

# PHYSICS: BIOLOGICAL SCIENCE, BA

Physics and astronomy are fundamental sciences aimed at discovering the basic principles that govern our universe. Physicists study the interplay between space, time, matter, and energy. Complex behavior in nature is explained in terms of elementary relations between constituent elements and the forces that bind them, over distances ranging from subatomic to cosmic scale. Astronomy encompasses the entire physical universe beyond the earth: the solar system, stars, galaxies, galaxy clusters and superclusters, quasars, and the large-scale structure of the universe. The basic tools in physics and astronomy are mathematics and experimental investigation and observation of the world around us.

At Penn, the curriculum for undergraduate Physics majors, which includes extensive laboratory experience, is based on faculty strengths in Condensed Matter Physics, Elementary Particle Physics, and Astrophysics. Undergraduate teaching is linked to faculty research efforts in these areas, and participation by undergraduates in research is strongly encouraged.

This concentration reflects increasing contributions of physicists (including members of our faculty) to implications of Physics to Biological Sciences. Undergraduate students choosing this concentration will prepare themselves for careers in scientific research or professional Medical Physics programs that have been instituted at Penn and other universities, among other possibilities.

The proposed concentration is distinct from the existing Biophysics Major, although the two share several required courses. The Biophysics Major requires much more chemistry, making it appropriate for students interested in protein science and other topics within the well-established field of Biophysics. The Physics major with a Concentration in Biological Science targets students with interests in the emerging field of Biological Physics, where researchers directly apply physical concepts and techniques to investigate biological systems; the emphasis is on developing new insights regarding biological systems from a perspective strongly rooted in Physics.

The minimum total course units (<https://www.college.upenn.edu/credits-needed-major>) for graduation in this major is 36. Double majors may entail more course units.

**For more information:** <http://www.physics.upenn.edu/>

For information about the General Education requirements, please visit the College of Arts & Sciences Curriculum (<https://www.college.upenn.edu/curriculum>) page.

Code	Title	Course Units
<b>College General Education Requirements and Free Electives</b>		
Foundational Approaches + Sectors <sup>1</sup> + Free Electives		16.5
<b>Major Requirements</b>		
<i>Core Requirements</i>		
MATH 104	Calculus, Part I	1
MATH 114	Calculus, Part II	1
MATH 240	Calculus, Part III	1
MATH 241	Calculus, Part IV	1

PHYS 230	Principles of Physics III: Thermal Physics and Waves	1
PHYS 240	Principles of Physics IV: Modern Physics (without laboratory) <sup>2</sup>	1
PHYS 361	Electromagnetism I: Electricity and Potential Theory	1
PHYS 362	Electromagnetism II: Magnetism, Maxwell's Equations, and Electromagnetic Waves	1
PHYS 411	Introduction to Quantum Mechanics I	1
PHYS 150	Principles of Physics I: Mechanics and Wave Motion	1.5
or PHYS 170	Honors Physics I: Mechanics and Wave Motion	
PHYS 151	Principles of Physics II: Electromagnetism and Radiation	1.5
or PHYS 171	Honors Physics II: Electromagnetism and Radiation	

### Concentration Requirements

BIOL 121	Introduction to Biology - The Molecular Biology of Life	1
BIOL 123	Introductory Molecular Biology Laboratory	0.5
BIOL 204	Biochemistry	1
or BIOL 205	Cell Biology	
BIOL 221	Molecular Biology and Genetics	1
PHYS 280	Physical Models of Biological Systems	1
or PHYS 580	Biological Physics	
PHYS 401	Thermodynamics and the Introduction to Statistical Mechanics and Kinetic Theory	1
Select 2 course units of Approved Electives		2
<b>Total Course Units</b>		<b>36</b>

<sup>1</sup> You may count no more than one course toward both a Major and a Sector requirement. For Exceptions, check the Policy Statement (<http://www.college.upenn.edu/sectors-policy>).

<sup>2</sup> PHYS 250 Principles of Physics IV: Modern Physics recommended.

## Honors

Applicants must have a minimum GPA of 3.3 in major-related courses.

Code	Title	Course Units
PHYS 499	Senior Honor Thesis (Semester 1)	1
PHYS 499	Senior Honor Thesis (Semester 2)	1
Thesis Accepted		

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2018 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.