BIOMEDICAL SCIENCE, BA

2nd Major for College Students only.

College students can apply for a second major in Biomedical Science. This will result in a single degree from the College with two majors (note that this option is only for students in the College, not Engineering students).

Students must complete 12.5 Credit Units of Engineering requirements, taken from the BAS Program (https://be.seas.upenn.edu/undergraduate/ curriculum/bas-requirements/). Background courses in Mathematics and the Natural Sciences are also required.

Curriculum

Code

Course Units

01

Minimal Math and Science Background Required:

Title

Mathematics		
MATH 1400	Calculus, Part I	
MATH 1410	Calculus, Part II	
ENM 2400	Differential Equations and Linear Algebra	
or MATH 24	I00alculus, Part III	
or MATH 26	000 nors Calculus, Part II	
ENM 3750	Biological Data Science I - Fundamentals of Biostatistics	
or ENM 344	CAnswering Questions with Data, for Everyone	
or ESE 4020) Statistics for Data Science	
or STAT 431	Statistical Inference	
Science		
BIOL 1121	Introduction to Biology - The Molecular Biology of Life	
BIOL 1123	Introductory Molecular Biology Laboratory	
BIOL 3310	Principles of Human Physiology	
CHEM 1012	General Chemistry I	
or CHEM 11	5Ħonors Chemistry I	
CHEM 1101	General Chemistry Laboratory I	
CHEM 1022	General Chemistry II	
or CHEM 11	6Honors Chemistry II	
CHEM 1102	General Chemistry Laboratory II	
PHYS 0140	Principles of Physics I (without laboratory)	
PHYS 0141	Principles of Physics II (without laboratory)	
Engineering Requ	lirements	
BE 1000	Introduction to Bioengineering	0.
ENGR 1050	Introduction to Scientific Computing (or CIS 1200 or higher)	
BE 2000	Introduction to Biomechanics	
BE 2200	Biomaterials	
BE 2700	Bioengineering Laboratory Principles	·
BE 3010	Bioengineering Signals and Systems	
or BE 3060	Cellular Engineering	
or BE 3500	Introduction to Biotransport Processes	
BE 3090	Bioengineering Modeling, Analysis and Design Laboratory I	
BE 4970	Senior Thesis in Biomedical Science	

Total Course Units	S	12.5
Engineering Elect	ive ¹	2
BE Elective (4000	or 5000 level)	2
BE 4980	Senior Thesis in Biomedical Science	1

Engineering Electives (Engineering XXXX) in the Engineering Category can be fulfilled by any course that counts as Engineering per the handbook (https://ugrad.seas.upenn.edu/student-handbook/coursesrequirements/engineering-courses/). Please note that EAS (Engineering and Applied Science) courses DO NOT count as Engineering.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2025 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.

Degree Concentrations

Students may select one of nine concentrations (http:// www.be.seas.upenn.edu/current-students/undergraduates/ concentrations.php).

Concentrations are not required, but are intended to provide students with the option to obtain a more focused education in a particular field of study or sub-topic within a given field. To satisfy the requirements for a concentration, students must select at least 4 courses from any of the categories listed below. At least two courses must be from Bioengineering.

Biomedical Data Science and Computational Medicine

Code	Title	Course Units
Select 2 courses i	n:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5040	Biological Data Science II: Data Mining Principles for Epigenomics	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	
BE 5590	Multiscale Modeling of Chemical and Biological Systems	
BE 5660	Networked Neuroscience	
Select 2 additiona	Il courses in:	2
BE 4900	Independent Project in Bioengineering	
BE 5040	Biological Data Science II: Data Mining Principles for Epigenomics	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	
BE 5590	Multiscale Modeling of Chemical and Biological Systems	
BE 5660	Networked Neuroscience	
CIS 4210	Artificial Intelligence	
or CIS 5210	Artificial Intelligence	

CIS 4	500	Database and Information Systems
CIS 5	200	Machine Learning
CIS 5	450	Big Data Analytics
CBE	5250	Molecular Modeling and Simulations
ESE 3	3050	Foundations of Data Science
ESE	5420	Statistics for Data Science
BION	1 5350	Introduction to Bioinformatics
or	CIS 5350	Introduction to Bioinformatics
or	MTR 5350	Introduction to Bioinformatics
BIOL	4511	Biological Data Analysis
BIOL	5536	Fundamentals of Computational Biology
or	CIS 5360	Fundamentals of Computational Biology
or	GCB 5360	Fundamentals of Computational Biology
GCB	5370	Advanced Computational Biology
STAT	9915	Seminar in Advanced Application of Statistics
Total Co	ourse Units	3

Biomedical Devices

(Code	Title	Course Units
ŝ	Select 2 courses	in:	2
	BE 4700	Medical Devices	
	BE 4720	Medical Device Development *	

4

BE 4900	Independent Project in Bioengineering ***	
BE 5020	From Biomedical Science to the Marketplace	
BE 5140	Rehab Engineering and Design	
BE 5180	Optical Microscopy	
BE 5210	Brain-Computer Interfaces	
BE 5280	Applied Medical Innovation I *	
BE 5290	Applied Medical Innovation II *	
BE 5510	Biomicrofluidics	
BE 5560	Molecular Diagnostics for Precision Medicine	
BE 5700	Biomechatronics	
Select 2 additiona	al courses in:	2
BE 4700	Medical Devices	
BE 4720	Medical Device Development *	
BE 4900	Independent Project in Bioengineering ***	
BE 5020	From Biomedical Science to the Marketplace	
BE 5140	Rehab Engineering and Design	
BE 5180	Optical Microscopy	
BE 5210	Brain-Computer Interfaces	
BE 5280	Applied Medical Innovation I	
BE 5290	Applied Medical Innovation II *	
BE 5510	Biomicrofluidics	
BE 5560	Molecular Diagnostics for Precision Medicine	
BE 5700	Biomechatronics	
ESE 2150	Electrical Circuits and Systems	
ESE 5050	Feedback Control Design and Analysis	

or MEAM 5	Feedback Control Design and Analysis	
ESE 5290	Introduction to Micro- and Nano- electromechanical Technologies	
MEAM 1010	Introduction to Mechanical Design *	
MEAM 2010	Machine Design and Manufacturing	
MEAM 5100	Design of Mechatronic Systems	
MEAM 4150	Product Design	
or OIDD 415	50Product Design	
MEAM 5140	Design for Manufacturability	
MEAM 5200	Introduction to Robotics	
Total Course Unit	ts	4
Cellular/Tissu	e Engineering and Biomaterials	
Code	Title	Course Units
Select 2 courses	in:	2
BE 3300	Self-Assembly of Soft Materials	
BE 4900	Independent Project in Bioengineering ***	
BE 5120	Bioengineering III: Biomaterials	
BE 5400	Principles of Molecular and Cellular Bioengineering	
BE 5530	Principles, Methods, and Applications of Tissue Engineering	
BE 5580	Principles of Biological Fabrication	
BE 5650	Developmental Engineering of Tissues	
BE 5690	Systems Biology of Cell Signaling Behavior	
BE 5780	Principles of Controlled Release Systems	
Select 2 addition	al courses in:	2
BE 3300	Self-Assembly of Soft Materials	
BE 4900	Independent Project in Bioengineering	
BE 5120	Bioengineering III: Biomaterials	
BE 5400	Principles of Molecular and Cellular Bioengineering	
BE 5530	Principles, Methods, and Applications of Tissue Engineering	
BE 5580	Principles of Biological Fabrication	
BE 5650	Developmental Engineering of Tissues	
BE 5690	Systems Biology of Cell Signaling Behavior	
BE 5780	Principles of Controlled Release Systems	
CBE 4300	Introduction to Polymers	
or MSE 430	OIntroduction to Polymers	
CBE 5570	Stem Cells, Proteomics and Drug Delivery - Soft Matter Fundamentals	
MEAM 5140	Design for Manufacturability	
MSE 5850	Materials for Bioelectronics	
or BE 5850	Materials for Bioelectronics	
MSE 5180	Structure and Function of Biological Materials	
Total Course Unit	ts	4

Biomedical Imaging and Radiation Physics

C	ode	Title	Course Units
S	elect 2 courses i	in:	2
	BE 4900	Independent Project in Bioengineering ***	
	BE 5180	Optical Microscopy	
	BE 5370	Biomedical Image Analysis	
	BE 5470	Fundamental Techniques of Imaging	
	BE 5810	Techniques of Magnetic Resonance Imaging	
	BE 5830	Physics of Medical / Molecular Imaging	
	BE 6500	Advanced Biomedical Imaging Applications	
S	elect 2 additiona	al courses in:	2
	BE 4900	Independent Project in Bioengineering ***	
	BE 5180	Optical Microscopy	
	BE 5370	Biomedical Image Analysis	
	BE 5470	Fundamental Techniques of Imaging	
	BE 5810	Techniques of Magnetic Resonance Imaging	
	BE 5830	Physics of Medical / Molecular Imaging	
	BE 6500	Advanced Biomedical Imaging Applications	
	MPHY 6030	Image-Based Anatomy	
	MPHY 6070	Radiation Biology	
	PHYS 4421	Modern Optics	
Total Course Units			4

Systems and Synthetic Biology

Code	Title	Course Units
Select 2 courses i	n:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5270	Immune Engineering	
BE 5400	Principles of Molecular and Cellular Bioengineering	
BE 5580	Principles of Biological Fabrication	
BE 5590	Multiscale Modeling of Chemical and Biological Systems	
BE 5650	Developmental Engineering of Tissues	
BE 5690	Systems Biology of Cell Signaling Behavior	
Select 2 additiona	al courses in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5270	Immune Engineering	
BE 5400	Principles of Molecular and Cellular Bioengineering	
BE 5580	Principles of Biological Fabrication	
BE 5590	Multiscale Modeling of Chemical and Biological Systems	
BE 5650	Developmental Engineering of Tissues	
BE 5690	Systems Biology of Cell Signaling Behavior	
CBE 4790	Biotechnology and Biochemical Engineering	
CBE 4800	Laboratory in Biotechnology and Biochemical Engineering	
CBE 5170	Principles of Genome Engineering	

CBE 5270	Advancements and Applications in Genome Editing and Engineering	
CBE 5540	Engineering Biotechnology	
CBE 5570	Stem Cells, Proteomics and Drug Delivery - Soft Matter Fundamentals	
MEAM 6630	Mechanics of Macromolecules	
BIOL 5262	Biological Foundations for Bioengineering and Biotechnology: Genomics and Omics Technologies	
Total Course Uni	ts	4
Nouroongino	oring	
Neuroengine		
Code	litie	Course Units
Select 2 courses	in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	
BE 5660	Networked Neuroscience	
Select 2 addition	al courses in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	
BE 5660	Networked Neuroscience	
NRSC 2249	Cognitive Neuroscience	
or PSYC 12	3©ognitive Neuroscience	
NRSC 2110	Molecular and Cellular Neurobiology	
or BIOL 21	ICMolecular and Cellular Neurobiology	
BIOL 4110	Neural Systems and Behavior	
or BIOL 51	10Neural Systems and Behavior	
BIOL 4142	Neurobiology of Learning and Memory	
NRSC 2205	Cellular Basis of Learning and Memory *	
NRSC 3334	Computational Neuroscience Lab	

Systems Neuroscience **Total Course Units**

NRSC 4425 NGG 5720

NGG 5730

Multiscale Biomechanics

Code	Title	Course Units
Select 2 courses i	n:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	
BE 5660	Networked Neuroscience	
Select 2 additional courses in:		2
BE 4900	Independent Project in Bioengineering	
BE 5210	Brain-Computer Interfaces	
BE 5300	Theoretical and Computational Neuroscience	

Neurotechnology: From Concept to Clinic

Electrical Language of Cells

4

T	otal Course Uni	ts	4
	NGG 5730	Systems Neuroscience	
	NGG 5720	Electrical Language of Cells	
	NRSC 4425	Neurotechnology: From Concept to Clinic	
	NRSC 3334	Computational Neuroscience Lab	
	NRSC 2205	Cellular Basis of Learning and Memory *	
	BIOL 4142	Neurobiology of Learning and Memory *	
	or BIOL 511	0Neural Systems and Behavior	
	BIOL 4110	Neural Systems and Behavior	
	or BIOL 211	CMolecular and Cellular Neurobiology	
	NRSC 2110	Molecular and Cellular Neurobiology	
	or PSYC 12	3©ognitive Neuroscience	
	NRSC 2249	Cognitive Neuroscience	
	BE 5660	Networked Neuroscience	

Therapeutics, Drug Delivery & Nanomedicine

Code

Select 2 courses	in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5100	Biomechanics and Biotransport	
BE 5140	Rehab Engineering and Design	
BE 5500	Continuum Tissue Mechanics	
BE 5700	Biomechatronics	
BE 5610	Musculoskeletal Biology and	
	Bioengineering	
Select 2 additiona	al courses in:	2
BE 4900	Independent Project in Bioengineering	
BE 5100	Biomechanics and Biotransport	
BE 5140	Rehab Engineering and Design	
BE 5500	Continuum Tissue Mechanics	
BE 5700	Biomechatronics	
BE 5610	Musculoskeletal Biology and	
	Bioengineering	
Total Course Units		

Immune Engineering

Code	Title	Course Units
Select 2 courses	in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5120	Bioengineering III: Biomaterials	
BE 4260	Immunology for Bioengineers (students cannot count both BIOL 4004 and BE 4260/ BE 5260 towards concentration)	
or BE 5260	Immunology for Bioengineers	
or BIOL 400	4Immunobiology	
BE 5270	Immune Engineering	
BE 5570	Quantitative Principles of Drug Design	
Select two addition	onal courses in:	2
BE 4900	Independent Project in Bioengineering ***	
BE 5120	Bioengineering III: Biomaterials	

	BE 4260	Immunology for Bioengineers (students cannot count both BIOL 4004 and BE 4260/ BE 5260 towards concentration)		
	or BE 5260	Immunology for Bioengineers		
	or BIOL 400	4Immunobiology		
	BE 5270	Immune Engineering		
	BE 5570	Quantitative Principles of Drug Design		
	ENGR 4500	Modern Biotechnology for Engineers		
	IMUN 5060	Immune Mechanisms		
	IMUN 5070	Immunopathology		
	IMUN 6090	Vaccines and Immune Therapeutics		
	or CAMB 60	Vaccines and Immune Therapeutics		
	REG 6180	Introduction to Vaccine Development		
G	otal Course Units			

Footnotes

Course

Units

- * Students may count only one of the asterisked courses per concentration.
- ** Students may only "double count" TWO courses for multiple concentrations.
- ***Students may only count one Independent Study (BE 4900 or BE 4920).