

## Biophysics

### Department of Physiology and Biophysics

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#### Overview

This area of study is available as a special major through the College of Arts and Sciences and must be approved by the Special Majors Committee. It is not a separately registered degree program. Refer to the Special Majors section in this catalog for more information.

The biophysics faculty share a common interest in combining biology and physical principles to solve important research questions in biology and medical sciences. Students with strong interests in biology as well as cell and molecular biology who wish to understand how to apply physical and chemical principles to biological problems are encouraged to apply.

Biophysics faculty study the structure and function of proteins, nucleic acids and lipids at the single molecular level. They investigate dynamics in areas such as vision and motility as well as molecular structure; signal transduction, transmission in nerve and muscle; cell-cell and cell-substrate interactions; structural determination of biological macromolecules; and tissues by using various spectroscopic methods, microscopic and imaging techniques.

The biophysics program also includes Medical Physics for those who plan to pursue a career in research or clinical medical physics, including various medical imaging techniques, therapeutic radiation or nuclear medicine physics. Students will receive the necessary background for a career or further studies in Biophysics or Medical Physics.

Students who wish to apply for acceptance into the special major in biophysics should meet with the Senior Academic Advisor and Chair, Special Major Program, College of Arts and Sciences, 275 Park Hall, North Campus, Buffalo, NY 14260 as soon as they decide to pursue a special major in biophysics. To obtain the maximum benefit from the program, it is important to begin the process as early as possible.

#### About our Degrees

##### Goals and Objectives

To educate well qualified students who can advance to graduate or professional studies and/or apply their skills in quantitative analysis of biological processes and phenomena in the private and public sectors.

##### Acceptance Information

Deadlines: Rolling admission. See catalog section on [Special Majors](#) for more information.

##### Recommended Acceptance Criteria

Minimum GPA of 2.0 overall.

An adequate background to study biophysics; no specific course requirements are set for admission to the special major.

##### Degree Requirements

Please see [Degrees and Policies](#).

#### About our Courses

For course descriptions, please see [Courses](#).

## Biophysics

[About our Faculty](#)

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Many of our faculty members specialize in studies of ionic processes and signal transduction mechanisms in nerves and synapses, cell membrane mechanics, cell-cell interactions, and intracellular vesicle trafficking processes. Some of them are associated with activities in the Neuroscience program, the Center for Single Molecule Biophysics, and the Toshiba Stroke Research Center, all of which reside in the UB School of Medicine and Biomedical Sciences.

See a list of our [Undergraduate Faculty](#).

### Extracurricular Activities

See the [UB Student Association](#).

### Practical Experience and Special Academic Opportunities

Participation in research projects at UB and Roswell Park Cancer Institute is available to upper-level undergraduates.

### Career Information and Further Study

Biophysicists study the physical principles of living cells and organisms, their electrical and mechanical energy, material transport across cell membranes, and related phenomena. They conduct research to investigate dynamics in such areas as seeing, hearing, and motility as well as molecular structures; signal transduction and transmission in nerves and muscles; cell-cell and cell-substrate interactions; determination of the structures of biological macromolecules; and tissues by using various spectroscopy methods, microscopic, confocal microscopic and medical imaging techniques.

#### **Skills gained in this program include:**

- Research techniques
- Gathering and interpreting data
- Ability to utilize technology

#### **Career Choices**

80% of biophysics graduates go on to graduate and/or professional school.

20% of biophysics graduates go on to find related employment.

#### **Positions of employment include:**

- Anatomist
- Anesthesiologist
- Aquatic biologist
- Biochemist
- Biomedical engineer
- Biophysicist
- Educator
- Environmental scientist
- Geneticist
- Geophysicist
- Health physicist
- Industrial health engineer
- Lab assistant
- Medical illustrator
- Medical physicist
- Medical or pharmaceutical sales
- Nuclear scientist
- Pharmacologist
- Toxicologist
- Physicist
- Psychology engineer

#### **Work settings include:**

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Medical labs, hospitals, clinics, medical industry, government agencies, business, and industry.

### Career Hints

Biophysics is a far more specific field, one which allows for more detailed research and employment. These skills are transferable, but a student should pursue a biophysics degree if they are interested in continuing their education. Job opportunities center on place of work: researcher in a pharmaceutical lab; engineer in industry; researcher/inspector for government agencies; or a high school science teacher. Employment depends on the individual's needs, values, and skills.

### Degrees Offered

**Undergraduate:** Biophysics is available as a Special Major

**Graduate:** MS, PhD

### Links to Further Information About this Program

- [Undergraduate Catalog](#)
- [Undergraduate Admissions](#)
- [Graduate Admissions](#)
- [Department of Physiology and Biophysics](#)
- [School of Medicine and Biomedical Sciences](#)

### Special Major (Biophysics) - B.S.

#### Recommended Acceptance Criteria

Minimum GPA of 2.0 overall.

An adequate background to study biophysics; no specific number of course requirements are set for admission.

#### Recommended Courses

[BIO 201](#) Cell Biology

[BIO 205](#) Fundamentals of Biological Chemistry or [BCH 403](#) Principles of Biochemistry\*

[CHE 101](#) General Chemistry or [CHE 105](#) Chemistry: Principles and Applications

[CHE 102](#) General Chemistry or [CHE 106](#) Chemistry: Principles and Applications

[CHE 203](#) Organic Chemistry or [CHE 201](#) Organic Chemistry

[MTH 141](#) College Calculus I

[MTH 142](#) College Calculus II

[MTH 241](#) College Calculus III or [MTH 306](#) Introduction to Differential Equations\*\*

[PHY 107](#) General Physics I

[PHY 108](#) General Physics II

[PHY 158](#) General Physics II Lab

[PHY 207](#) General Physics III

[BPH 400](#) Biological Physics

[BPH 402](#) Biophysics Techniques

[BPH 498](#) Research

[BPH 458](#) Experimental Biophysics (Senior Project)

[CHE 319](#) Physical Chemistry or [CHE 349](#) Physical Chemistry for Life Sciences

#### Summary

Total required credit hours for the major.....73

*At least 10 credit hours of electives must be in upper-level (300 or above) math or science: BCH, BIO, BPH, CHE, MTH, PHY, or other by approval of the department.*

See [Baccalaureate Degree Requirements](#) for general education and remaining university requirements.

#### Recommended Sequence of Program Requirements

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### FIRST YEAR

Fall [CHE 101](#) or [CHE 105](#); [MTH 141](#); [PHY 107](#)  
Spring [CHE 102](#) or [CHE 106](#); [MTH 142](#); [PHY 108](#), [PHY 158](#)

### SECOND YEAR

Fall [CHE 203](#) or [CHE 201](#)  
Spring [BIO 201](#); [PHY 207](#); [CHE 204](#)\*\*\*; [PHY 257](#)\*\*\*  
Fall or Spring [MTH 241](#) or [MTH 306](#)\*\*

### THIRD YEAR

Fall [BPH 400](#); [CHE 319](#) or [CHE 349](#)  
Spring [BIO 205](#)\*; [BPH 402](#)

### FOURTH YEAR

Fall [BCH 403](#)\*; [BPH 405](#)\*\*\*, [BPH 498](#)  
Fall or Spring [BPH 458](#)

\* Either [BCH 403](#) or [BIO 205](#) is recommended.

\*\*Either [MTH 241](#) or [MTH 306](#) is recommended for this program; however, the department recommends that students take both courses.

\*\*\*Other recommended courses: [BPH 404](#), [BPH 405](#), [BPH 410](#), [CHE 204](#), [CHE 320](#), [MTH 309](#), [PHY 208](#), [PHY 257](#).

### BPH 400: Principles of Biophysics

**Credits:** 4

**Semester(s):** Fall

**Type:** LEC

Principles of biophysics and physics applied to biological problems as well as to single protein molecules will be discussed. The topics to be covered will be centered on biological cells and their molecules, molecular motion, energy, thermodynamics and chemical forces, cooperative phenomena, enzymes and molecular machines, and various molecular machines in biological membranes. The course addresses contemporary topics and their understanding in biophysical and physical principles underlying the function of individual molecules in biology.

### BPH 402: Biophysics Techniques

**Credits:** 3

**Semester(s):** Spring

**Type:** LEC

Biophysical techniques including optical microscopy (confocal microscopy), spectroscopic techniques (e.g. fluorescence), NMR, MRI and CT imaging, X-ray diffraction in structural biology, and electrophysiological techniques (membrane potential and patch clamping). Each technique is introduced by a didactic presentation followed by a laboratory demonstration by the instructor. This course is dual listed with [BPH 502](#).

### BPH 404: Physics of Medical Imaging I

**Credits:** 3

**Type:** LEC

Part I of a two semester course covering the basic physical principles of medical imaging. Provides an understanding of the

principles of radiography (x-ray tubes and generators, x-ray interactions, screen/film systems, scattered radiation control, fluoroscopy, mammography, and digital imaging systems), image quality concepts and visual perception. Dual listed with [BPH 504](#).

### BPH 405: Biophysical Basics: Processes

**Credits:** 4

**Semester(s):** Spring

**Type:** LEC/REC

The first section covers basic physicochemical concepts of various properties related to cell membrane transport: osmotic pressure, permeability, membrane potential, excitability of nervous tissues and various ion channels. The remaining sections consist of introductory sessions by various instructors on up-dated topics in their respective research fields: endocytic recycling in cells, exocytosis in synapses, membrane fusion, ion channel kinetics, ligand-gated ion channels, membrane mechanics, axonal properties, protein folding, and protein-nucleic acid interaction with optical trapping method. This course is dual listed with [BPH 505](#).

### BPH 458: Experimental Biophysics

**Credits:** 3

**Semester(s):** Fall, Spring

**Type:** LAB

Senior research project: students work in the laboratories of faculty carrying out research in various areas of experimental (or theoretical) biophysics. Exposes students to techniques including: ion-channel and membrane protein structure analysis, electrophysiological procedures applicable to the investigation and analysis of neurological problems, biomaterials characterization, molecular structure determination, and biophysical techniques for the analysis and characterization of proteins. Opportunities are usually available to receive training in some clinical biophysical

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procedures and techniques in various hospital settings. A lab report describing student research accomplishments is required.

### **BPH 498: Research**

**Credits:** 1-4

**Semester(s):** Fall, Spring, Summer

**Type:** LAB

*The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.*

Under the direction of faculty, experimental and theoretical research in the areas of biophysics, physiology and neurosciences.

### **BPH 499: Independent Study**

**Credits:** 1-4

**Semester(s):** Fall, Spring, Summer

**Type:** TUT

*The content of this course is variable and therefore it is repeatable for credit. The [University Grade Repeat Policy](#) does not apply.*

For students having specific academic interests or objectives; requires department faculty sponsor before registration.