophysics courses that are appropriate for freshmen with AP credits.

5.1 For the Biophysics Major with the Goal of pursuing Graduate School

Freshman Year Fall		
030.101	Intro Chemistry I	3
030.105	Intro Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics I Lab	1
H/S Elective	H/S Elective	3
	Semester Credits	**16**
	Cumulative Credits	*16*

Freshman Year Spring		
030.102	Intro Chemistry II	3
030.106	Intro Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
173.112	General Physics II Lab	1
H/S Elective	H/S Elective	4
	Semester Credits	**17**
	Cumulative Credits	*33*

Sophomore Year Fall		
030.205	Organic Chemistry I	4
110.202	Calculus III	4
250.253	Protein Engineering and Biochem Lab (PEBL)	3
H/S Elective	H/S Elective	6
	Semester Credits	**17**
	Cumulative Credits	*50*

Sophomore Year Spring		
030.206	Organic Chemistry II	4
110.201	Linear Algebra	4
250.372	Biophysical Chemistry	4
250.205	Intro Scientific Comp[1]	3
	Semester Credits	**15**
	Cumulative Credits	*65*

Junior Year Fall		
250.315	Biochemistry I	4
250.302	Modeling the Living Cell	4
250.521	Research Problems	3
171.310	Biological Physics	4
H/S Elective	H/S Elective	2
	Semester Credits	**17**
	Cumulative Credits	*82*

Junior Year Spring		
250.316	Biochemistry II	3
250.383	Mol Biophysics Lab[2]	3
250.522	Research Problems	3
H/S Elective	H/S Elective	6
	Semester Credits	**15**
	Cumulative Credits	*96*

Senior Year Fall		
List 1/2 Elective	*One of the following is recommended:*	3
250.421	Adv Sem Membrane Proteins	
Elective	Open Elective	6
H/S Elective	H/S Elective	3
	Semester Credits	**12**
	Cumulative Credits	*108*

Senior Year Spring		
List 1/2 Elective	*One of the following is recommended:*	3
250.411 *or* 250.401	Adv Sem Structural Biology of Chromatin[2] Adv Sem Macromolecular binding[2]	
250.381	Spectroscopy	3
Open	Open Elective	6
	Semester Credits	**12**
	Cumulative Credits	*120*

5.2 For the Biophysics Major with the Goal of pursuing Medical School

Freshman Year Fall		
030.101	Intro Chemistry I	3
030.105	Intro Chemistry I Lab	1
110.108	Calculus I	4
171.101	General Physics I	4
173.111	General Physics I Lab	1
H/S Elective	H/S Elective	3
	Semester Credits	**16**
	Cumulative Credits	*16*

Freshman Year Spring		
030.102	Intro Chemistry II	3
030.106	Intro Chemistry II Lab	1
110.109	Calculus II	4
171.102	General Physics II	4
173.112	General Physics II Lab	1
H/S Elective	H/S Elective	4
	Semester Credits	**17**
	Cumulative Credits	*33*

Sophomore Year Fall		
030.205	Organic Chemistry I	4
030.225	Intro Organic Chem Lab	3
110.202	Calculus III	4
250.253	Prot Eng & Biochem Lab[1]	3
H/S Elective	H/S Elective	3
	Semester Credits	**17**
	Cumulative Credits	*50*

Sophomore Year Spring		
030.206	Organic Chemistry II	4
110.201	Linear Algebra	4
350.372	Biophysical Chemistry	4
250.205	Intro Scientific Comp[1]	3
	Semester Credits	**15**
	Cumulative Credits	*65*

Junior Year Fall		
250.315	Biochemistry I	4
250.302	Modeling the Living Cell	4
171.310	Biological Physics	4
250.521	Research Problems	3
H/S Elective	H/S Elective	2
	Semester Credits	**17**
	Cumulative Credits	*82*

Junior Year Spring		
250.316	Biochemistry II	3
250.383	Mol Biophysics Lab[2]	3
250.522	Research Problems	3
H/S Elective	H/S Elective	3
Open	Open Elective	3
	Semester Credits	**15**
	Cumulative Credits	*96*

Senior Year Fall		
List 1 elective	Two of the following is recommended:	6
250.421	Adv Sem Membrane Proteins	
550.311	Probability & Statistics for Biological Sciences	
H/S Elective	H/S Elective	3
	Semester Credits	3
	Cumulative Credits	**12**
		108

Senior Year Spring		
List 1 elective	One of the following is recommended:	3
250.411 *or* 250.401	Adv Sem Structural Biology of Chromatin[2] Adv Sem Macromolecular Binding[2]	
H/S Elective	H/S Elective	6
250.381	Spectroscopy	3
	Semester Credits	**12**
	Cumulative Credits	*120*

5.3 Courses suitable for freshmen with AP credits who intend to major in biophysics

The JHU Office of Academic Advising maintains policies about acceptance and equivalencies of AP credits for incoming freshmen. The Jenkins Biophysics department follows their guidelines and accepts their recommendations regarding AP credits for required courses.

The following biophysics courses are suitable for freshmen with AP credits and will allow those students to get started on completing the requirements for the major.

AS.250.205 Introduction to Computing (Fall or Spring)

This course has no pre-requisites, and no special permission is required for freshmen to take it.

6. Degree Checklists

The JHU Office of Academic Advising maintains an up-to-date listing of requirements for the Biophysics major:

https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biophysics/

https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biophysics/biophysics-bachelor-arts/

The e-catalogue is used for Degree Audit (graduation requirements) and this is what the University follows. Please check this, as it can change from year-to-year.

7. Degree Requirements

NEW For JHU students entering Fall 2024, the degree requirements have been reduced significantly in accord with the new vision of the CUE2 undergraduate curriculum tailored to 6 Foundational Abilities. Students who entered JHU prior to Fall 2024 need to follow the earlier curriculum.

7.1 Curriculum

Classes below are required for all students, except requirements unique to Pre-2024 admits are highlighted in red text.

7.1.1 Required Chemistry Courses

The biophysics major requires 6 courses in chemistry.

1. AS.030.101 Introductory Chemistry I
2. AS.030.102 Introductory Chemistry II
3. AS.030.105 Introductory Chemistry Laboratory I
4. AS.030.106 Introductory Chemistry Laboratory II

5. AS.030.205 Organic Chemistry I
6. AS.030.206 Organic Chemistry II with Biochemistry (preferred choice)
   or
   AS.030.212 Advanced Organic Chemistry

7.1.2 Required Physics Courses

The biophysics major requires 4 courses in physics:

1 first year physics lecture series (2 courses);
1 first year physics lab series (2 courses); and

For the first-year physics lecture series, there are four options. All of these are accepted by the Biophysics major, however the preferred series is Option 1 (traditional didactic format) or Option 2 (flipped format) below:

First Year Physics Option 1:

1. AS.171.101 General Physics: Physical Science Major I
   and
2. AS.171.102 General Physics: Physical Science Major II

OR

First Year Physics Option 2:

1. AS.171.107 General Physics for Physical Science Majors I (AL)
   and
2. AS.171.108 General Physics for Physical Science Majors II (AL)

In lieu of the 101/102 or 107/108 physics series, the biophysics major also accepts one of the following series:

First Year Physics Option 3:

1. AS.171.103 General Physics I for Biological Science Majors
   and
2. AS.171.104 General Physics II for Biological Science Majors

OR

First Year Physics Option 4 (primarily for students double-majoring in physics and biophysics):

1. AS.171.105 Classical Mechanics I
   and
2. AS.171.106 Electricity and Magnetism

For the first year of physics labs, two series are available:

First Year Physics Lab Option 1 (for students choosing lecture options 1, 2, or 3):

1. AS.173.111 General Physics Laboratory I
   and
2. AS.173.112 General Physics Laboratory II

OR

First Year Physics Lab Option 2 (for students choosing lecture option 4):
Generally, only students seeking to double major in both physics and biophysics will choose this series.

1. AS.173.115 Classical Mechanics Laboratory
   and
2. AS.173.116 Electricity and Magnetism Laboratory

7.1.3 Required Biophysics Courses

The biophysics major requires 5 courses in biophysics.

1. AS.250.205 Introduction to Computing (Fall and Spring)
2. AS.250.372 Biophysical Chemistry (requires Introduction to Computing) (Spring 2025)
3. AS.250.315 Biochemistry I (Fall 2024)
4. AS.250.381 Spectroscopy and its Application in Biophysical Reactions (requires Biophysical Chemistry and Biochemistry I) (Spring 2025)
5. AS.250.383 Molecular Biophysics Laboratory (Spring 2025, Fall 2024- Approval required.)

7.1.4 Required Math Courses

The biophysics major requires 4 courses of mathematics, including the three semester calculus series and a fourth specialized math course. The three calculus courses are

1. AS.110.108 Calculus I
2. AS.110.109 Calculus II (for Physical Sciences and Engineering)
3. AS.110.202 Calculus III or AS.110.211 Honors Multivariable Calculus

The fourth specialized can be any of the following:

4a. AS.110.201 Linear Algebra
4b. AS.110.212 Honors Linear Algebra
4c. AS.110.302 Differential Equations and Applications
4d. EN.550.291 Linear Algebra & Differential Equations
4e. EN.550.311 Intermediate Probability and Statistics
4f. EN.550.310 Probability and Statistics for Phys. Sciences and Engineering
4g. EN.550.211 Probability and Statistics for Life Sciences

7.1.5 Required Research Experience

Students entering JHU Fall 2024 and later: The research requirement for the major in biophysics is 2 credits, by taking the course AS.250.520, entitled "Introduction to Biophysics Research". This course is not given a letter grade but is taken S/U. Students can register for 3 credits, but to meet the university limits, we only require 2.

Students entering JHU before Fall 2024: The research requirement for the major in biophysics is 6 credits, by taking two semesters of the course AS.250.520, entitled "Introduction to Biophysics Research". This six-credit sequence is not given a letter grade but is taken S/U.

All students: After completing the credit requirements for research, students are encouraged to continue their research, enrolling in the course AS.250.521 entitled "Research in Biophysics". Because students will have improved proficiency in independent research, they can take AS.250.521 for a letter grade, but for no more than six credits per year. All research courses are offered in the fall, spring, and summer terms. Note that research during Intersession is not for credit.

A full description of the research requirements and how to find a research experience can be found in Section 12: Appendix A.

Two important things about the research requirement to keep in mind:

> Intersession research (250.574) can be conducted for a grade but does not count towards the major.
>
> The Registrar's academic year starts with the summer session, and only 6 credits of research can be earned within any one academic year. In other words, the Registrar does not allow 3 credits to be earned in the summer and 3 credits to be earned in both the following fall and spring semesters.

7.1.6 Pre-2024 JHU Admits only: Advanced Seminar Requirement:

Students must complete a course from the Advanced Seminar List.

250.403	Advanced Seminar Bioenergetics (Spring)
250.421	Advanced Seminar in Membrane Protein Structure, Function & Pharmacology (Fall 2024)
250.411	Advanced Seminar in Structural Biology of Chromatin (Spring 2025-check avail)
250.420	Advanced Seminar in Macromolecular Binding (Fall 2025)

7.2 Required Natural Science Electives

Three natural science electives are required.

7.2.1 "List #1" Electives

A minimum of three "List #1" electives must be taken from the following list:

250.253/254	Protein Engineering and Biochemistry lab (Fall and Spring 2024)
250.302	Modeling the Living Cell (Fall 2024)
250.316	Biochemistry II (Spring 2025)
171.201	Special Relativity and Waves (Fall 2024)
171.202	Modern Physics
171.310	Biological Physics (Fall 2024)
605.202	Data Structures
601.220	Intermediate Programming
171.648	Physics of Cell Biology: From Mechanics to Information
250.405	Systems Genome Biology (Fall 2024)
250.403	Advanced Seminar Bioenergetics[1] (Spring sometimes—check availability)
250.421	Advanced Seminar in Membrane Protein Structure, Function & Pharmacology[1] (Fall 2024)
250.411	Advanced Seminar in Structural Biology of Chromatin[1] (Spring 2025-check availability)
250.420	Advanced Seminar in Macromolecular Binding[1] (Fall 2025)

[1] Students entering JHU Pre-Fall 2024 cannot double count one advanced seminar to both the advanced seminar requirement and to the List #1 requirement.

7.2.2 Pre-2024 JHU Admits only: "List 2" Electives

Three courses are required from "List 2" electives:

020.306	Cell Biology
020.330	Genetics
020.344	Virology
020.346	Immunology
020.363	Developmental Biology
020.380	Eukaryotic Molecular Biology
171.310	Biological Physics (Fall 2024)
250.310	Exploring Protein Biophysics using nuclear Magnetic Resonance (NMR) Spectroscopy (Spring 2025)
550.311	Probability and Statistics for the Biological Sciences and Engineering

Additionally, any 3-credit or higher 300-level or higher course in the Departments of Biology, Biophysics, Chemistry, Math, or Physics can be used as List 2 electives. This includes courses in List 1 that are not being counted as list 1 electives. Advanced seminar classes also count towards List 2, but cannot be double-counted with the Advanced Seminar requirement.

NOTE: We do not accept Gateway Java/Python as a list 1 or list 2 as it is 100-level and is redundant with Introduction to Scientific Computing (AS.250.205).

7.3 Students entering JHU with AP Credits

The JHU Office of Academic Advising maintains policies about acceptance and equivalencies of AP credits for incoming freshmen. The Jenkins Biophysics department adheres to these policies.

7.4 Transfer credits

The majority of transfer credit requests in the Jenkins Biophysics department concern courses in chemistry, physics, mathematics and biology. We do not normally make any decisions about the appropriateness of any transfer courses in those subject areas. Rather, we defer to departments at JHU for all decisions about whether courses taken elsewhere are equivalent to the respective JHU courses.

Prior to taking any courses outside of Hopkins, biophysics majors desiring to take courses at other institutions and bring credits back to JHU should seek approval from the JHU Advising office as well as the DUS in the department in which the course is offered. Often the DUS in that department will require a syllabus and course description for consideration.

As with transfer credits, if the other department accepts the courses as equivalent to their own courses, the biophysics department will accept the equivalency. For requirements that are taught by our Biophysics department, the Biophysics DUS will be responsible for this determination, often in consultation with the biophysics professor who teaches the course in question.

7.5 Study Abroad

Biophysics majors can participate in study abroad programs. Because of our upper-level requirements, it is usually easiest for our majors to use the summer term for study abroad. Spending a fall or spring semester abroad is also possible but requires advanced planning. If you are interested in studying abroad, discuss this possibility with your faculty advisor early in your sophomore year to create a plan that enables you to meet the major requirements without overloading your schedule.

7.6 KSAS Requirements

The Jenkins Department of Biophysics is within the Krieger School of Arts & Sciences and follows their general degree guidelines. Therefore, in addition to the major course requirements, an undergraduate degree in biophysics requires:

- Minimum of 120 credits total (this includes credits in the major)

Pre-2024 Admits

- 9 credits of humanities courses
- 9 credits of social science courses

- 12 credits of writing courses

Fall 2024 Admits and later:

- JHU has switched to a 'Foundational Abilities' (FA) model. All students must fulfill minimum credit requirements in each of the 6 FAs.

7.6.1 Writing Course Requirements

Pre-2024 Admits: The Krieger School of Arts & Sciences requires 12 credits total of courses with a "Writing" (or "W") designation. Although many humanities and social science courses have a writing designation, biophysics majors are also able to fulfill writing credits by taking the courses within the major, which will give them exposure to scientific writing:

250.420	Advanced Seminar Macromolecular Binding
250.383	Molecular Biophysics Laboratory
250.403	Advanced Seminar Bioenergetics
250.411	Advanced Seminar in Structural Biology of Chromatin
250.421	Advanced Seminar in Membrane Protein Structure, Function & Pharmacology
250.253	Protein Engineering and Biochemistry Lab

Fulfilling the writing credits solely with these biophysics courses requires advanced planning because not all of these courses are offered every year.

Fall 2024 Admits and Later: Students are required to complete at least 6 credits of Writing and Communication (W&C) foundational ability coursework. For the Biophysics major, students are able to fulfill this requirement by completing AS.250.383, a required 3-credit course for the major, and by selecting a designated W&C course as one of their major electives, such as those listed directly above: AS.250.420, AS.250.421, AS.250.411, AS.250.253.

7.6.2 Humanities and Social Science Requirements

It is generally recommended that students spread these courses out over the course of their eight semesters.

7.7 Academic Performance Rules

7.7.1 Minimum Grade Requirements

The biophysics major requires that students earn a grade of "C" or greater for all courses required in the major. A student who earns a grade of "C-" or below must repeat the course and earn a better grade.

The KSAS guidelines on minimum grade requirements apply to all other courses.

7.7.2 Repetition of Course Content

Students earning a grade of C- or less in a course required for the major must repeat the course.

7.7.3 Courses Taken Pass/Fail

KSAS has a policy of allowing students to take courses Pass/Fail if those courses are outside a student's major.

7.7.4 Double Counting Policy

For the purposes of double majoring (or minoring), Johns Hopkins allows students to "double count" the same course. The Jenkins Biophysics department follows this policy. However, we do not allow double-counting within the major. For example, EN.550.311 (Statistics and Probability) cannot simultaneously fulfill the math requirement and the list 2 elective requirement.

7.7.5 Departmental Honors Program

The Jenkins Biophysics department offers outstanding students the opportunity to earn honors in Biophysics. This honors distinction appears on the student's transcript upon graduation. If the honors requirements are approved prior to April 1 (for Spring graduation), an "Honors" distinction will additionally appear in the commencement program.

The requirements for departmental honors in biophysics are two-fold:

- The student must maintain an overall GPA of 3.5 or greater
- The student must write and receive approval of an Honors paper that is based on their 6 or more credits of required research. Details on the honors procedures and the format of the Honors paper can be found in Section 13: Appendix B.

7.7.5.1 Honors Deadlines

May Commencement:
Generally, the honors paper must be submitted by March 25 of the senior year to meet the May commencement deadline.

December Commencement:
Generally, the honors paper must be submitted by November 17 of the senior year to meet the December commencement deadline.

7.7.6 Ethics in Learning

The Jenkins Biophysics department follows the Johns Hopkins guides for ethics in learning. Violations of academic integrity will not be tolerated and will be handled in accordance with the guidelines established by the Krieger School of Arts and Sciences.

8. 5th Year BA/MA Program in Biophysics

The TC Jenkins Department of Biophysics offers outstanding undergraduate biophysics majors the opportunity to advance their education through a combined, 5-year B.A., M.A. program. Candidates for this program must be current biophysics undergraduates with a departmental GPA of 3.5 or greater and a strong research history. All bachelors' requirements must be completed before matriculating into the master's program.

If you are interested in pursuing the 5th year BA/MA program, discuss this with your Jenkins advisor.

The Biophysics department does not offer an MA to non-majors.

9. No Minor in Biophysics

The Biophysics department does not offer a minor in biophysics.

10. Undergraduate Planning for Professional Schools

10.1 Graduate School Requirements

The biophysics major at Johns Hopkins is an excellent preparation for doctoral studies in a wide variety of fields including pharmacology, computational biology, structural biology, immunology, and of course, biophysics. Section 5.1 shows a typical path to completion of the biophysics major that provides a general preparation for advanced quantitative study. Undergraduates with well-defined graduate interests in specific areas are encouraged to discuss their plans with their faculty advisors to choose appropriate electives.

10.1.1 Computational Electives

Computational skills are increasingly important for advanced scientific study. In addition to our required Introduction to Computing course, students are encouraged to take more than one of our upper level "List 1" electives that develop computing skills. We do not accept Gateway Java as a list 1 or list 2 as it is 100-level and is redundant with Introduction to Scientific Computing (AS.250.205).

250.302 Modeling the Living Cell

10.1.2 Research Experience

The undergraduate research experience provides essential preparation for graduate research. Although only 6 (or 2) research credits are required, students interested in graduate school should do independent laboratory research for 2 years or more to enable them to pursue a

scientific problem in a significant manner. In addition to preparing students for graduate research, well-developed undergraduate research experiences makes students more competitive candidates for admission to top graduate programs. See Appendix C: Are you considering graduate school?

10.2 Considerations for Completion of the Pre-Medical Requirements

There is plenty of room in the academic schedule of a biophysics major to easily meet the pre-medical requirements (see Section 5.2). See this pre-professional site. Though nearly all requirements for medical school can be satisfied by biophysics major requirements, most medical schools require a one-semester laboratory in organic chemistry, which is satisfied by taking AS.030.225 Organic Chemistry Laboratory. In addition, some of the biophysics (and general university) requirements should be tailored to satisfy medical school admissions criteria. These are listed below:

10.2.1 Organic Chemistry Lab

There are several semesters in which "Open" electives must be taken to meet the 12-credit minimum for full-time student status. Pre-medical students are therefore advised to consider Organic Chemistry Laboratory as one of these electives.

10.2.2 College level "biology" course

General Biology is not required for the Biophysics major, does not count towards any of the requirements or electives for the biophysics major, nor is it required for medical school. Though students with no biology background are sometimes recommended a General Biology course by JHU Office of Academic Advising, this is unnecessary for most students.

Biophysics majors can complete the premedical requirement for a year of college level "biology" laboratory with any two of following (required) courses:

250.315	Biochemistry I
250.316	Biochemistry II
250.372	Biophysical Chemistry

10.2.3 College level "biochemistry" or "biology" lab

Biophysics majors complete the premedical requirement for "biochemistry" or "biology" laboratory with the following (required) courses:

Biology course	Paired Lab course
From Biophysics • Biochemistry I 250.315 • Biochemistry II 250.316 • Biophysical Chemistry 250.372 • Modeling the living cell 250.302	*From Biophysics* • Protein Engineering & Biochemistry Laboratory 250.253 • Molecular Biophysics Laboratory 250.383 *From Biology*

• All Advanced Seminars *From Biology* • Genetics 020.303 • Molecular Biology 020.304 • Cell Biology 020.306 • Genetics 020.303 • Developmental Biology 020.363	• Cell Biology Lab 020.316 • Developmental Genetics Lab 020.340

10.2.4 Statistics

Biophysics majors meet the pre-medical requirement for a statistics course through one of the following "List 2" electives:

550.211	Probability and Statistics for the Life Sciences and Engineering
550.310/311	Probability and Statistics for the Phys Sciences and Engineering

10.2.5 Sociology/Psychology

Biophysics majors meet the pre-medical requirement for a sociology/psychology course through their KSAS H/S distribution choices.

11. Faculty Contact List

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12. Course Listings

This manual serves as a guide for undergraduate planning and is only updated once per year.

The most up-to-date course listings and descriptions can be found in the JHU catalog on line at https://e-catalogue.jhu.edu/

Students can also find schedules of classes on **sis.jhu.edu**. Classes for the future semester are only updated midway through the current semester. Because sis only shows classes for 1 year, the Public Class search on the login page can also be used to search multiple years of course offerings.

13. Appendix A: Undergraduate Research Guide for Biophysics Majors

Research Requirements

Independent research is a key component (and a formal requirement) of the Hopkins Biophysics Major. Research is typically scheduled as a series of formal courses:

The research requirement for the major in biophysics is 6 credits, by taking two semesters of the course AS.250.520, entitled "Introduction to Biophysics Research". This six-credit sequence is not given a letter grade but is taken S/U. After completing this sequence, students are encouraged to continue their research, enrolling in the course AS.250.521 entitled "Research in Biophysics". Because students will have achieved proficiency in independent research from their first year of research, they can take AS.250.521 for a letter grade, for up to six credits per year. Each of these two courses are offered in the fall, spring, and summer terms. Note that research during Intersession is not accepted for credit.

Research during intersession is not accepted to meet the Biophysics major requirements.

Research Philosophy

The undergraduate biophysics research experience is an apprenticeship in which majors engage in guided but independent research Johns Hopkins research laboratories. To initiate this apprenticeship, students must search for and initiate a relationship with a "Research Supervisor" who is willing to work directly with the student.

In the initial phase, which may last for as long as a semester, the student may simply learn techniques, become familiar with the research problem and relevant literature and learn and understand the questions and goals of the overall research project. By the second semester, the student is expected to become a semi-independent researcher able to perform experiments and come up with improvements in procedures and experimental design. The first year of research (AS.250.520) must be taken S/U. From the second year onward (AS.250.521), research will be graded based on the student's performance (see the rubric on page 23). Although productivity in the first semester of research will likely be low, effort should be constant. As described above, an averaged of 10-12 hours of active, engaged research over the 13 week semester is required for 3 credits of research. This does not include being in the lab but browsing the internet or social media while a reaction or simulation runs)

By the end of the second semester, most students are able to obtain publishable data. Many students who complete more than two semesters of biophysics research become co-authors of abstracts and papers published with their Research Supervisor. Thus, it is strongly encouraged that students participate in research for two or more years. Students and Supervisors both benefit from the extended training, and are more likely to make significant discoveries in their second year of research. Along these lines, students are *STRONGLY* encouraged *NOT* to switch labs from semester to semester, but rather to pursue one research project during their time at Hopkins.

When to add research to your schedule

It is a good idea to start thinking about undergraduate research as a freshman or sophomore. Many students who enter JHU with AP credits start their research projects early their sophomore year, but starting in your junior year is also fine. Although it is permitted, waiting until senior year to start research is strongly discouraged

"Research Supervisor" *versus* "Faculty Sponsor:

The "Research Supervisor" is defined as the head of the laboratory in which you carry out your research.

The "Faculty Sponsor" must be a full-time faculty member in the Jenkins Dept. of Biophysics. This will normally be your academic advisor in the Biophysics department. In your second year and beyond, your sponsor will assign your research grade in close consultation with your Research Supervisor. You must register for the Biophysics research using the section number of your Faculty Sponsor.

The Jenkins Faculty Sponsor must be confident that the Research Supervisor is qualified for and committed to this apprenticeship program. The Research Supervisor must be able and willing to observe and evaluate the performance of the student. Moreover, the research topic should be appropriate to the biophysics major, broadly defined.

If you are conducting research under the supervision of a full-time faculty member in the Jenkins Department of Biophysics, that person can also serve as your "Faculty Sponsor".

Biophysics research topics and locations

The Biophysics major allows undergraduate research experiences in a broad range of topics; however clinical research and survey-type investigations are not allowed. With these restrictions in mind, students can initiate an apprenticeship with a Research Supervisor in any laboratory in Arts and Sciences, Medicine, Engineering and Public Health. A vigorous and wide-ranging search for potential Research Supervisors is the best way to ensure a successful apprenticeship. Repetitive tasks that require little or no initiative or intellectual input from the student, such as plate scoring or bottle washing, do not, by themselves, constitute a suitable research apprenticeship. Rather, research activities by the student must directly test a hypothesis or enhance our understanding of a specific area of science.

Labs outside of JHU

Students can be approved to perform summer research for credit at a lab outside of JHU. The research must fulfill the same criteria as JHU research (no clinical or survey-based research). Students cannot receive credit if they are participating in an internship or otherwise being financially supported by the research supervisor. The research supervisor must be an MD or PhD who agrees to evaluate the student (and not a parent/family member), and the research must be taken S/U.

Four steps to find a research position at JHU

1. Find out what research interests you that is being carried out at JHU.

Follow your natural interests in searching the JHU web pages of science faculty. The web pages for the Jenkins Biophysics Department and the Graduate Program in Biophysics are both good places to start.

As you read faculty research descriptions, you may come across a topic that caught your interest in a previous class or a technique that just sounds cool. Your faculty advisor can help direct you to research labs that match your interests. Do not hesitate to ask them for advice, as your advisor may have insight from previous undergraduate research experiences that you may not be able to identify from published and/or posted material.

Once you have identified two or three labs that interest you, download a paper or two from those labs and familiarize yourself with the scientific questions being addressed as well as the techniques that are employed.

2. Contact faculty members.

As soon as you have identified a research lab that interests you, send an email to the faculty member in charge, inquiring whether he or she has an opening. Since the process of identifying a lab and a research project takes a lot of effort on both sides, it is *strongly advised* that you make faculty contacts the semester *prior* to when you want to start research. It is important in this first contact to introduce yourself to faculty members with a thoughtful paragraph: tell them about yourself (courses you have taken, any previous research experience, your long-term goals), and state why you are interested in his or her lab. Be prepared to send a short resume, transcript, or recommendation from an instructor or TA. If the faculty member is interested, make an appointment to discuss potential research projects. Since most faculty have busy schedules, you will have the best luck making an appointment by providing the faculty member with a readable, formatted table letting them know all the times you are available to meet during the week, rather than asking "when can you meet".

3. Register for research.

Log into SIS. Under the Registration menu, click on Online Forms. Select Independent Academic Work. Complete the form, providing full explanations where needed, and submit it. The form will be sent to your faculty sponsor for approval. Once the sponsor approves it, you will see the position/ project in your Confirmed Enrollment screen in SIS.

Students are limited to *six total credits per academic year. This almost always involves two one-semester three-credit courses* (course numbers listed above), taken in the fall, winter, or summer. A maximum of three credits may be taken in any of these three terms. Fewer credits may be taken, although this is not advised, since most research projects require a "critical mass" of effort by the student.

Note that the six-credit limit per year of research is strictly enforced by the registrar's office. The registrar's academic year starts with the summer semester. If you earn 3 research credits in the summer and 3 in the fall, you are not eligible to earn additional research credits in the spring.

4. At the beginning of each semester:

The student and the Research Supervisor must complete **PART 1** of the "**Supervisor's Report for Independent Research in Biophysics**". (attached below) before the end of the second week of the semester (the Add deadline), and give the completed form to their research sponsor (usually their academic advisor in the Biophysics department.

5. At the end of each semester:
The student completes one of the course requirements as described below:

5A. If the student is completing their first semester of research (e.g. the student has a total of 3 or less research credits):

- The student is required to write a 2-3 page **Progress Report** and submit this to the Research Supervisor for grading.
- Upon receipt of the Progress Report, the Research Supervisor completes **PART 2 of** "**Supervisor's Report for Independent Research in Biophysics**" (attached below).
- The student delivers the Progress Report and the completed Supervisor's Report to the Faculty Sponsor. The Faculty Sponsor must receive ALL of this material by the end of the final exam period.
- Prior to submitting the grade and credits to the Registrar, the Faculty Sponsor may consult with the Research Supervisor to confirm that the assigned grade (S/U) matches the effort and accomplishments made by the student.
- Guidelines for how to write a Progress Report are provided on page 5 of this handout.

5B. If the student is completing their second (and all subsequent) semesters of research (for a total of six or more research credits):

- The student should prepare a poster or a series of powerpoint slides that provide a self-contained description of the research, including introduction and hypothesis, methods, results, conclusions, and literature cited, and submit this to both the Research Supervisor and Faculty Sponsor for grading, as described above.
- Upon receipt of the Poster, the Research Supervisor completes **PART 2 of** "**Supervisor's Report for Independent Research in Biophysics**" (attached below). The supervisor must meet with the student to discuss the report, including any deficiencies or areas that need

improvement, and plans for the upcoming semester of research, and also discuss the poster/powerpoint slides.

- The student then delivers the Poster and the completed Supervisor's Report to the Faculty Sponsor before the end of the final exam period. Graduating seniors in their terminal semester should note that they risk losing their "graduating" status for that commencement period if they miss this deadline. This is a hard deadline established by the Registrar.
- Prior to submitting the grade and credits to the Registrar, the Faculty Sponsor may consult with the Research Supervisor to confirm that the assigned grade (S/U or letter for AS250.521) matches the effort and accomplishments made by the student.
- Guidelines describing how to prepare a poster are provided on page 13 of this handout.

6. Grading:

Research done to fulfill AS.250.520 (year 1) is graded S/U, whereas research done to fulfill AS.250.521 (year 2+) is given a letter grade. The Faculty Sponsor will submit a research grade online upon receipt of the following:

The Progress Report or Poster; and
The "Supervisor's Report for Independent Research in Biophysics" Part 2

SUPERVISOR'S REPORT FOR INDEPENDENT RESEARCH IN BIOPHYSICS

PART 1. To be completed by the RESEARCH SUPERVISOR and STUDENT at the START of the semester.

Independent research is a key component of the Biophysics Major. Student research involves significant independent effort in the laboratory. Students must work ten hours per week in the lab (at a minimum) to receive three credits during a full (fall or spring) semester. As the summer period is shorter, summer research is expected to involve a proportionately greater effort per week, so that the total effort matches that for the fall / spring semester. By signing below, we (Student and Supervisor) agree to this effort level in the coming semester:

Student signature_____ Date:_____

Supervisor signature _____ Date: _____

Student: return a COPY of PART 2 this form (next page) to your Jenkins Faculty Sponsor in biophysics prior to the drop/add deadline of the current semester. Part 2, on the next page, must be filled out by your Supervisor and returned to your biophysics sponsor *before the end of finals, along with your written Progress Report or Poster (see above for details on the Progress Report or Poster).*

SUPERVISOR'S REPORT FOR INDEPENDENT RESEARCH IN BIOPHYSICS

PART 2. To be completed by the RESEARCH SUPERVISOR at the END of the SEMESTER.

Student/HopkinsID_____/_____Term _____

Biophysics Faculty Sponsor _____

Research Supervisor _____

Course number (circle one): AS.250.520 (year 1) AS.250.523 (year 2+)

Supervisor: In the space below and on the back, describe the research accomplishments made by the student in the last semester and its significance. Also, comment on level of effort made by the student, their proficiency level, and any areas where the student can make improvements. Then fill out the check boxes at the bottom

	EXCELLENT	VERY GOOD	SATISFACTORY	NEEDS IMPROVEMENT	UNSATISFACTORY
ATTENDANCE					
UNDERSTANDING SCIENTIFIC BACKGROUND					
TIME MANAGEMENT					
EXPERIMENTAL SKILLS					
PRODUCTIVITY					
RECORD KEEPING					
VERBAL SCIENTIFIC COMMUNICATION					
WRITTEN SCIENTIFIC COMMUNICATION					
DEMONSTRATE INITIATIVE					
OVERALL					

Significance of the research:

Progress made this semester:

Plans for the coming semester:

Areas that need improvement:

SUGGESTED GRADE_____ CREDITS_____

SUPERVISOR'S SIGNATURE_____
Student: return a COPY of PART 2 of this form to your research sponsor in biophysics prior to the end of finals week, along with the written component (i.e., your Research Report or Poster; see above).

Progress Report Guidelines

The Progress Report should include:

- The Student's name, the Research Supervisor's name, his/her title and affiliation, student's name, when accomplished e.g., Fall 2012, Spring 2013, Summer 2013.
- **Introduction**: Background rationale with reference/s; how the work fits into the overall objectives of the research program.
- **Methods**: Briefly give techniques used.
- **Results**: Give results obtained. If too early in the project for results, more on methodology might be appropriate.
- **Discussion**: Significance of results and their relation to future plans.

Poster Preparation Guidelines

Supervisors may have specific instructions or styles for laboratory posters, but a general guide for approaching this task is to prepare 9 OR 12 letter-sized (8.5 x 11 in) power point slides as following:

- **Title**: (1 slide) This slide contains the title of your study along with your name and the name of your Research Supervisor and when the work was accomplished, e.g. Fall 2012, Spring 2013, etc..
- **Abstract**: (1 Slide) This is essentially one paragraph that outlines the question that was addressed, summarizes the main results and states the conclusions. Do not use a font size smaller than 18.
- **Introduction**: (1 Slide) *This slide is optional*. You may choose to include it if you feel that your Abstract does not adequately describe the background for your project. Do not use a font size smaller than 18.
- **Results**: (5 or 8 Slides) Provide figures or graphs of data. Each result should have a scientific title that summarizes the main finding as well as a figure legend that briefly describes the methods. Do not use a font size smaller than 18.
- **Conclusions**: (1 Slide) A bullet point list of the main conclusions of the work. This section also contains a reference to the funding source for the work. A brief description of future experiments may also be appropriate in the Conclusions section. Do not use a font size smaller than 18.
- You must submit both paper and electronic copies of your poster to your Jenkins Faculty Advisor.

Frequently Asked Questions about Graded Research in Biophysics & the Biophysics Poster Session:

What time commitment is expected for research?

A general guideline is that 1 credit equals 3-4 hours laboratory work per week during the semester. An absolute minimum effort of 10 hours per week is expected for 3 credits of research. As the research progresses, students often find that they want to work more hours in the laboratory so that they can get more done. We encourage this, but cannot award more than three credits per semester, and six credits per academic year. Note that the level of effort should be evenly maintained throughout the semester.

Is research in year 2+ (AS.250.521) a guaranteed grade of "A"?

No. Research is a graded class, and "grades" necessarily have more than one value. Thus, you should take it seriously, like all your other classes. At a minimum, you should be committing 10-12 hours per week for 3 credits of research. However, simply showing up for this many hours will not guarantee a grade of "A". You want to show interest and initiative with your project; you want to ask lots of questions, and make progress in gaining technical skills, optimizing methods, acquiring knowledge, and making discoveries.

My Progress Report is longer than 3 pages. Is this a problem?

A Progress Report longer than 3 pages is generally not a problem. If you have questions about what to include, you should seek the advice of your Faculty Sponsor.

What is the Biophysics Undergraduate Research Festival (BURF)?

Biophysics Undergraduate Research Festival (BURF) takes place in April of each year. The event is usually held at Mudd Hall lounge area. Every Biophysics major and freshman who are interested in learning about Biophysics are invited. The first hour is a poster session in which all Biophysics undergraduate students who are engaged in research present a poster which are viewed by faculty and students in the department. The poster session is followed by a 45 min long research symposium (100 Mudd) in which we have presentations (10-15 minute talks) given by three to four selected graduating seniors on their research progress. Afterwards, we share food, drinks and fellowship in the Mudd lounge.

I have only completed 3 credits of research, but it went really well, and I was able to collect a lot of cool data. I want to make a poster and participate in the Biophysics Poster Session/BURF. Am I allowed?

Congratulations on your early success in the lab! During your first semester of research, you will still need to write your paper for your grade, but of course you are welcome to additionally prepare a poster and participate in the Biophysics Poster Session. You should have both your Research Supervisor and your Faculty Sponsor approve your poster.

I did research in the fall (or previous summer) but not in the spring. Can I still participate in the poster session?

Yes, even if you conducted your research in the fall (or previous summer) but did not continue through the spring, you are still invited to present your poster in the Biophysics Poster Session. In fact, we encourage you to participate. Keep in mind that you should have submitted both paper and electronic copies of your poster to your Jenkins Faculty Sponsor during the semester you conducted research for a grade. Thus, printing your submitted poster for the spring BPS should only require some file formatting.

Am I required to participate in the Biophysics Poster Session?

No, since our poster session will be annually, it is not a course requirement per se. Therefore, you are not required to participate, and your participation will not be graded. However, it is highly recommended that you participate in the BPS for as many years as you can. A poster session is a valuable opportunity for you to present your work to the faculty and to your peers. It will allow faculty to get to know you better, see what kind of researcher you have become, and in general, write stronger letters of recommendation on your behalf.

I will be seeking Honors in Biophysics. Does the poster take the place of the Honors Paper?

No, the requirements for Honors in Biophysics have not changed. These requirements can be found in this very Manual in Appendix B.

Participation in a Biophysics Poster Session will be a requirement (in addition to the Honors Paper) for majors seeking to earn Honors in Biophysics.

14. Appendix B: Departmental Honors in Biophysics

14.1 Eligibility

Students who have met the requirements for the Biophysics major and who satisfy the following requirements are eligible for departmental honors at graduation:

• Overall GPA 3.5 or better

• "Honors Paper" in Biophysics approved in writing by the student's *Research Supervisor* and *Faculty Sponsor* and conforming to the attached guidelines.

To evaluate if you are eligible:

- Determine your overall GPA.
- Consult with your research advisor about writing a paper describing your research project.
- Contact the DUS for Biophysics (Prof M Johnson) to declare your intent to pursue honors.

14.2 Honors Paper

The honors paper must describe independent research carried out by student as part of biophysics research requirement (250.520/521). Library research is not acceptable for this purpose. The length should be ~20 pages double-spaced, plus figures and literature citations. The format should follow the layout of a research paper; a guide for each section is given below.

14.2.1 Honors Paper Layout

Abstract (250 words, no longer)

A typical abstract typically contains one sentence describing the problem, one sentence describing its significance, one sentence describing the approach, and two-three sentences stating the results and conclusions.

Introduction (~4-6 pages)

Provide background information necessary to understand the study undertaken. Be sure to state why the problem you addressed is important as well as how your research relates to previous work. Assume that your reader is another undergraduate biophysics major with some scientific training but who does not work in the same lab. Your goal is to provide sufficient information for such a reader to understand and appreciate your project, but nothing extraneous.

Materials and Methods (~2-3 pages)

Describe your experimental protocols, and state where you obtained reagents. There should be enough detail to allow an independent researcher to reproduce your experiments. Since the methods section describes the experiments you have already done, it should be written in the past tense.

Results (~4-10 pages)

Provide a narrative that describes the outcome of the experiments performed. Figures documenting the results should be accompanied by legends that enable the reader to understand what is in the figure. It is preferable if the figures are imbedded in the text, but they can also be placed together at the end of the paper. The space taken by figures is not counted in the page limitation of the paper. The results section should be written in the past tense.

Discussion (~4 pages)

Discuss what was learned, the reliability of the results, any limitations to the interpretation, significance of your conclusions, future directions.

Literature references

These must follow the format of a standard journal in the field, such as *Biophysical Journal*, *Protein Science*, *Nature Structural Biology*, *Nucleic Acids Research*, etc. Take care to include references to the primary literature, not just review articles or textbooks. Your paper should represent a scholarly effort. In general, any time you report a specific scientific finding or restate a specific idea or thesis, the author of the experiments or the idea should be cited. The citation of a timely review article can support general statements that refer to a collection of phenomena. Your research advisor can direct you to the best literature sources in the area of your research project. The citations should be placed in a list at the end of the paper (endnotes rather than footnotes). Citations can either be numbered in order of appeared in the main text, or marked by Author, year in the main text and listed alphabetically in the reference section.

14.2.2 Honors Paper Due Date

For a May commencement, the honors distinction is due to the Registrar's Office in early April. To meet that deadline, the following is a suggested timeline for completing the paper requirements:

- Contact the Biophysics Director of Undergraduate Studies (DUS), currently Prof Margaret Johnson. Notify the DUS that you intend to pursue departmental honors: the Biophysics DUS is the person responsible for submitting your name to the registrar.

- Turn your completed honors paper into your *Research Supervisor* for comments and/or approval by March 15. **Give your *Research Supervisor* at least one week to read the paper and provide feedback to you.** Revise the paper following their feedback, until they approve.

- Once your *Research Supervisor* has approved your honors paper, give a copy to your *Faculty Sponsor* for comments and/or approval. Include the DUS in the correspondence so they are kept up-to-date on your timeline. Your faculty sponsor should receive the paper no later than March 22. (Sometimes the Research Supervisor and the Faculty Sponsor are the same person.) **Give your *Faculty Sponsor* at least one week to read the paper and provide feedback.**

- Ask both your *Research Supervisor* and your *Faculty Sponsor* to send an email to the Biophysics DUS indicating their approval of the paper, as soon as they approve it. It is fine to have them send a simple email sent directly to the DUS stating, "I approve the honors paper written by xx student entitled "Your fabulous title."". The DUS will submit the approval for departmental honors directly to the registrar.

For Honors Designations in the May graduation program, all six of these steps must be completed no later than April 1.

For Honors Designations in the Dec graduation program, all six of these steps must be completed no later than Nov 17th.

This means that the latest time to set up an appointment with your *Research Supervisor* to discuss the honors paper should be early February for May grad, and early October for Dec grad.

15. Appendix C: Are you considering graduate school?

Resources – your professors!

All faculty in the biophysics department attended graduate school for their PhD. Aside from the MDs at the School of Medicine, that will typically be true of all your professors. We are also members of at least one Graduate program at JHU, and excepting perhaps the newest faculty, we are familiar with the admissions requirements for graduate programs and the expectations of the most competitive programs. Not everyone will give you the exact same advice, but there is some generally agreed upon wisdom.

Undergraduate Research is critical

Nowadays this is an essential prerequisite for graduate studies. Performing undergrad research demonstrates your interest and motivation to pursue graduate research. With research, you address problems that have not yet been solved, whereas in course work you learn to solve problems where the answer is already known. Research presents new challenges, including figuring out exactly what is the specific and narrowly-defined problem/question you will address with your approach, and how this connects to a larger hypothesis about your project. With research you learn what is known in a field, and what is not known and represents an active direction of research.

The more semesters you spend doing research, the easier it is to convince graduate programs that you are committed to graduate research. Finding the best undergrad research lab for you may mean moving to more than one lab. The benefit is that this exposes you to more fields or approaches (e.g. experiment vs theory or computation, single-molecule measurements vs cryoEM, etc), and more mentorship styles. The downside is that you make less progress and establish less independence on a single research project. While it is good to switch to a new lab to find the fields that excite and inspire you, do this early. It is important to balance new experience with sustained progress on one project. The PI will get to know you better, and the deeper you get into a project the better you can appreciate the challenges and joys that accompany problem-solving in independent research. You will also be much more likely to co-author a paper, which is always a strength.

Summer internships are positively viewed. They demonstrate that you pursued/applied to a competitive program and relocated to a new environment to further your research interests. JHU has internal undergraduate research awards (PURA) open to all undergrads. These are **highly** competitive, so you often have to apply more than once to improve your chances of award.

Course work shows off your interests and study skills

Perfect GPAs are not a requirement for graduate school. A strong GPA does signal to the committee that you have good time-management, study habits, work ethic, and intellectual aptitude for succeeding in graduate/advanced course work. A low GPA is a thus a red flag. Course work/major also reflects your interests. Biophysics is inherently interdisciplinary and quantitative, which is generally a strength when applying to natural sciences programs. It is worth noting that Engineering PhD programs tend to prefer students with degrees in engineering,

as the course load is more quantitative, but this is hardly exclusive. Courses and research you pursue as an undergraduate Biophysics major can demonstrate a good fit to engineering degrees. Physics programs similarly tend to select for undergraduate physics majors, particularly given the more rigid, less interdisciplinary course requirements of Physics PhD programs.

Recommendation Letters should come from faculty knowledgeable about you

You will need recommendation letters from 3 professors. You ideally want faculty that know you well and can make insightful and specific comments about your critical thinking and problem-solving skills, independence, leadership, research record, academic excellence, and writing/communication skills. The more they can say about you, typically, the stronger the letter. Professors who have supervised your research efforts are the most important letter writers, because they have the best sense of how you are progressing and growing as an independent scientist (everyone has a first research experience somewhere, usually as an undergrad!).

Applicant Statements help communicate your motivation and interests

These statements are your chance to communicate your motivation for choosing graduate school and the scientific fields or approaches that excite or intrigue you. Attending a PhD program because you want to keep taking classes or because you are not sure what else to do is not a compelling reason for admission. Scientific research requires dedication to a years-long project, well after your coursework ends. It requires hard work, perseverance, and your own driving motivation. The payoff is that you contribute something brand new, whether ideas, methods, or products, that further humanity's scientific understanding of the world.

16. Appendix D: Undergraduate Awards

Awards for Biophysics Majors
These awards recognize excellence in academics and/or research for graduating seniors, or provide travel support for current undergraduates to a conference. JHU also offers awards for current undergraduate students, like the PURA, that are not restricted to Biophysics students.

Szuts travel award:
Eligibility: All biophysics majors. Application is required to the DUS, with approval from your research supervisor. This award is limited to students that will attend a conference along with a Jenkins faculty member. This is a restriction of the funding source.

Detlev Bronk award:
Eligibility: Graduating seniors only. This award recognizes academic excellence in terms of GPA, and goes to a student with a top GPA, selected by faculty.

H. Keffer Hartline award:
Eligibility: graduating seniors only. The Hartline award recognizes undergraduate research excellence. To be eligible, students must have participated in at least one BURF/Poster session, and they must submit an Honors thesis (see Appendix B.).

17. Appendix D: History of Jenkins Biophysics

The Biophysics Department was established with funds from Mrs. May McShane Jenkins and named in honor of her late husband Thomas Courtenay Jenkins (1866-1938), a Baltimore financier and art collector. Mrs. Jenkins was always interested in physiotherapy. Her eagerness (as her will stated) to encourage exploration of "water, heat, and light in the treatment of disease" led Mrs. Jenkins to make donations in 1947 and 1955 for the study of biophysics at Johns Hopkins. Upon her death in 1957 the University received the bulk of her estate to endow the Thomas C. Jenkins Department of Biophysics. A final distribution took place in 2000.

In 1949, the first course in biophysics was offered at Johns Hopkins. The following year Jenkins Hall was dedicated as the center of biophysical research at the Homewood campus. In 1953, the first Chairman of Biophysics Dr. F. Keffer Hartline (1967 Nobel Prize winner in Physiology or Medicine) left the University and was replaced the following year by Dr. Francis "Spike" Carlson, who was part of the faculty group to start biophysics here. He served until 1971. Under his leadership in 1956 "fundamental studies" in biophysics was formally established as the separate Thomas C. Jenkins Department of Biophysics in the Faculty of Philosophy (the predecessor of the School of Arts and Sciences). Medicine and health studies in biophysics were placed under the Schools of Medicine and Public Health, respectively. Jenkins Hall was expanded to its current size three years later. Dr. Carlson was succeeded as Chairman by Dr. Warner Love (1971-74); Dr. Michael Beer (1974-80); Dr. Warner Love again (1980-83), Dr. Shin Lin (1983-96), Dr. Eaton E. Lattman (1996-2004) and Dr. George Rose (2004-2007). The current Chair is Prof. Douglas Barrick (2020-Pres.).

In accepting Mrs. Jenkins' 1957 bequest, Dr. Milton S. Eisenhower, then President of Johns Hopkins explained the significance of biophysics:

> *The interrelation of biology and physics is an important field of study. There are few investigators with the thorough training of both biology and physics, who can do advanced work in the combined biophysics field. Johns Hopkins is performing a unique service in producing investigators who are capable of advancing biology in terms of physics and mathematics.*

In that spirit, this Department always seeks to be a center of "fundamental" biophysical studies. Faculty members from other disciplines who are oriented towards biophysics receive joint appointments. We are very much involved in the Program in Molecular and Computational Biophysics (PMB). In the mid 1980s, Jenkins Hall was completely renovated, allowing us to easily take advantage of the burgeoning use of computers and other new technologies. This permitted the installation of a University-run computer lab. The building has been upgraded several times, most recently in 2014.