CALIFORNIA STATE POLYTECHNIC UNIVERSITY, POMONA

ACADEMIC SENATE

ACADEMIC PROGRAMS COMMITTEE

REPORT TO

THE ACADEMIC SENATE

AP-032-156

Physics, B.S. – Biophysics Option

Academic Programs Committee	Date: 04/03/2016
Executive Committee Received and Forwarded	Date: 05/18/2016
Academic Senate	Date: <u>05/25/2016</u> <u>First Reading</u> <u>06/01/2016</u> <u>Second Reading</u>

BACKGROUND: The Department of Physics and Astronomy is proposing a new Option in Biophysics under its Bachelor of Science in Physics, to be offered under semesters. The rationale for this program is to provide more opportunities for physics majors to engage in interdisciplinary learning, focused on the application of physics to problems in biology. Since this is an increasingly important area of research in the 21st century, it is expected that this program will be quite useful for students.

RESOURCES CONSULTED:
Faculty
Department Chairs
Associate Deans
Deans
Office of Academic Programs

DISCUSSION:
Before reaching the Academic Programs Committee, this program was reviewed by the College Curriculum Committee in the College of Science as well as the Dean of Science and the Office of Academic Programs. The Academic Programs Committee then conducted campus-wide consultation, as well as its own review of the program. No comments were received by the Academic Programs Committee.

RECOMMENDATION:

The Academic Programs Committee recommends approval of the Option in Biophysics.

BS in Physics
(Biophysics Option)

CURRICULUM SHEET

CURRICULUM SHEET

	Program Name: Bachelor of Science in Physics—Biophysics Option			
	Total Units (Major [including option/emphasis]+GE-Double Count): 119			
	Major Courses – Core – Units: 45			
Course Number		**Title**	**Units (lec/lab)**	**GE Area Double Count**
CHM 1210/1210L		General Chemistry 1	3/1	B1, B3
MAT 1140		Calculus I	4	B4
MAT 1150		Calculus II	4	
MAT 2140		Calculus III	4	
MAT 2250		Linear Algebra with Applications to Differential Equations	4	
MAT 2010		Introduction to Computational Methods in Mathematics	4	
PHY 1510/1510L		Introduction to Newtonian Mechanics	3/1	
PHY 1520/1520L		Introduction to Electromagnetism and Circuits	3/1	
PHY 2530/2530L		Introduction to Electromagnetic Radiation and Special Relativity	3/1	
PHY 2540/2540L		Introduction to Thermal and Quantum Physics	3/1	
PHY 3600/3600A		Mathematical Methods of Physics 1	3/1	
PHY 4630		Senior seminar	1	
	Major Courses – Core Electives – Units: None			
	Option Courses – Units: 16			
Course Number		**Title**	**Units (lec/lab)**	**GE Area Double Count**
CHM 1220/1220L		General Chemistry II	3/1	
BIO 1210/1210L		Foundations of Biology: Energy, Matter, and Information	3/1	B2
BIO 1220/1220L		Foundations of Biology: Evolution, Ecology, and Biodiversity	3/1	
PHY 4330/4330A		Thermal and Statistical Physics	3/1	
Option Electives: 19 units				
Course Number		**Title**	**Units (lec/lab)**	**GE Area Double Count**
2 units chosen from:				
PHY 4510L		Advanced Laboratory Physics—Advanced Instrumentation	1/1	
PHY 4520L		Advanced Laboratory Physics—Contemporary Experiments	1/1	

4 units chosen from:			
PHY 3210/3210A	Advanced Classical Mechanics	3/1	
PHY 4010/4010A	Quantum Mechanics 1	3/1	
PHY 4140/4140A	Electricity and Magnetism 1	3/1	
3 units chosen from:			
PHY 3040/3040L	Electronics for Scientists	2/1	
PHY 3440/3440A	Applied Optics	2/1	
PHY 4090/4090A	Computational Physics	2/1	
PHY 4170/4170L	Wave Optics	2/1	
PHY 4610/4620	Senior Project	1/2	
10 units chosen from the following list, with the provisions that at least 1 unit must be a lab class, at least 3 units must be upper-division, and at least 3 units must be from biology:			
BIO 2060/L	Basic Microbiology	3/1	
BIO 2340/L	Human Anatomy	2/2	
BIO 2350/L	Human Physiology	3/1	
BIO 2400	Genetics	3	
BIO 3220	Cell and Molecular Biology	3	
BIO 4020/L	Developmental Biology	3/1	
BIO/PHY 4100	Biophysics	3	
BIO 4190/L	Neuroscience I: Cell and Molecular	3/1	
BIO 4200	Neuroscience II: Systems Neuroscience	3	
BIO 4240	Neuromuscular Physiology	3	
BIO 4320/L	Molecular Biology Techniques	3/1	
BIO 4360/L	Protein Biotechnology	2/2	
BIO 4380/L	Bioinformatics	3/1	
BIO 4450/L	Physiology I	3/1	
BIO 4460/L	Physiology II	3/1	
BIO 4660/L	Microbial Physiology	3/1	
BIO 4670/L	General Virology	2/2	
CHM 2010/L	Elements of Organic Chemistry	3/1	
CHM 2600	Introduction to Organic Molecular Modeling	3	
CHM 3110	Classical Physical Chemistry	3	
CHM 3120	Quantum Physical Chemistry	3	
CHM 3140/L	Organic Chemistry I	4/1	
CHM 3210/3270L	Elements of Biochemistry/Biochemistry I lab (Note that 3270L can be taken with either 3210 or 3270)	3/1	
CHM 3270/3270L	Biochemistry I	3/1	
CHM 3280/L	Biochemistry II	3/1	
CHM 4210	Computational Biochemistry	3	

GE units not double-counted: 39 (Areas A1, A2, A3, B5, C1, C2, C3, C4, D1, D2, D3, D4, E)

Unrestricted electives: 1

4-YEAR ROADMAP

Department: Physics and Astronomy
Physics Major-Integrated Science Option
Curriculum Year: 2018-2019

Your department has developed this road plan, taking into account prerequisites and schedule restrictions.
Students should pay attention to these concerns when deviating from this plan.

Option Core
Option Electives
GE
Major Core

Year 1: Fall

Course	Description	Units
MAT 1140	Calculus I (GE Area B4)	4
CHM 1210/L	General Chemistry I (GE Area B1&B3)	4
SCI 1010/A	Freshman Experience I (Partial GE Area E)	2
ENG ???	Composition Course (GE Area A1)	3
	Total	**13**

Year 1: Spring

Course	Description	Units
MAT 1150	Calculus II	4
PHY 1510/L	Introduction to Newtonian Mechanics	4
SCI 1020	Freshman Experience II (Complete GE Area E)	1
LD GE 5	Any lower-division course in GE Area A, C, or D	3
CHM 1220/L	General Chemistry II	4
		16

Year 2: Fall

Course	Description	Units
MAT 2140	Calculus III	4
PHY 1520/L	Introduction to Electromagnetism & Circuits	4
BIO 1210/L	Foundations of Biology: Energy, Matter, and Information (GE Area B2)	4
LD GE 7	Any course in GE Area GE Area A, C, or D	3
	Total	**15**

Year 2: Spring

Course	Description	Units
MAT 2010	Introduction to Computational Methods in Mathematics	4
MATH 2250	Linear Algebra with Applications to Differential Equations	4
PHY 2530/L	Introduction to Electromagnetic Radiation & Special Relativity	4
BIO 1220/L	Foundations of Biology: Evolution, Ecology, and Biodiversity	4
	Total	**16**

Year 3: Fall

Course	Description	Units
PHY 2540/L	Introduction to Thermal & Quantum Physics	4
PHY 3600/A	Mathematical Methods of Physics 1	4
BIO ???	Bio elective 1	3
LD GE 8	Any lower-division course in GE Area A, C, or D	3
LD GE 9	Any lower-division course in GE Area A, C, or D	3
	Total	**17**

Year 3: Spring

Course	Description	Units
PHY ????	Physics lab elective	2
PHY ????	PHY Restrictetd Elective	3
BIO ???	Bio elective 2	3
LD GE 10	Any lower-division course in GE Area A, C, or D	3
LD GE 11	Any lower-division course in GE Area A, C, or D	3
		14

Year 4: Fall

Course	Description	Units
PHY 4330/A	Thermal and Statistical Physics	4
BIO ???	Bio Lab Elective	1
PHY ????	Bio elective 3	3
LD GE 12	Any lower-division course in GE Area A, C, or D	3
LD GE 13	Any lower-division course in GE Area A, C, or D	3
	Total	**14**

Year 4: Spring

Course	Description	Units
PHY 4630	Senior Seminar	1
PHY ???	PHY Theory Elective	4
Synthesis 1	Any course in GE Area B5, C4, or D4	3
Synthesis 2	Any course in GE Area B5, C4, or D4	3
Synthesis 3	Any course in GE Area B5, C4, or D4	3
	Free elective	1
	Total	**15**

TWO-YEAR COURSE SCHEDULE

Physics and Astronomy Projected Two-Year Course Schedule

Please refer to BroncoDirect for the current academic quarter course schedule

(x=offered, a=as needed, o=occasional)

Prefix	Number	Title	Units	2018 Fall	2019 Spring	2019 Fall	2020 Spring
AST	1010	Stars, Galaxies, and the Universe	3	x	x	x	x
AST	2000	Special Study for Lower-Division Students	1-2	a	a	a	a
AST	2990/2990A/2990L	Special Topics for Lower-Division Students	1-3	o	o	o	o
AST	3050	Archaeoastronomy	3				x
AST	3240	Observational Astronomy	2		x		x
AST	3240A	Observational Astronomy Computer Activity	1		x		x
AST	3420	Life, the Universe, and Everything	3	x	x	x	x
AST	4000	Special Study for Upper-Division Students	1-2	a	a	a	a
AST	4240	Astrophysics I: Stars and Planetary Systems	3	x		x	
AST	4240A	Astrophysics I Recitation	1	x		x	
AST	4250	Astrophysics II: Galaxies and the Universe	3		x		x
AST	4250A	Astrophysics II Recitation	1		x		x
AST	4610	Senior Project 1	1	a	a	a	a
AST	4620	Senior Project 2	2	a	a	a	a
AST	4990/4990A/4990L	Special Topics for Upper-Division Students	1-3	o	o	o	o
PHY	1020	Fundamentals of Physics	3	x		x	
PHY	1050	The Physics of Musical Sound	2		x		x
PHY	1050L	Physics of Musical Sound Laboratory	1				x
PHY	1210	Physics of Motion, Fluids, and Heat	3	x	x	x	x
PHY	1210L	Laboratory on Motion, Fluids, and Heat	1	x	x	x	x
PHY	1220	Physics of Electromagnetism, Circuits, and Light	3	x	x	x	x
PHY	1220L	Laboratory on Electromagnetism, Circuits, and Light	1	x	x	x	x
PHY	1510	Introduction to Newtonian Mechanics	3	x	x	x	x

PHY	1510A	Newtonian Mechanics Recitation	1	x	x	x	x
PHY	1510L	Newtonian Mechanics Laboratory	1	x	x	x	x
PHY	1520	Introduction to Electromagnetism and Circuits	3	x	x	x	x
PHY	1520A	Electromagnetism and Circuits Recitation	1	x	x	x	x
PHY	1520L	Introductory Laboratory on Electromagnetism and Circuits	1	x	x	x	x
PHY	2000	Special Study for Lower-Division Students	1-2	a	a	a	a
PHY	2120	Physics for Elementary Educators	2	x	x	x	x
PHY	2120L	Physics for Elementary Educators Lab	1	x	x	x	x
PHY	2530	Introduction to Electromagnetic Radiation and Special Relativity	3	x	x	x	x
PHY	2530A	Electromagnetic Radiation and Special Relativity Recitation	1	x	x	x	x
PHY	2530L	Introductory Laboratory on Electromagnetic Radiation and Special Relativity	1	x	x	x	x
PHY	2540	Introduction to Thermal and Quantum Physics	3	x	x	x	x
PHY	2540A	Thermal and Quantum Physics Recitation	1	x	x	x	x
PHY	2540L	Introductory Laboratory on Thermal and Quantum Physics	1	x	x	x	x
PHY	2990/2990A/2990L	Special Topics for Lower-Division Students	1-3	o	o	o	o
PHY	3010	Energy and Society	3		x		x
PHY	3020	Physics for Future Presidents	3	x		x	
PHY	3040	Electronics for Scientists	2		x		x
PHY	3040L	Electronics for Scientists Laboratory	1		x		x
PHY	3060	History of Physics	3	x		x	
PHY	3210	Advanced Classical Mechanics	3		x		x
PHY	3210A	Advanced Classical Mechanics Recitation	1		x		x
PHY	3440	Applied Optics	2	x		x	
PHY	3440A	Computational Activities in Applied Optics	1	x		x	
PHY	3600	Mathematical Methods of Physics 1	3	x	x	x	x
PHY	3600A	Mathematical Methods of Physics Recitation	1	x	x	x	x
PHY	3610	Mathematical Methods of Physics 2	3		x		x
PHY	4000	Special Study for Upper-Division Students	1-2	a	a	a	a
PHY	4010	Quantum Mechanics 1	3	x		x	

PHY	4010	Biophysics	3		x		x
PHY	4010A	Quantum Mechanics 1 Recitation	1	x		x	
PHY	4020	Quantum Mechanics 2	3				x
PHY	4040	Introduction to High Energy Physics	3		x		
PHY	4060	Introduction to Condensed Matter Physics	3	x			
PHY	4090	Computational Physics	2		x		x
PHY	4090A	Computational Physics Activity	1		x		x
PHY	4140	Electricity and Magnetism 1	3		x		x
PHY	4140A	Electricity and Magnetism 1 Recitation	1		x		x
PHY	4150	Electricity and Magnetism 2	3	x		x	
PHY	4170	Wave Optics	2		x		x
PHY	4170L	Wave Optics Laboratory	1		x		x
PHY	4220	Plasma Physics	3			x	
PHY	4330	Thermal and Statistical Physics	3	x		x	
PHY	4330A	Thermal and Statistical Physics Recitation	1	x		x	
PHY	4410	Internship in Physics	1-2	a	a	a	a
PHY	4510A	Advanced Laboratory Physics - Advanced Instrumentation Recitation	1	x	x	x	x
PHY	4510L	Advanced Laboratory Physics - Advanced Instrumentation	1	x	x	x	x
PHY	4520A	Advanced Laboratory Physics - Contemporary Experiments Recitation	1	x	x	x	x
PHY	4520L	Advanced Laboratory Physics - Contemporary Experiments	1	x	x	x	x
PHY	4610	Senior Project 1	1	a	a	a	a
PHY	4620	Senior Project 2	2	a	a	a	a
PHY	4630	Senior Seminar	1		x		x
PHY	4990/4990A/4990L	Special Topics for Upper-Division Students	1-3	o	o	o	o

MISSION, OUTCOMES, AND ASSESSMENT PLAN

MISSION STATEMENT, OUTCOMES, AND ASSESSMENT PLAN FOR THE PHYSICS MAJOR: BIOPHYSICS OPTION

Mission:

The mission of the Biophysics Option is to provide students with multidisciplinary preparation for a wide variety of careers and advanced programs of study that involve the application of physical principles to biological and medical problems, including basic and applied research, careers in biomedical and biotechnology industries, professional studies for clinical careers, and science education.

Program Objectives:

1. Biophysics majors will learn and be able to apply the basic principles of foundational theories of physics to develop models of biological processes and phenomena.
2. Biophysics majors will be able to use common mathematical and computational techniques to obtain quantitative predictions from models.
3. Biophysics majors will be able to work with experimental apparatus to make quantitative measurements on *in vivo* and *in vitro* biological specimens, will be able to identify the limitations of various measuring devices, and will be able to quantify measurement uncertainties and identify sources of error.
4. Biophysics majors will be able to communicate an understanding of fundamental physics principles, of problem solving strategies, and of analyses of experimental data and the inherent uncertainties, in both written and oral forms.
5. Biophysics majors, upon graduation, will be prepared for careers in clinical work, research, teaching, industry, or public service, as well as advanced study in biophysics and related fields.

Student Learning Outcomes:

We have designed the student learning outcomes to be closely aligned with the program objectives:

Area 1: Scientific Principles

LO 1a: Students will be able to identify the appropriate physical quantities to solve for when given information on a physical or biological system and asked to predict its behavior.

LO 1b: Students will be able to identify the appropriate equations to apply for modeling a system, will be able to state the reasons why those equations are necessary and others are not, and will be able to invoke biological principles and data to justify the use of those equations when modeling a biological system.

LO 1c: Students will be able to invoke biological principles and data to evaluate the appropriateness or accuracy of a proposed physical model of a biological system.

LO 1d: Students will be able to use physics models to obtain quantitative predictions for biological systems and devices. Examples may include the performance of medical devices, physical limits on processes in cells, and physiological processes in human organ systems.

LO 1e: In developing these models, students will be able to draw upon key foundational theories of physics, particularly (but not limited to) thermodynamics and statistical mechanics.

Area 2: Theoretical and mathematical skills:

LO 2a: Students will be able to use estimation techniques and dimensional analysis to obtain

quantitative predictions from simple models of a physical or biological system, with the goal of getting estimates that are accurate to within an order of magnitude.
LO 2b: Students will be able to apply standard analytical techniques for the solution of ordinary and partial differential equations to solve common physics equations in situations that are relevant to the biological world.
LO 2c: Students will be able to use proportional reasoning and dimensional analysis to check analytical solutions, and to predict the qualitative behavior of physical and biological systems.
LO 2d: Students will be able to use computer tools to solve physically and/or biologically relevant problems that are not amenable to exact solutions.
Area 3: Experimental and technological skills
LO 3a: Students will be able to set up and troubleshoot components of experimental and/or computational tools in order to perform a measurement or simulation of a physically relevant quantity or phenomenon.
LO 3b: Students will be able to quantitatively describe the limitations of their experimental apparatus or algorithm, and use information on those limitations to determine uncertainties in measured quantities or precision of computed quantities.
LO 3c: Students will be able to analyze experimental or simulation data and compare the results of the data analysis with predictions from physical theories.
LO 3d: Students will be able to use basic laboratory tools and techniques from either biochemistry or a subfield of biology, at a level comparable to a second-year (or higher) student in biology or biochemistry.
Area 4: Professional Communication Skills
LO 4a: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of experimental or computational investigations of biophysical problems.
LO 4b: Students will be able to give verbal presentations on physical principles, applications of physical and biological principles, and the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.

Curriculum Matrix: We will collect evidence for assessment of learning outcomes from (1) courses required of all students in this program and (2) relevant electives taken by a large portion of the students in the program. Core courses are listed in **bold red**, and elective courses are listed in *gray italics*. We are leaving out activity courses that are designed primarily to reinforce concepts from lecture, but are including selected activity courses that include significant hands-on projects.

	Learning outcomes														
Classes	1a: Identify physical quantities	1b: Identify appropriate equations	1c: Use Biological Principles	1d: Obtain real-world predictions from models	1e: Use foundational theories	2a: Estimation	2b: Analytical techniques	2c: Proportional reasoning	2d: Computation	3a: Set up experiments or computations	3b: Uncertainty	3c: Data analysis	3d: Biology and biochemistry lab proficiency	4a: Written communication	4b: Spoken communication
PHY 2530: EM waves & relativity	x	x		x	x	x	x	x							
PHY 2530L: EM waves & relativity lab						x		x		x	x	x		x	x*
PHY 2540: Thermo & QM	x	x		x	x	x	x	x							
PHY 2540L: Thermo & QM lab						x		x		x	x	x		x	x*
PHY 3040: Electronics	x	x		x	x	x	x	x							
PHY 3040L: Electronics lab						x		x		x	x	x		x	x*
PHY 3440: Applied Optics	x	x		x	x	x	x	x							
PHY 3440A: Applied optics computational activity						x			x			x		x	
PHY 3600: Math methods	x	x		x	x	x	x	x							
PHY 4090: Computational	x	x		x	x	x		x	x	x	x	x		x	
PHY 4100: Biophysics	x	x	x	x	x	x	x	x	x*			x		x	x
PHY 4170: Wave optics	x	x		x	x	x	x	x							
PHY 4170L: Wave optics lab						x		x		x	x	x		x	x
PHY 4330: Thermo	x	x		x	x	x	x	x							
Physics theory electives	x	x		x	x	x	x	x							
PHY 4510 A/L and/or PHY 4520 A/L:						x		x		x	x	x		x	x*
PHY 4610/4620: Senior project (if project topic is biophysical)	x*	x*	x	x*	x*	x	x*	x	x*	x	x	x	x*	x	x
PHY 4630: Seminar			x*	x		x		x				x		x	x
Advanced bio/chem lectures			x			x		x							
Advanced bio/chem labs			x			x		x	x*	x	x	x	x	x	x*
				*When applicable; instructor-dependent											

Methods of Assessment:

The committee responsible for assessment will request the following from instructors of relevant courses:

1) Copies of questions, problems, and assignments that are particularly useful for assessing the program's learning outcomes.
2) A summary (including scores, grades, or other quantitative results) of class performance on those assignments, problems, etc. in the past year (including both the average and the range).
3) Examples of student work that highlight areas of particularly common strengths and weaknesses.

Timeline of Assessment:

In order to align our assessment efforts with the five year planning and program review cycle, and to synchronize assessment of courses with similar learning outcomes, we plan to collect and analyze evidence relating to each learning objective twice in a five year cycle. All courses mentioned below are those listed on the Curriculum Matrix above. When assessing biophysics majors' performance in biology or chemistry courses, we will contact biology or chemistry instructors whose courses are eligible for biophysics major elective credit and have especially high number of biophysics majors, and request data on performance of biophysics majors on relevant tests, projects, or problem sets.

Year	Data Collection	Key Learning Outcomes	Action/Plans
1	Lecture/discussion courses without accompanying labs, chemistry or biology classes (200 level or higher) with high biophysics enrollments.	LO 1a-1e, 2a-2c (Concepts, principles, and theories)	• Presentation to department. • Evaluation in light of previous 5 year review. • Plans for near-term improvements.
2	Lab and activity classes, and senior seminar, biology or biochemistry lab electives (200 level or higher) with high biophysics enrollments.	LO 2d, 3a-3d, 4a-4b (Laboratory, technological, and professional skills)	• Presentation to department. • Evaluation in light of previous 5 year review. • Plans for near-term improvements.
3	Lab and activity classes, and senior seminar, biology or biochemistry lab electives (200 level or higher) with high biophysics enrollments.	LO 1a-1e, 2a-2c (Concepts, principles, and theories)	• Presentation to department. • Evaluation in light of year 1 plans. • Begin planning more substantial changes and improvements.
4	Lab and activity classes, and senior seminar	LO 2d, 3a-3d, 4a-4b (Laboratory, technological, and professional skills)	• Presentation to department. • Evaluation in light of year 1 plans. • Begin planning more substantial changes and improvements.
5	Summary of years 1-4, and additional data for areas identified as needing further analysis.		• Evaluation of past years of effort. • Evaluate effectiveness of attempts to improve. • Reconsider program objectives. • Plan changes for future.

Learning outcomes

Classes	1a: Identify physical quantities	1b: Identify appropriate equations	1c: Use symmetry	1d: Obtain real-world predictions from models	1e: Use foundational theories	2a: Estimation	2b: Analytical techniques	2c: Proportional reasoning	2d: Computation	3a: Set up experiments or computations	3b: Uncertainty	3c: Data analysis	4a: Written communication	4b: Spoken communication
PHY 1510: Newtonian Mechanics	I	I	I	I	I	I	I	I						
PHY 1510L: Newtonian Mechanics Lab						I		I		I	I	I	I	I
PHY 1520: E&M	I	I	I	I	I	I	I	I						
PHY 1520L: E&M Lab						I		I		I	I	I	I	I
PHY 2530: EM waves & relativity	D	D	D	D	D	D	D	D						
PHY 2530L: EM waves & relativity lab						D		D		D	D	D	D	D*
PHY 2540: Thermo & QM	D	D	D	D	D	D	D	D						
PHY 2540L: Thermo & QM lab						D		D		D	D	D	D	D*
MAT 2010: Numerical Methods									I					
PHY 3040: Electronics	D	D	D	D	D	D	D	D						
PHY 3040L: Electronics lab						D		D		D	D	D	D	D*
AST 3240: Observational Astronomy	D	D		D	D	D	D	D						
AST 3240A: Observational Astronomy Computer Activity						D		D		D	D	D	D	D*
PHY 3210: Mechanics	D	D	D	D	D	D	D	D	D					
PHY 3440: Applied Optics	D	D	D	D	D	D	D	D						
PHY 3440A: Applied optics computational activity						D			D			D	D	D*
PHY 3600: Math methods	D	D	D	D	D	D	D	D						
PHY 4010: Quantum	M	M	M	M	M	M	M	M						
PHY 4090: Computational	M	M	M	M	M	M		M	M	M	M	M	M	M*
PHY 4140: E&M	M	M	M	M	M	M	M	M						
PHY 4170: Wave optics	M	M	M	M	M	M	M	M						
PHY 4170L: Wave optics lab						M		M		M	M	M	M	M*
PHY 4330: Thermo	M	M	M	M	M	M	M	M						
PHY 4510 A/L: Adv. Lab 1						M		M		M	M	M	M	M*
PHY 4520 A/L: Adv. Lab 2						M		M		M	M	M	M	M*
PHY 4630: Seminar				M		M		M				M	M	M*

*When applicable; instructor-dependent

Learning outcomes

Classes	1a: Identify physical quantities	1b: Identify appropriate equations	1c: Use Biological Principles	1d: Obtain real-world predictions from models	1e: Use foundational theories	2a: Estimation	2b: Analytical techniques	2c: Proportional reasoning	2d: Computation	3a: Set up experiments or computations	3b: Uncertainty	3c: Data analysis	3d: Biology and biochemistry lab proficiency	4a: Written communication	4b: Spoken communication
PHY 1510: Newtonian Mechanics	I	I		I	I	I	I	I							
PHY 1510L: Newtonian Mechanics Lab						I		I		I	I	I		I	I
PHY 1520: E&M	I	I		I	I	I	I	I							
PHY 1520L: E&M Lab						I		I		I	I	I		I	I
PHY 2530: EM waves & relativity	D	D		D	D	D	D	D							
PHY 2530L: EM waves & relativity lab						D		D		D	D	D		D	D*
PHY 2540: Thermo & QM	D	D		D	D	D	D	D							
PHY 2540L: Thermo & QM lab						D		D		x	x	x		x	D*
BIO 1210, 1220: Intro bio principles			I												
BIO 1210l, 1220L: Intro bio labs													I		
MAT 2010: Numerical Methods									I						
PHY 3040: Electronics	D	D		D	D	D	D	D							
PHY 3040L: Electronics lab						D		D		D	D	D		x	D*
PHY 3440: Applied Optics	D	D		D	D	D	D	D							
PHY 3440A: Applied optics computational activity						D			D			D		D	D*
PHY 3600: Math methods	D	D		D	D	D	D	D							
PHY 4090: Computational	M	M		M	M	M		M	M	M	M	M		M	M*
PHY 4100: Biophysics	M	M	D	M	M	M	M	M	D*			M		M	M*
PHY 4170: Wave optics	M	M		M	M	M	M	M							
PHY 4170L: Wave optics lab						M		M		M	M	M		M	M*
PHY 4330: Thermo	M	M		M	M	M	M	M							
Physics theory electives	M	M		M	M	M	M	M							
PHY 4510 A/L and/or PHY 4520 A/L:						M		M		M	M	M		M	M*
PHY 4610/4620: Senior project (if project topic is biophysical)	M*	M*	M	M*	M*	M	M	M	M*	M	M	M	M*	M	
PHY 4630: Seminar			M*	M		M		M				M		M	M*

Advanced bio/chem lectures			D			M		M							
Advanced bio/chem labs			D			D		D	D*	D	D	D	D	D	D*

*When applicable; instructor-dependent

Learning outcomes

Classes	1a: Identify physical quantities	1b: Identify appropriate equations	1c: Obtain real-world predictions from models	1d: Use foundational theories of physics	1e: Describe foundational principles of biology, chemistry, & geology	2a: Estimation	2b: Analytical techniques	2c: Proportional reasoning	2d: Computation	3a: Set up experiments or computations	3b: Uncertainty	3c: Data analysis	4a: Written communication	4b: Spoken communication	5a: Integrate content and pedagogy	5b: Observe phenomena & develop explanations	5c: Use explanations to make predictions	5d: Evaluate experimental outcomes	5e: Represent physical processes multiple ways
PHY 1510: Newtonian Mechanics	I	I	I	I		I	I	I									I		I
PHY 1510L: Newtonian Mechanics Lab						I		I		I	I	I	I	I		I	I	I	I
PHY 1520: E&M	I	I	I	I		I	I	I									I		I
PHY 1520L: E&M Lab						I		I		I	I	I	I	I		I	I	I	I
PHY 2530: EM waves & relativity	D	D		D		D	D	D									D		D
PHY 2530L: EM waves & relativity lab						D		D		D	D	D	D	D*		D	D	D	D
PHY 2540: Thermo & QM	D	D		D		D	D	D									D		D
PHY 2540L: Thermo & QM lab						D		D		D	D	D	D	D*		D	D	D	D
MAT 2010: Numerical Methods									I										
PHY 3040: Electronics	D	D		D		D	D	D											D
PHY 3040L: Electronics lab						D		D		D	D	D	D	D*		D	D	D	
PHY 3210: Mechanics	D	D	D	D		D	D	D	D										D
AST 3240: Observational Astronomy	D	D		D		D	D	D								D	D	D	D
AST 3240A: Observational Astronomy Computer Activity						D		D		D	D	D	D	D*		D	D	D	D
PHY 3440: Applied Optics	D	D	D	D		D	D	D											D
PHY 3440A: Applied optics computational activity						D			M			D	D	D*		D	D		D
PHY 3600: Math methods	D	D		D		D	D	D											
PHY 4090: Computational	M	M		M		M		M	M	M	M	M	M	M*					M
PHY 4100: Biophysics	M	M	M	M	D	M	M	M	D*			M	M	M*		M	M	M	M
PHY 4170: Wave optics	M	M		M		M	M	M											M
PHY 4170L: Wave optics lab						M		M		M	M	M	M	M*		M	M	M	M
Physics theory electives	M	M		M		M	M	M											M
PHY 4510 A/L and/or PHY 4520 A/L:						M		M		M	M	M	M	M*		M	M	M	

PHY 4610/4620: Senior project (for relevant project topics)	M*	M*	M	M*	M*	M	M*	M	M*	M	M	M	M	M	M	M			M
PHY 4630: Seminar					M										D				
Teaching Experience															I, D				
BIO 1210					I														
BIO 1210L					I														
BIO 1220					I														
BIO 1220L					I														
CHM 1210					I														
CHM 1210L					I														
CHM 1220					I														
CHM 1220L					I														
GSC 1110: Principles of Geology					I														
GSC 1140: Principles of Geology Laboratory					I														
GSC 1160: Astronomy					I														

*When applicable; instructor-dependent

Curriculum Proposal: Option in Biophysics

Prepared by Alex Small, Associate Professor, Department of Physics and Astronomy

Key information

The department of Physics and Astronomy is submitting this request to create an **option** in Biophysics under the existing Bachelor of Science program in Physics.

There are currently no options under the existing Bachelor of Science program in Physics. This option will include courses from the departments of Physics and Astronomy, Biological Sciences, Chemistry and Biochemistry, and Mathematics and Statistics.

Aims of the program

This program, ***designed with the support of the faculty of the departments of Biological Sciences and Chemistry and Biochemistry (see letters of support at end of document)***, will provide students with opportunities for ***interdisciplinary study at the interface of the physical and biological sciences***. The goal is to produce fully cross-trained students who are fluent in the highly quantitative and reductionist approaches of the physical scientist, yet are comfortable with the complexity, detail, and wet lab work of the life scientist. These students will be able to join teams (whether in the private sector, academic work, or clinical settings) where the task at hand may involve a biological or medical problem, but the intellectual and technological approaches draw heavily upon the tools and quantitative techniques of physical science.

Consistent with this aim, we have the following Mission Statement for the Biophysics Option:

> *The mission of the Biophysics Option is to provide students with multidisciplinary preparation for a wide variety of careers and advanced programs of study that involve the application of physical principles to biological and medical problems, including basic and applied research, careers in biomedical and biotechnology industries, professional studies for clinical careers, and science education.*

In pursuit of that mission, the curriculum for this degree option (described below) will require a mix of core physics courses (both laboratory and theoretical) at the same level as those taken by other physics majors, the same introductory biology courses as biology majors, and then a mix of electives that include upper-division biology and chemistry lectures and labs as well as project-oriented physics classes that emphasize laboratory and computational techniques. The biology and chemistry electives in this option emphasize topics most relevant to the career interests of most physicists working in biology: cellular and molecular biology, physiology, biochemistry, and molecular modeling for research careers, and anatomy and physiology for medical imaging careers.

Consistent with a curriculum that emphasizes the methods of physics complemented by a solid foundation in biology and chemistry, we have the following Program Objectives:

1. Biophysics majors will learn and be able to apply the basic principles of foundational theories of physics to develop models of biological processes and phenomena.
2. Biophysics majors will be able to use common mathematical and computational techniques to obtain quantitative predictions from models.

3. Biophysics majors will be able to work with experimental apparatus to make quantitative measurements on *in vivo* and *in vitro* biological specimens, will be able to identify the limitations of various measuring devices, and will be able to quantify measurement uncertainties and identify sources of error.

4. Biophysics majors will be able to communicate an understanding of fundamental physics principles, of problem solving strategies, and of analyses of experimental data and the inherent uncertainties, in both written and oral forms.

5. Biophysics majors, upon graduation, will be prepared for careers in clinical work, research, teaching, industry, or public service, as well as advanced study in biophysics and related fields.

To achieve those objectives, we have the following Learning Outcomes, which are closely aligned with the Program Objectives:

Area 1: Scientific Principles

LO 1a: Students will be able to identify the appropriate physical quantities to solve for when given information on a physical or biological system and asked to predict its behavior.

LO 1b: Students will be able to identify the appropriate equations to apply for modeling a system, will be able to state the reasons why those equations are necessary and others are not, and will be able to invoke biological principles and data to justify the use of those equations when modeling a biological system.

LO 1c: Students will be able to invoke biological principles and data to evaluate the appropriateness or accuracy of a proposed physical model of a biological system.

LO 1d: Students will be able to use physics models to obtain quantitative predictions for biological systems and devices. Examples may include the performance of medical devices, physical limits on processes in cells, and physiological processes in human organ systems.

LO 1e: In developing these models, students will be able to draw upon key foundational theories of physics, particularly (but not limited to) thermodynamics and statistical mechanics.

Area 2: Theoretical, mathematical, and computational skills:

LO 2a: Students will be able to use estimation techniques and dimensional analysis to obtain quantitative predictions from simple models of a physical or biological system, with the goal of getting estimates that are accurate to within an order of magnitude.

LO 2b: Students will be able to apply standard analytical techniques for the solution of ordinary and partial differential equations to solve common physics equations in situations that are relevant to the biological world.

LO 2c: Students will be able to use proportional reasoning and dimensional analysis to check analytical solutions, and to predict the qualitative behavior of physical and biological systems.

LO 2d: Students will be able to use computer tools to solve physically and/or biologically relevant problems that are not amenable to exact solutions.

Area 3: Experimental and technological skills
LO 3a: Students will be able to set up and troubleshoot components of experimental and/or computational tools in order to perform a measurement or simulation of a physically relevant quantity or phenomenon.

LO 3b: Students will be able to quantitatively describe the limitations of their experimental apparatus or algorithm, and use information on those limitations to determine uncertainties in measured quantities or precision of computed quantities.

LO 3c: Students will be able to analyze experimental or simulation data and compare the results of the data analysis with predictions from physical theories.

LO 3d: Students will be able to use basic laboratory tools and techniques from either biochemistry or a subfield of biology, at a level comparable to a second-year (or higher) student in biology or biochemistry.

Area 4: Professional communication skills
LO 4a: Students will be able to write professional-quality reports that describe the methods, results, and interpretation of experimental or computational investigations of biophysical problems.

LO 4b: Students will be able to give verbal presentations on physical principles, applications of physical and biological principles, and the results of physics investigations, at a level understandable by an audience of novices. These presentations may include visual aids.

A separate document describes the methods by which these learning outcomes will be assessed.

Justification of need for this program

There has long been a fruitful interplay between the life and physical sciences, from the invention of the microscope and Galileo's investigations in biomechanics[1], to the medical imaging and radiation therapy devices that are now commonplace in modern hospitals. ***Unfortunately, there has also long been a separation of expertise between the physical and life sciences***, with the typical undergraduate science program being structured to cultivate deep expertise in one and only superficial knowledge of the other. Cross-trained people have typically been found only in a few specialties (e.g. medical imaging, biophysical chemistry). However, in the 21st century, many of the most important, challenging, and exciting questions in the life sciences are being investigated with techniques and ideas from the physical sciences, from laboratory and event computational investigations of cellular and molecular processes to clinical studies with cutting-edge radiological tools.

An Option in Biophysics would open up paths into the frontiers of biological research. There is perhaps no greater recognition of the prominence of the physical sciences in biology than the recent Nobel Prizes for superresolution imaging (Chemistry prize, 2014) and molecular modeling (Chemistry prize, 2013). Superresolution imaging is a method for imaging cells at the nanometer scale, and was developed primarily by people with degrees in physics (e.g. Stefan Hell, Eric Betzig, W. E. Moerner, Xiaowei Zhuang) but is applied primarily in biology. Likewise, molecular modeling uses sophisticated computational tools to predict the behavior of biological molecules via theories from physics and physical chemistry. One cannot use these techniques to answer questions without a meaningful

[1] Galilei, G. (1974). Two new sciences (S. Drake, Trans.): Wisconsin UP.

understanding of the biological basis of the questions being posed, but one cannot produce reliable answers without a thorough understanding of the physics and chemistry underlying the tools and their limitations.

Moreover, whereas some of the tools brought to biology from physics have either been reduced to "turn-key" usability or else been adopted primarily by subspecialists, in recent years physical and computational tools are seeing ever more rapid and widespread adoption in the life sciences, whether from molecular modeling, optical imaging, bioinformatics, or other areas. For all of these tools, effective use requires a cross-trained perspective, with equal comfort performing cell culture and performing advanced calculations for data analysis, or equal comfort interpreting gene sequences and interpreting molecular spectra. In recognition of this growing interdependence of the physical and life sciences, in the 2004 book *Facilitating Interdisciplinary Research*[2], the National Academies recommended that:

> Undergraduate students should seek out interdisciplinary experiences, such as courses at the interfaces of traditional disciplines that address basic research problems, interdisciplinary courses that address societal problems, and research experiences that span more than one traditional discipline. *(Executive summary, page 4)*

Cal Poly Pomona could assist students on that path by considering another recommendation of the National Academies:

> Institutions should support interdisciplinary education and training for students, postdoctoral scholars, researchers, and faculty by providing such mechanisms as undergraduate research opportunities, faculty team-teaching credit, and IDR [InterDisciplinary Research] management training. *(Executive summary, page 5)*

The creation of an interdisciplinary Option in Biophysics could be the first step on that road for Cal Poly. Indeed, the creation of interdisciplinary undergraduate degree programs with depth in more than one field is explicitly highlighted in the report.[3]

It is worth noting that the prominence of biophysics in modern life sciences research extends beyond a few reports and prizes. The Biophysical Society, a leading national and international organization of people working at the intersection of physics and biology has 9,400 members[4], while the Federation of American Societies of Experimental Biology (an umbrella organization for many different fields of biology) has 125,000 members spread among 27 societies[5], making Biophysical Society twice the size of the average professional organization for biologists. Although universities tend not to confer undergraduate degrees in specific sub-fields or niches of a discipline, biophysics is unique in being not a specific niche but rather a large interdisciplinary field of growing prominence. Offering an Option in Biophysics would therefore give our students a chance to study a vitally important branch of 21st century science without specializing in a way that would undermine the breadth that is traditionally (and rightly) valued in undergraduate education.

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[2] National Academies Press, 2004, free pdf available at http://www.nap.edu/catalog/11153/facilitating-interdisciplinary-research

[3] *ibid*, page 96

[4] http://www.biophysics.org/MembershipSubgroups/tabid/61/Default.aspx

[5] http://www.faseb.org/About-FASEB/Who-We-Are.aspx

Beyond research paths, perhaps the strongest evidence of the market demand for cross-trained students outside of research settings is that ***<u>the highest paid physics jobs in 2014 were in medical settings, according to the Bureau of Labor Statistics.</u>***[6] This is tangible evidence of market demand for physicists who are knowledgeable about the life sciences. Additionally, physics majors typically have some of the highest MCAT scores of any group of undergraduate students, making them very competitive for admission to medical school.[7] Unfortunately, physics majors rarely have room in their curricula to take all of the biology, chemistry, and other courses needed for medical school admissions. Additionally, the Howard Hughes Medical Institute's report *Scientific Foundations for Future Physicians*[8] explicitly calls for pre-medical students to study physics and biology as integrated subjects. Despite these calls, however, most students study physics and biology as separate subjects rather than as part of an integrated program. The proposed Option in Biophysics would provide such an integrated program, with room for students to take the prerequisites for medical school while also getting the physics training that tends to make physics majors especially competitive medical school applicants.

Finally, although we currently have no formal survey data with which to gauge student interest, the Biophysics course (Physics 410/Biology 410, to be numbered 4100 under semesters) is the course that sits at the interdisciplinary center of this option, and the demand for this course is the best indicator of student interest in biophysics. Although 410 was originally intended to be offered every other year, due to high demand (especially among biology majors, who comprise a large majority of the enrollment), since 2009 it has been offered every winter quarter. Offering the course multiple times per year has not been contemplated because historically it was only offered every other year, but if demand increases we can and will consider a variety of ways of accommodating student demand.

Additionally, the Applied Optics course (Physics 344, to be numbered 3440 under semesters) is another physics course that has been taught with a strong emphasis on the interface between physics and biology. Prior to 2010 it was not offered on a regular basis. In Fall of 2010, however, Dr. Alex Small began to teach the course with an emphasis on biomedical applications of optics, and highlighted this to students. Since then, the course has had consistently high enrollment by the standards of an upper division physics course. Again, this course has traditionally been offered only once per year because of low demand, but if demand continues to increase with the emphasis on biomedical applications, we can and will consider a variety of ways to accommodate student demand.

These course enrollment totals are summarized in the table below.

Academic Year	Biophysics (BIO 410/PHY 410) Enrollment	Applied Optics (PHY 344) Enrollment
2008-2009	21	0
2009-2010	23	0
2010-2011	27	26*
2011-2012	35	20
2012-2013	44	23
2013-2014	28	21

[6] http://www.bls.gov/oes/current/oes192012.htm
[7] https://www.aip.org/sites/default/files/statistics/undergrad/mcat-lsat1.pdf
[8] Howard Hughes Medical Institute, *Scientific Foundations for Future Physicians* (2009), http://www.hhmi.org/grants/sffp.html

2014-2015	31	26
2015-2016	Not yet available	24

*This is the first time that it was offered with an emphasis on biomedical applications.

Courses required for the program

This program requires 120 units, divided as follows:

1) 45 units of courses taken by all students in the Bachelor of Science program in Physics, including both biophysics students and students in other options:

CHM 1210/1210L	General Chemistry 1*	3/1
MAT 1140	Calculus I**	4
MAT 1150	Calculus II	4
MAT 2140	Calculus III	4
MAT 2250	Linear Algebra with Applications to Differential Equations	4
MAT 2010	Introduction to Computational Methods in Mathematics	4
PHY 1510/1510L	Introduction to Newtonian Mechanics	3/1
PHY 1520/1520L	Introduction to Electromagnetism and Circuits	3/1
PHY 2530/2530L	Introduction to Electromagnetic Radiation and Special Relativity	3/1
PHY 2540/2540L	Introduction to Thermal and Quantum Physics	3/1
PHY 3600/3600A	Mathematical Methods of Physics 1	3/1
PHY 4630	Senior seminar	1

*Double-counts for GE Areas B1 and B3

**Double-counts for GE Area B4.

2) 16 units of courses required for the Option in Biophysics:

CHM 1220/1220L	General Chemistry II	3/1
BIO 1210/1210L	Foundations of Biology: Energy, Matter, and Information***	3/1
BIO 1220/1220L	Foundations of Biology: Evolution, Ecology, and Biodiversity	3/1
PHY 4330/4330A	Thermal and Statistical Physics	3/1

***Double-counts for GE Area B2

3) 19 units of electives for the Option in Biophysics:

2 units chosen from:		
PHY 4510L	Advanced Laboratory Physics—Advanced Instrumentation	1/1
PHY 4520L	Advanced Laboratory Physics—Contemporary Experiments	1/1
4 units chosen from:		
PHY 3210/3210A	Advanced Classical Mechanics	3/1
PHY 4010/4010A	Quantum Mechanics 1	3/1
PHY 4140/4140A	Electricity and Magnetism 1	3/1
3 units chosen from:		
PHY 3040/3040L	Electronics for Scientists	2/1
PHY 3440/3440A	Applied Optics	2/1
PHY 4090/4090A	Computational Physics	2/1
PHY 4170/4170L	Wave Optics	2/1
PHY 4610/4620	Senior Project	1/2

10 units chosen from the following list, with the provisions that at least 1 unit must be a lab class, at least 3 units must be upper-division, and at least 3 units must be from biology:		
BIO 2060/L	Basic Microbiology	3/1
BIO 2340/L	Human Anatomy	2/2
BIO 2350/L	Human Physiology	3/1
BIO 2400	Genetics	3
BIO 3220	Cell and Molecular Biology	3
BIO 4020/L	Developmental Biology	3/1
BIO 4100	Biophysics	3
BIO 4190/L	Neuroscience I: Cell and Molecular	3/1
BIO 4240	Neuromuscular Physiology	3
BIO 4320/L	Molecular Biology Techniques	3/1
BIO 4360/L	Protein Biotechnology	2/2
BIO 4380/L	Bioinformatics	3/1
BIO 4450/L	Physiology I	3/1
BIO 4660/L	Microbial Physiology	3/1
BIO 4670/L	General Virology	2/2
CHM 2010/L	Elements of Organic Chemistry	3/1
CHM 2600	Introduction to Organic Molecular Modeling	3
CHM 3110	Classical Physical Chemistry	3
CHM 3120	Quantum Physical Chemistry	3
CHM 3140/L	Organic Chemistry I	4/1
CHM 3210/3270L	Elements of Biochemistry/Biochemistry I lab (Note that 3270L can be taken with either 3210 or 3270)	3/1
CHM 3270/3270L	Biochemistry I	3/1
CHM 3280/L	Biochemistry II	3/1
CHM 4210	Computational Biochemistry	3

4) 39 units of GE courses (in addition to the double-counted courses listed above).
5) 1 unit of unrestricted elective.

Separate from this document, we have developed a curriculum sheet and also a list of student learning outcomes that includes an assessment plan.

New courses to be developed

None.

This program is designed to make effective use of existing courses. The purpose of this program is not to bring a new field to our campus, but rather to have ***a program that combines courses available in existing disciplines and builds on existing capabilities***.

Faculty teaching in the proposed program

Lower-division courses for this program are foundational, and may be taught by any of the faculty in Physics and Astronomy, Biological Sciences, Chemistry and Biochemistry, and Mathematics and Statistics. The upper-division physics courses in this program will primarily be taught by the people listed below:

- Dr. Nina Abramzon, Professor (with tenure), PhD in Physics (1999). Research experience in plasma physics and spectroscopy, including biomedical applications of plasmas.
- Dr. Steven McCauley, Professor (with tenure), PhD in Physics (1982). Research experience in photosynthesis.
- Dr. Hector Mireles, Professor (with tenure), PhD in Physics (2000). Research experience in magnetism, microscopy, and physics of "soft" materials.
- Dr. Jorge Moreno, Assistant Professor (probationary), PhD in Physics (2010). Research experience in computational astrophysics.
- Dr. Matthew Povich, Assistant Professor (probationary), PhD in Astronomy (2009). Research experience in observational astronomy.
- Dr. Alexander Rudolph, Professor (with tenure), PhD in Physics (1988). Research experience in observational astronomy and physics and astronomy education.
- Dr. Qing Ryan, Assistant Professor (probationary), PhD in Physics (2014). Research experience in physics education.
- Dr. Homeyra Sadaghiani, Associate Professor (with tenure), PhD in Physics (2005). Research experience in physics education.
- Dr. Ertan Salik, Associate Professor (with tenure), PhD in Physics (2001). Research experience in fiber optics and biosensors.
- Dr. Alex Small, Associate Professor (with tenure), PhD in Physics (2005). Research experience in biophotonics, mathematical models in biology, statistical physics, and soft materials.
- Dr. Kurt Vandervoort, Professor (with tenure), PhD in Physics (1990). Research experience in superconductivity, atomic force microscopy, and biofilms.

Additional Resources Required

None. This program is designed to give students the opportunity to pursue an interdisciplinary path that draws on existing resources on campus.

While it is hoped that this program will attract significant student interest, necessitating more advising and project mentoring for biophysics students, the Department of Physics and Astronomy (the primary home for this program) is ***already in the midst of a 5-position hiring plan that will include two tenure-track hires in biophysics***. This plan was developed in consultation with the Dean in 2012, with the first search process beginning in 2013 and this third search currently underway. While the anticipated new biophysics faculty will primarily be teaching our lower-division service and upper-division core courses, many of those courses are included in this Option in Biophysics, and one key purpose of hiring those faculty will be to have our courses taught by people experienced in applications of physics to biology, so that they can show physics majors in all programs/options the ways in which the subject is relevant to modern challenges. Consequently, even in many of their core physics classes the biophysics students will learn from people who draw upon experience in biophysics research for their examples and approaches. (They will also get complementary perspectives from other physics faculty, ensuring a grounding in the breadth and fundamentals of physics, rather than a narrow perspective.)

Additionally, if the program attracts significant student interest, those new hires—alongside current faculty with research programs in biophysics—will be able to supervise senior projects in biophysics.