BIOCOMPUTATIONAL ENGINEERING MAJOR AT SHADY GROVE

Program Director: Lan Ma, Ph.D

Biocomputational engineering brings together the field of bioengineering, a discipline grounded in fundamentals of physics, chemistry, and biology, with computation and data science, which enhances the value of all fields. The objective of the biocomputational engineering program is to provide a breadth of fundamentals in biology and quantitative problem solving while developing skills in computation and data science that can be applied to the modeling of complex biological systems and the analysis of complex biological data sets in order to create new knowledge from the molecular to organ to system levels, and to develop innovative processes for the prevention, diagnosis, and treatment of disease. The synthesis of bioengineering, computation, and data science gives the graduates unique capabilities to solve existing and emerging challenges of the modern medical world.

Admission to the Major

Prior to being admitted to the Biocomputational Engineering major, students must complete the prerequisite math/science courses, lower-level General Education requirements (or an associate's degree), and a total of 60 credits. Students are welcome to apply as transfer students from community college or four-year institutions. For more information regarding admission to the Biocomputational Engineering major, visit http://biocomp.umd.edu/admissions/.

Program Educational Objectives

The BCE program provides students with a foundation in quantitative problem solving, engineering, and biology. In addition, the program provides students with data science skills. The students' educational outcomes position them for careers in data science, in particular in the biomedical and biotechnology fields.

Our graduates are grounded in fundamentals that will serve them throughout their professional careers. They will have an understanding of human behavior, societal needs and forces, the dynamics of human efforts, and the impact of those efforts on human health and our environment. With these underpinnings and abilities, we have defined three Program Educational Objectives we expect our graduates to attain. In 3-5 years after graduation, our graduates will:

1. Be successful in Biocomputational Engineering careers or post-graduate educational pursuits by applying scientific depth, technical skills, and knowledge gained through practical experiences.
2. Address the data-driven computational biomedical challenges facing society in both the near and long term by demonstrating an awareness of their field and an ability for lifelong learning.
3. Serve their profession, promote equity and justice through technology, and positively impact society by drawing upon a foundation of professional ethics.

Student Learning Outcomes

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

REQUIREMENTS

Prior Study

Prior to being admitted to the Biocomputational Engineering major, students should have completed basic math/science/engineering courses, lower-level general education requirements (or an associate's degree from a Maryland public institution), and 60 credits.

Course	Title	Credits
ENGL101	Academic Writing	3
MATH140	Calculus I	4
MATH141	Calculus II	4
MATH241	Calculus III	4
PHYS161	General Physics: Mechanics and Particle Dynamics	3
PHYS260	General Physics: Electricity, Magnetism and Thermodynamics	3
PHYS261	General Physics: Mechanics, Vibrations, Waves, Heat (Laboratory)	1
ENES100	Introduction to Engineering Design	3
CHEM135	General Chemistry for Engineers	3
CHEM136	General Chemistry Laboratory for Engineers	1
BSCI170	Principles of Molecular & Cellular Biology	3
or BIOE120	Biology for Engineers	
MATLAB programming course -- e.g. BIOE241 or equivalent		3
Lower-level general education requirements or A.A./A.S. degree from a Maryland public institution		25
Total Credits		**60**

Required Courses

Course	Title	Credits
ENBC301	Introduction to Biocomputational Engineering	1
ENBC311	Python for Data Analysis	3
ENBC312	Object Oriented Programming in C++	3
ENBC321	Machine Learning for Data Analysis	3
ENBC322	Algorithms	3
ENBC331	Applied Linear Systems and Differential Equations	3
ENBC332	Statistics, Data Analysis, and Data Visualization	3

ENBC341	Biomolecular Engineering Thermodynamics	3
ENBC342	Computational Fluid Dynamics and Mass Transfer	3
ENBC351	Quantitative Molecular and Cellular Biology	3
ENBC352	Molecular Techniques Laboratory	2
ENBC353	Synthetic Biology	3
ENBC425	Imaging and Image Processing	3
ENBC431	Finite Element Analysis	3
ENBC441	Computational Systems Biology	3
ENBC491	Senior Capstone Design in Biocomputational Engineering	3
Professional Writing Requirement		3
Elective Courses		12
Total Credits		**60**

Elective Courses

Students are required to take four technical electives (12 credits). The courses must be selected from an approved list of engineering and biology courses; the list will be updated regularly by the program director. At least two of the elective courses must be from the category of engineering, mathematics, or programming, while at most two of the electives can be from the category of biology courses. The program will offer electives; at the same time, the program will arrange for opportunities for electives outside the program, including USG programs offered by other universities.

Course	Title	Credits
Possible technical electives		**12**
ENBC403	Research Methods in Biological Data Mining	
ENBC411	(Advanced Programming in Python)	
ENBC413	(Data Analysis with R)	
ENBC423	Applied Computer Vision	
ENBC435	(Numerical Methods)	
ENBC442	(Computational Molecular Dynamics)	
ENBC443	(Multiscale Simulation Methods)	
ENBC444	(Modeling Protein Folding)	
ENBC445	(Spatial Control of Biological Agents)	
ENBC455	Bioinformatics Engineering	

GRADUATION PLANS

Click here (https://eng.umd.edu/advising/four-year-plans/) for roadmaps for graduation plans in the A. James Clark School of Engineering.

Additional information on developing a graduation plan can be found on the following pages:

- http://4yearplans.umd.edu
- the Student Academic Success-Degree Completion Policy (https://academiccatalog.umd.edu/undergraduate/registration-academic-requirements-regulations/academic-advising/#success) section of this catalog