UNIVERSITY OF MARYLAND AT The Universities AT SHADY GROVE

The Future of Public Health, Biostatistics, and Artificial Intelligence:

A Guide to Career Pathways with a Biocomputational Engineering Degree

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Exploring the

Future of the Booming Biotech Industry

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THE TREMENDOUS IMPACT OF THE BIOTECHNOLOGY INDUSTRY

Since the advent of the biotechnology industry in the 1970s, the field has grown tremendously, fueling numerous advancements in medicine and health care. There are currently over 250 biotech products and vaccines offered today, and many of them are for diseases that were once untreatable. The demand for skilled and qualified individuals to join various companies and organizations in the booming field has soared.

But what exactly is biotechnology?

> Biotechnology is "the use of biology to solve problems and make useful products," according to Encyclopedia Britannica. "The most prominent area of biotechnology is the production of therapeutic proteins and other drugs through genetic engineering."

At its core, biotechnology involves leveraging biological processes to improve quality of life, and the field has continually had huge impacts on the medicine and health care spaces. The biotech field has provided groundbreaking technologies for debilitating and rare diseases. In the 1980s, recombinant insulin was the first product created through genetic engineering to gain approval from the U.S. Food and Drug Administration. This allowed insulin to be produced in larger qualities at a lower cost, a significant advancement for individuals with diabetes who rely on synthetic human insulin daily. Gene therapy and the Human Genome Project has widely increased our understanding of normal and disease biology, which has equipped researchers to develop new medicines and treatments for previously untreatable diseases.

Modern biotech researchers explore the root causes of disease at the molecular level and produce therapeutic proteins that can aid the body's natural response. They also develop traditional pharmaceuticals to halt the spread of disease by studying and analyzing genes, proteins and their related biological pathways, with the assistance of computer technology.

The COVID-19 pandemic has only highlighted the pressing need for biotechnology researchers, who are collaborating and racing to develop vaccines at a rapid pace worldwide. This latest life-threatening new infectious disease and its uncontained spread has illustrated the far-reaching impact of scientists and engineers who are committed to biotechnology and wielding its power for the common good.

VALUE IN VERSATILITY: AN INDUSTRY WITH MULTIPLE TOUCHPOINTS

The biotech field is wide-encompassing, and intersects with various fields, including:

Public/global health - The biotech industry supports the treatment and eradication of global diseases. For instance, biotech researchers are on the front lines in the investigation of therapeutic drugs and vaccines for COVID-19.

Health care technology - Utilizing artificial intelligence, blockchain, interoperability, and cloud technology, new resources can improve patient care and outcomes while streamlining processes and automating tasks.

Biomedical engineering - Biomedical engineers lead innovation in the design of new health equipment and devices, including: imaging and diagnostic equipment, surgical tools, health monitoring equipment (from EKGs to wearables), artificial limbs, and organs and advanced prosthetics.

Stem cell research - Stem cells can be used to regenerate diseased cells. Researchers grow the specific cell type, test the cells, and then conduct animal and human trials. Individuals with various conditions such as spinal cord injuries, Type 1 diabetes, Parkinson's disease, and heart disease, among others, can benefit from stem cell therapies.

Data science - Individuals in the biotech industry apply statistical analyses to molecular biology, including genomics and proteomics, and rely on a strong foundation in mathematics, statistics, and programming to carry out their research.

Computer science - Computer science is the study of computers and includes the foundations of programming and algorithms. Biotech researchers apply the principles of computer science and engineering to understand and analyze biological data.

Value in Versatility: An Industry with Multiple Touchpoints (Continued)

Drug development - Researchers discover new drugs, test them, and conduct experiments to identify benefits, side effects, interactions with other treatments, and more. Computer modeling is a large component of drug discovery. For example, sophisticated computer models can be used to predict which chemical structures can bind to drug targets.

Data modeling - Biotechnology involves the analysis and manipulation of large data sets and data modeling is the process of evaluating which data will be stored and how.

Medical technology - This is a broad field that consists of all technological tools and devices that are used in prevention, diagnosis, monitoring, and treatment.

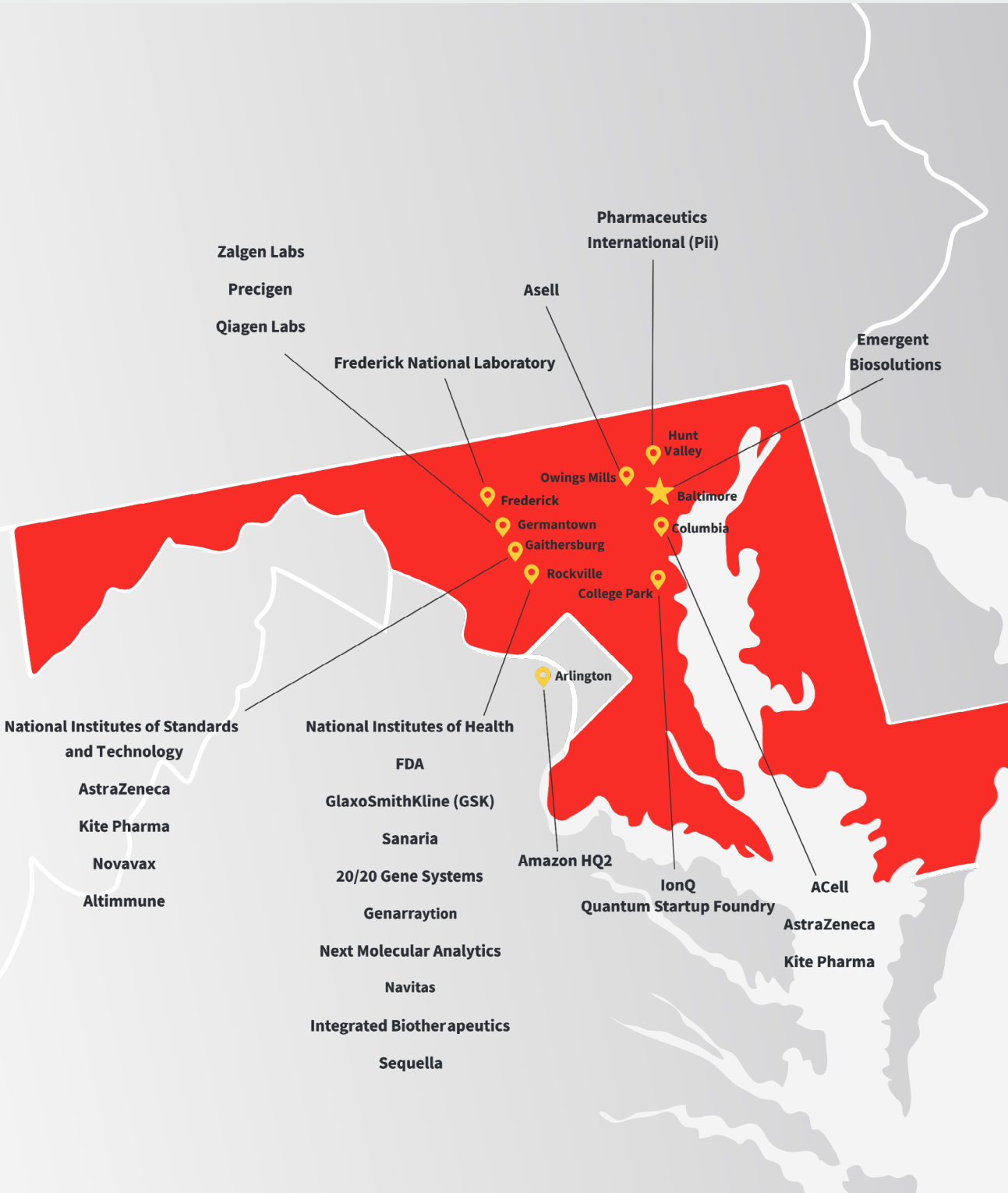
Health IT - Health Information Technology includes computer hardware, software, or infrastructure that is used to store or retrieve clinical information, such as electronic health records.

Biostatistics - Biostatisticians apply statistical methods to interpret data in the areas of biology and public health. Their interpretations could determine the safety and efficacy of a drug based on data from a trial. Or they could predict the spread of an epidemic. The expertise of biostatisticians is also required in planning drug/vaccine trials or trials for medical equipment.

THE GROWING DEMAND FOR BIOTECH ENGINEERS IN THE DMV

The DC, Maryland and Virginia metropolitan area is at the forefront of emerging technologies and innovation in the life sciences sector, serving as a hub for biotech, biomedical, and pharmaceutical research.

Maryland alone is home to 500+ biotech firms and 2,700 life sciences organizations. Serving as headquarters for the National Institutes of Health, the FDA, and the National Institute of Standards and Technology, the area is anchored by many government resources. In addition, several companies and firms like AstraZeneca, GlaxoSmithKline (GSK), Kite Pharma, ACell, and Novavax have a presence in the area. Emergent Biosolutions has vaccine manufacturing plants in Baltimore, Precigen has a facility in Germantown, and GlaxoSmithKline has a vaccine research and development center in Rockville.



A Booming Biotech Region

In 2018, the BioHealth Capital Region was ranked fourth in GEN's list of Top 10 U.S. Biopharma Clusters. The area is third in NIH funding with awards totaling $1.5 billion, anchored by the University System of Maryland and Johns Hopkins University. It is also third in patents and fourth in lab space.

#4 IN GEN'S LIST OF TOP 10 U.S. BIOPHARMA CLUSTERS

#4 IN LAB SPACE

#3 IN PATENTS

#3 IN NIH FUNDING

Several scientific breakthroughs were made in Maryland, including the first mapping of the human genome, the first rapid test for Ebola, and the first FDA-approved blood test for colon cancer. In March of 2020, 17 Maryland biotech companies joined forces to find new vaccines and therapeutics for COVID-19. The companies include Pfizer, GSK, Novavax, and Emergent Biosolutions.

The growth of the biotech industry, especially in the BioHealth Capital Region, propels a demand for skilled engineers, especially those with a strong foundation in physical and biological sciences and computation and data science.

TRENDS AND INSIGHTS FOR PUBLIC HEALTH, BIOSTATISTICS, AND ARTIFICIAL INTELLIGENCE

Public Health

While chemotherapy and radiotherapy are popular and effective cancer treatments, biotechnology companies have focused on developing targeted therapies and personalized treatments. These acknowledge and take into account that a patient's genetics can play a role in how they respond to certain medicines or cancer drugs. Biotechnology professionals are also at the forefront of accelerating research that can slow or cure cancers. In Maryland, A&G Pharmaceutical has identified a specific biomarker that can detect more than 80% of breast cancers and is creating test kits for early detection.

> "We have yet to realize the full potential of precision medicine, but we are making significant headway...Options for many people with cancer have dramatically improved through targeted therapies that reverse the effects of specific gene mutations in their tumor cells."

- Eva Kiesler, former Senior Science Editor at Memorial Sloan-Kettering Cancer Center and Meredith Begley, Health and Medical writer at Memorial Sloan-Kettering Cancer Center

Biostatistics

Biostatisticians play a significant role in solving research questions by collecting, analyzing, processing, and interpreting massive data sets. They also help to design clinical trials to ensure that the results are meaningful. Clinical trials, public health programs, epidemiological studies, survival rates, evidence-based medicine, and genome sequencing data analysis all depend on biostatistics, which is the application of statistics to biology. In response to the COVID-19 pandemic, statistics experts at Stanford have been using their expertise to fight the outbreak, by tracking genetic mutations, developing new approaches to predictive models, and designing new clinical trials.

> "Cleaning and processing data remains one of the largest open challenges for biostatistics and data science. As we examine electronic health records and data from wearable computing, the modeling of longitudinal and survival data have never been more important or more difficult. Biostatisticians are also central to many of the most important scientific problems of our time: reproducibility and replicability, the appropriate use of screening tests, the health impacts of climate change, and the importance of methods and software in scientific research."

- Dr. Dimitris Rizopoulos, professor at Erasmus University Medical Center, and Dr. Jeff Leek, professor at the Johns Hopkins Bloomberg School of Health

Artificial Intelligence

Machine learning tools that use artificial neural networks can leverage millions of medical reports, clinical trials, and medical journals in a sophisticated fashion that is simply not possible for a human. The term "artificial intelligence" first came about more than 60 years ago and its application has expanded dramatically in health care since then. For example, virtual assistants like the Amazon Echo Dot can aid people with Alzheimer's disease by giving them reminders about meals and medication. In addition, dermatologists can use algorithms to identify and diagnose skin cancers such as melanoma with the help of MelaFind technology, which uses infrared light to evaluate moles. In the future, it is expected that all medical imaging modalities will use machine learning to draw better conclusions from images than humans are able to.

> "We're able to train machines to exhibit humanlike intelligence and apply that in a clinical setting. We haven't achieved human intelligence, but we're getting close to it."

- Dr. Paul Weber, associate dean for continuing medical education at Rutgers's Robert Wood Johnson and New Jersey medical schools.

What Can You Do in the

Biotechnology Industry?

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CAREER PATHWAYS IN THE BIOTECH FIELD

To tackle today's most pressing public health challenges, there is a great need for individuals with the ability to apply computer programming knowledge to analyze biological data sets and create new diagnostic technologies for the treatment and prevention of disease.

Below are some examples of ways you can make an impact by choosing one of the many career paths available in this industry:

Bioinformatics Scientist

About the role: Bioinformatics scientists study large data sets at the molecular level, design web-based informatics tools, and develop biological databases.

Settings: Private corporations, universities, government agencies

National Average Salary: $96,000

Bioinformatician

About the role: Bioinformaticians create mathematical models and specialized computer software to analyze biological data.

Settings: Biotechnology companies, pharmaceutical companies

National Average Salary: $96,000

Image Processing Scientist

About the role: Image Processing Scientists develop advanced imaging and image processing algorithms.

Settings: Biotechnology companies, research firms

National Average Salary: $77,000

Validation Specialist

About the role: Validation Specialists complete qualification and validation studies on software or equipment. They also develop protocol documents and reports that demonstrate how each device or process is validated.

Settings: Pharmaceutical manufacturing facilities and laboratories

National Average Salary: $74,000

CAREER PATHWAYS IN THE BIOTECH FIELD

Statistical Geneticist

About the role: Statistical Geneticists develop new statistical methods to solve problems related to genetics and to understand the genetic basis of human disease. They may collaborate with other investigators for research on cancer, heart disease, health-related behaviors, and more.

Settings: Pharmaceutical companies, universities

National Average Salary: $69,000

Health Informatics Consultant

About the role: Health Informatics Consultants ensure that companies follow federal regulations, train staff members on new procedures or technologies, and keep a pulse on future advancements and technology requirements in health informatics.

Settings: Health care facilities

National Average Salary: $65,000

Biotechnology Consultant

About the role: Biotechnology Consultants provide information for and recommend new products and technologies associated with the biological sciences. They may help clients make purchasing decisions or introduce them to new products, such as medical devices.

Settings: Consulting firms, self-employed; clients include hospitals, research facilities, government agencies

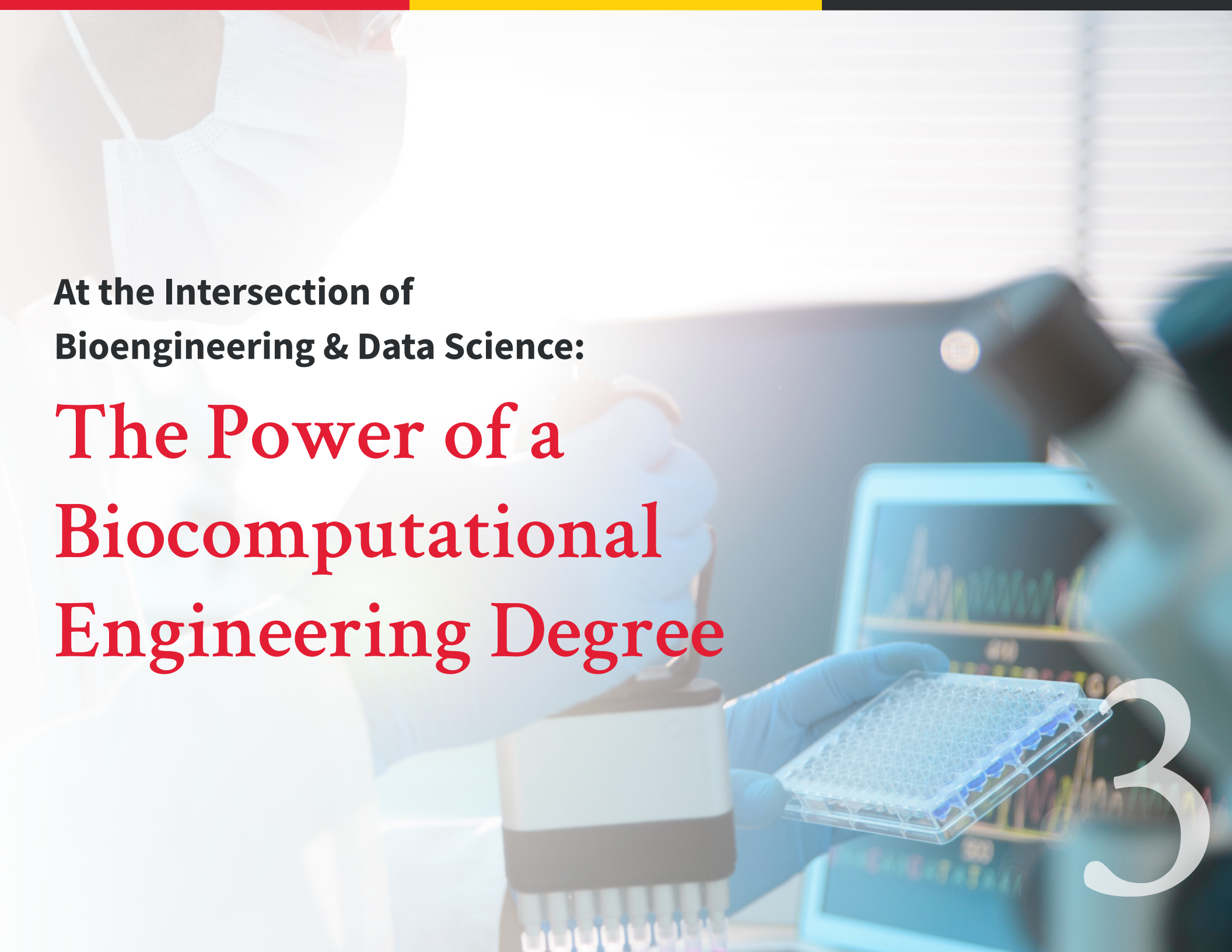
National Average Salary: $77,000

Biomedical Engineers

About the role: Biomedical engineers design biomedical equipment, such as artificial internal organs; evaluate the safety and efficacy of biomedical devices; and run computer simulations to evaluate new drug therapies. They combine a foundation in engineering with knowledge of medical sciences. Employment is projected to grow 4% from 2018 to 2028, about as fast as the average for all occupations, according to the U.S. Bureau of Labor Statistics. This is due to the rising number of medical technologies and the medical needs of an aging population.

Settings: Manufacturing firms, universities, research facilities

National Average Salary: $91,000



At the Intersection of
Bioengineering & Data Science:

The Power of a Biocomputational Engineering Degree

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WHAT IS BIOCOMPUTATIONAL ENGINEERING?

Biocomputational engineering is an emerging field that fuses bioengineering — a discipline grounded in the fundamentals of physics, chemistry, and biology — with computation and data science. This new degree is a more specific and targeted degree than a bioengineering program because it offers a strong, multidisciplinary curriculum that includes statistics, data analysis, data visualization, machine learning, programming, and more.

In the biotech field, biocomputational engineers apply their knowledge of computer programming to analyze biological data sets and create new diagnostic technologies for the treatment and prevention of disease. **With a foundation in data science**, **biocomputational engineering graduates will be able to tackle and solve medical problems with large, complex data sets, while understanding the nuances of the research thanks to their life sciences background**. Individuals earning a computer science degree will not have the breadth of knowledge of biology and biotechnology to equip them to seek solutions to the specific challenges related to health care and medicine.

Biotech companies have a high demand for biology-minded individuals who excel in programming and data sciences. This integration of unique, but equally vital, skill sets exists in the biocomputational engineering degree and graduates will have a competitive advantage that will make them highly qualified for jobs in the biotech vertical.

ABOUT THE VARIETY OF DISCIPLINES INCORPORATED IN THE BIOCOMPUTATIONAL ENGINEERING DEGREE

Multiple disciplines fit into the biocomputational engineering degree, including the following four areas:

Programming & Computer Science

Fundamentals of programming, algorithms, and simulation as well as data analysis and visualization make up a critical component of the degree.

Machine Learning/Artificial intelligence

Artificial intelligence methods are used for mining big data sets and for making decisions using data sets.

Biotechnology & Health IT

Analyzing thermal and mechanical properties of devices or systems is a core competency and students will be well-versed specifically on the biomechanics of biomedical devices.

Life Science Technology

The concepts of synthetic biology and biological engineering serve as a bedrock of the biocomputational engineering degree. Wet lab experiments allow students to observe cellular and molecular processes and phenomena.

A New Degree to Solve

Today's Biotech Challenges

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EQUIPPING FUTURE BIOTECH EXPERTS

One of the first degrees of its kind, the University of Maryland's new bachelor of science in biocomputational engineering combines biology with data science to equip and empower students to make an impact in the biotech industry. In fact, it was designed specifically to address the soaring need for engineers with expertise in the life sciences and in computational methods, especially in the areas of biotechnology, pharmaceuticals, biomedical devices, telemedicine, and electronic medical records.

Through UMD's program in biocomputational engineering, students are given the skills and experience they need across a range of disciplines to be able to tackle today's biggest challenges in public health.

> "For someone with computational skills and a systems mindset, BCE is an opportunity to marry the two sciences of data science and engineering. A lot of this (BCE) world is IT integration within hospital informatics systems. There is an obvious, evolving need for this field in hospitals."
>
> *- John Page, Vice president of Engineering at BD Integrated Diagnostic Solutions and UMD Bioengineering Advisory Board Member*

This unique program is held at the state-of-the-art Biomedical Sciences and Engineering (BSE) education facility at the Universities at Shady Grove. The program, which is geared toward transfer students from community colleges or four-year institutions, offers junior- and senior-level courses at the new BSE education facility. The building opened in 2019 and was sustainably designed and built and certified as LEED-NC Platinum, the highest rating for sustainability by the U.S. Green Building Council.

The six-level, 220,000-square-foot facility features teaching laboratories, a clinical training facility, a product design laboratory, active learning classrooms, lecture halls, and an innovation and entrepreneurship center.

Curriculum, Academic Outcomes and In-Demand Skills

Below are some of the courses (a total of 60 credits) in UMD's strategic, multidisciplinary curriculum, taught by full-time professors with backgrounds in computational biology, biotechnology, and data science:

- Introduction to Biocomputational Engineering
- Python for Data Analysis
- Machine Learning for Data Analysis
- Applied Linear Systems and Differential Equations
- Quantitative Molecular and Cellular Biology
- Object Oriented Programming in C++
- Finite Element Analysis
- Technical Writing
- Molecular Techniques Laboratory

Curriculum, Academic Outcomes and In-Demand Skills (Continued)

Graduates of this program will receive a B.S. degree in biocomputational engineering from the University of Maryland, College Park, and will graduate with the ability to:

- Model the spread of infectious agents through the air
- Identify potential drug targets to emerging pathogens
- Build computer models to determine interactions between potential drugs and pathogens
- Mine large data sets to model the spread of a pathogen
- Help advance global health by designing therapeutics against pathogenic agents
- Build computer models to predict the success of drugs
- Develop computer models to predict the global spread of a pandemic
- Guide public health decisions using fundamentals in science and engineering
- Contribute to the success of new drugs
- Advance medical technology by using big data to creatively solve problems
- Leverage technology and machine learning to improve health care safety

Graduates will also possess the following in-demand skills:

- Computer Programming (Python, C++, R)
- Machine Learning
- Data Visualization
- Computer Modeling
- Molecular Lab Technologies

AN ENVIRONMENT BUILT FOR BREAKTHROUGHS — ALL ABOUT THE SHADY GROVE CAMPUS

The biocomputational engineering degree was created and designed as a direct response to the growing demand for qualified engineers with skills and knowledge bases in the life sciences as well as computer programming. Courses for the degree program will be taught at the new Biomedical Sciences and Engineering (BSE) education facility at the Universities at Shady Grove, conveniently located in Rockville, MD.

The Shady Grove campus also offers a full range of student services including academic coaching, career advising, and leadership training. There are a variety of ways for students to become involved and to meet each other, including numerous student organizations and campus-wide events. Students can receive financial aid counseling and scholarship help by making an appointment at the Center for Student Engagement & Financial Resources. They also have access to free counseling services through the Center for Counseling and Consultation as well as study rooms and research assistance at the Priddy Library.

Montgomery County, "the economic engine" of Maryland, is experiencing a strong demand for innovators and visionaries in the Science, Technology, Engineering, Mathematics, and Medical (STEMM) fields. **The innovative BSE building on the Shady Grove campus offers an environment packed with spaces for collaboration, research, and entrepreneurship that is built for STEMM breakthroughs**.

An Environment Built for Breakthroughs — All About the Shady Grove Campus (Continued)

Programs delivering coursework at the location, including UMD's biocomputational engineering degree, will produce forward-thinking researchers and changemakers to meet the state's escalating projected job growth in bioscience.

Below are some of the most notable aspects of the BSE facility at the Universities at Shady Grove:

- **Six-level, 220,000-square-foot facility**
- **20 fully-equipped teaching laboratories**
- **Two 120+ seat lecture halls**
- **12 active learning classrooms**
- **Product design laboratory and maker space for student research**
- **Expanded student services**
- **Clinical training facility**
- **Innovation and entrepreneurship center (students will have the opportunity to work with local businesses to advance new ideas)**
- **Certified as LEED-NC Platinum, the highest rating for sustainability by the U.S. Green Building Council.**

Watch the video to learn more about the BSE building and to explore its key features.

Click to play the video

PREPARING THE NEXT GENERATION OF DATA-DRIVEN CHANGEMAKERS - Q&A WITH DR. IAN WHITE

Dr. Ian White is the Associate Chair and Director of Undergraduate Studies at the Fischell Department of Bioengineering at the University of Maryland (UMD). We interviewed Dr. White about the demand for a biocomputational engineering degree and about the ways the program prepares students to serve as leaders in the biotech field.

What was the motivation for creating this degree program? Can you explain the need and demand for a B.S. in Biocomputational Engineering?

I have directed the undergraduate degree in bioengineering at UMD for about the last five years. I constantly hear from our graduates that they feel passionate about their bioengineering degree but that they believe that they'd have many more career opportunities if they had skill depth in programming and data sciences. At the same time, I have heard from employers that there are many career opportunities available at biotechnology companies for students with training in programming and data sciences. Some of the bioengineering students have completed a minor in computer science, but this can be cumbersome. We believe that we have created a degree that combines the necessary fundamentals in bioengineering and biotechnology with the skills in programming and data science that will provide graduates with a significant competitive advantage.

How is the curriculum preparing students to thrive in the biotech industry? What jobs could they start after earning their B.S. and which jobs would they need advanced degrees for?

To start, the program is grounded in fundamentals of both engineering and biology. This means that all graduates will inherently be quantitative problem solvers with a complementary knowledge of cellular and molecular biology. Adding to this, the program teaches skills in programming, statistics, data analysis, and machine learning. This positions graduates as ideal candidates to solve problems important in medicine. While graduates will have the skills to take any programming or data science job, they will be ideal candidates for biotech firms and consulting firms who need problem solvers with knowledge of biology/medicine and skills to analyze large and complex data sets.

What would you say are the most important skills and knowledge bases that this program offers students that they wouldn't gain otherwise?

As with any engineering degree, the biggest asset that our graduates can boast is a talent for quantitative problem solving. In my opinion, this skill is the most prominent characteristic of an engineering graduate, and separates our graduates from those who may have focused only on biology, biotechnology, or programming. Beyond quantitative problem solving, our graduates will have a unique combination of fundamental knowledge in biology with basic skills in programming and data science. As compared to graduates who have a degree in bioengineering or biomedical engineering, our graduates will be skilled in programming and data science and thus can get to work solving medical problems with complex data sets. At the same time, as compared to students with degrees in computer science, our graduates will have the fundamental biology/biotechnology knowledge to apply their programming and data science skills to solve problems that impact health care and medicine.

What is unique about the Biocomputational Engineering Degree?

The uniqueness lies in this combination of engineering, biology/biotechnology, and data science. Graduates will have the necessary skills to solve complex problems and will have the fundamental knowledge to understand the intricacies of the problems that they are solving.

What are the significant real-world impacts that graduates can go on to make in biotech?

Herein lies what we are most excited about. Graduates from our program will have the opportunity to immediately impact human health. Today more than ever our world is in need of new therapies — for cancer, neurodegenerative diseases, cardiovascular diseases, and newly emerging infectious diseases. Moreover, the importance of rapid vaccine development is more clear than ever. Solving these problems requires computer modeling, bioinformatics, analysis of large and complex data sets, and many other important computational skills. Fortunately for our graduates, the Universities at Shady Grove campus is located in the midst of one of the hottest geographical regions for therapeutics development in the world.

Do you have any industry trends or insights in the field that you would like to share? How are these developments incorporated into the curriculum?

Nearly every field is enhanced by leveraging data science. This is true for biotechnology and medicine as well. These companies are learning new ways to utilize computer modeling and machine learning to improve what they do. Our graduates will be prepared to step into this rapid evolution. To continue to adapt to the needs of the local industry, we are establishing partnerships between our program and companies that would hire our graduates. In particular, our partners would assist us in designing the projects that the students work on in their courses.

How can a student determine if this is the right program for them? Which characteristics would a student need to have to succeed in this degree and in the biotech field?

Students who enjoy working with computers or programming and who are passionate about applying their talents to improve human health are ideal for the program. Similarly, students who find that they are good at math and want to apply these skills to solve important problems will do very well in and beyond the program. At the same time, students who resonate with biology but are interested in learning how to use programming to solve today's complex problems in biology are also great candidates for the program.

Can you share some information about the faculty teaching these program courses? Which classes do you teach, if any?

My role is to direct the bioengineering degree at UMD as well as the biocomputational engineering degree. The instructors in the program will be full-time teachers in the program and will have backgrounds in computational biology, biotechnology, and data science. They will all be trained in modern instructional techniques that promote active learning and inquiry-based learning in the classroom, and they will prioritize student outcomes and student success above anything else.

How long have you been in the field of bioengineering? Why are you passionate about it?

I earned all of my degrees in electrical engineering and started my career in the telecommunications field in the early 2000s. While pursuing my degree, the technical aspects of the work (electronics, fiber optics, programming, modeling) kept me motivated, but after entering the workforce, I was lacking in the necessary passion to excel. After some soul searching, I decided that applying my skill set to improving health care would ignite the passion that I was looking for. In particular, I found that I could apply my skill set to developing rapid diagnostics that can improve health outcomes. I left the telecommunications field in 2005 to pursue a postdoctoral training opportunity in biomedical engineering. Following this, I was fortunate to obtain a faculty position in the Fischell Department of Bioengineering at UMD to establish a research group that aims to address the challenges in the field of disease diagnostics.

Tell us about your research interests and achievements.

I lead the amplified molecular sensors laboratory at UMD. We aim to overcome the challenges that are preventing the realization of the next generation of diagnostic systems. In particular, we emphasize the development and application of novel amplification strategies to add orders of magnitude improvement to chemical and biomolecular sensing, while at the same time improving the simplicity and usability of sensors and diagnostic systems. Our research has applications in identifying new ways to diagnose cancer, as well as rapid and low-cost methods to diagnose viral infections and antimicrobial-resistant bacterial infections. To date, our most successful invention has been a paper-strip-based chemical and biological sensor that is not only easier to use than its commercial competitors, but it's also orders of magnitude cheaper than the previous commercial solution while maintaining the same performance. Seeing the commercialization of this technology has been one of the most rewarding experiences for our group members.

What advice do you have for prospective students thinking about applying to this program?

My advice to any student deciding what path to pursue is to choose the path that combines their skills and their passion for improving their world around them. When you are passionate about the problems that you are solving in life, going to work is rewarding. This leads to success and pride at work as well as self-esteem and happiness beyond the workplace.

ADMISSIONS REQUIREMENTS AND PREREQUISITES: TRANSFER PATHWAYS TO THE BIOCOMPUTATIONAL ENGINEERING PROGRAM

Any student looking to transfer to UMD's biocomputational engineering program must complete the prerequisite math/science courses and 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 a community college or four-year institution. For more information regarding course equivalencies, please visit the UMD Transfer Course Database. Below is more detailed information about these requirements:

- **Successful completion (C- or better) of all prerequise courses listed in the table below**
- **Complete 60 transferrable credits (or an associate's degree)**
- **Achieve a cumulative grade point average (GPA) of 2.5**

For the full list of transfer prerequisites, please see the table on the next page.

University of Maryland Course*	Credits	Montgomery College	Howard Community College	Frederick Community College	Prince George's Community College
Academic Writing (ENGL101)	3	ENGL102	ENGL121	ENGL101	EGL1010
Calculus I (MATH140)	4	MATH181	MATH181	MATH185	MAT2410
Calculus II (MATH141)	4	MATH182	MATH182	MATH195	MAT2420
Calculus III (MATH241)	4	MATH280	MATH240	MATH285	MAT2430
Differential Equations for Scientists and Engineering (MATH246)	3	MATH282	MATH260	MATH275	MAT2460
General Physics: Mechanics and Particle Dynamics (PHYS161)	3	PHYS161	PHYS110	PHYS151	PHY1030
General Physics: Vibration, Waves, Heat, Electricity and Magnetism/Lab (PHYS260/261)	4	PHYS262	PHYS111	PHYS252	PHY2030
Introduction to Engineering Design (ENES100)	3	ENES100	ENES100	ENGR100	EGR1010
General Chemistry for Engineers/Lab or General Chemistry and Energetics (CHEM135/136 or CHEM271/272)	4	CHEM132	CHEM135 or CHEM102	CHEM102	CHM2000 or CHM1020
Principles of Molecular & Cellular Biology or Biology for Engineers (BSC1170 or BIOE120)	3	BIOL150 or ENES120	BIOL141 or BIOL120	BSCI150	BIO1140
Matlab programming course (BIOE241 or equivalent)	3	ENES240 or equivalent	ENES271	MATH220 and CMIS105	EGR1140
UMD General Education requirements or Associate's Degree	22	Completion of Associate's Degree requirements. See community college suggested transfer pathway or contact your community college advisor.			
TOTAL TRANSFER CREDITS	60				

Frequently Asked Questions About

Pursuing a Bachelor's Degree in Biocomputational Engineering

FAQS ABOUT THE NEW BIOCOMPUTATIONAL ENGINEERING PROGRAM

We've outlined several of our most frequently asked questions to help guide your decision-making process as you consider the University of Maryland's B.S. in Biocomputational Engineering.

Where are classes held?

The courses in the biocomputational engineering program, which are all junior- and senior-level courses, are held at the new, state-of-the-art Biomedical Sciences and Engineering (BSE) education facility at the Universities at Shady Grove in Rockville, MD.

What do I need to do to be eligible for the program?

Before being admitted to the biocomputational engineering program, you must complete prerequisite math/science courses, lower-level General Education requirements (or an associate's degree), and 60 total credits. Students can apply as transfer students from community colleges or four-year institutions. For more information, visit the program's Admissions page.

Are there financial aid opportunities available?

The A. James Clark School of Engineering offers engineering scholarships to talented undergraduates, including transfer students. Students may also apply for federal financial aid, national scholarships, and university scholarships. For more information, visit the School of Engineering Admissions & Financial Aid page or the Universities at Shady Grove Admissions & Aid page.

What jobs can I have after graduating from the biocomputational engineering program?

Due to a strong foundational knowledge of biology and medicine as well as data science and computation, graduates will be uniquely positioned as ideal candidates for biotech firms and consulting firms. They will be highly qualified for meaningful and fulfilling career opportunities in the emerging biopharma, biotech, and biomedical industries, especially in Maryland and throughout the mid-Atlantic region.

Are organizations in the biotech industry hiring?

Absolutely. The biotech industry is a huge and growing industry actively seeking new experts with skills in biology and data science. The COVID-19 pandemic has also shed light on the ever-increasing demand for researchers and engineers to devote their time toward the study and prevention of new infectious diseases.

Who teaches the courses in the biocomputational engineering program?

The instructors are full-time UMD professors with backgrounds in computational biology, biotechnology, and data science. They are trained in modern instructional techniques that promote active learning and inquiry-based learning in the classroom.

I have more questions. Who can I speak to for more information?

You are welcome to reach out to our program coordinator, who would be happy to answer your questions. You can contact Emily Bailey, Biocomputational Engineering Program Coordinator, at biocomp@umd.edu or you can book a meeting with her.

Take the Next Step

Toward a Thriving Biotech Career

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LEARN MORE ABOUT THE BIOCOMPUTATIONAL ENGINEERING DEGREE

UMD's new Biocomputational Engineering degree is a unique program that is one of the first of its kind. By incorporating both the principles of biology and data science, the program prepares students with versatile, in-demand skills so they can solve the world's biggest health care challenges. If you are eager to become a changemaker in the biotech field, we invite you to connect with us to find out how you can make a difference.

Connect with us for additional resources about the Biocomputational Engineering degree **Request More Information**

Pick a time that is convenient for you to chat with our program coordinator, Emily Bailey **Book a Meeting**

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"This is a very exciting program and a must for the future of bioscience and bioengineering. Biocomputational engineers are urgently needed where health care is headed. Approximately 20% of the U.S. GDP is spent on health care. Quantitative approaches are desperately needed to improve efficacy and lower cost."

- Naresh Menon, Founder of ChromoLogic, LLC and UMD Fischell Department of Bioengineering Advisory Board Member

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