

Contact: Rachel Boon

**REQUEST FOR NEW PROGRAM AT IOWA STATE UNIVERSITY: BACHELOR OF SCIENCE
IN BIOMEDICAL ENGINEERING**

Action Requested: Consider approval of the request by Iowa State University for a Bachelor of Science in Biomedical Engineering in the College of Engineering.

The Council of Provosts and Board office support approval of this program.

Description of proposed program. The proposed Bachelor of Science in Biomedical Engineering (BME) will leverage current faculty expertise in biomedical engineering to offer an engineering degree that is conventional at major engineering colleges in the United States, meets workforce needs, creates a new pathway for students into medical school, and fits unique features of Iowa State University including veterinary medicine and research strengths.

Biomedical engineering is the sixth most popular engineering bachelor's degree in the U.S. The table below shows the number of bachelor of science degrees awarded in the various engineering disciplines in 2020-2021 (source: IPEDS). This degree program has become an essential component of a comprehensive college of engineering, and approval will enable Iowa State to maintain its strong national stature in engineering.

CIP	Number of Degrees Awarded	Discipline
14.1901	36809	Mechanical
14.1001	17157	Electrical
14.0801	14989	Civil
14.0901	10205	Computer
14.0701	10026	Chemical
14.0501	8517	Biomedical
14.3501	5876	Industrial
14.0201	5581	Aerospace
14.0101	2464	Engineering, General
14.0903	1888	Software
14.1401	1799	Environmental
14.1801	1519	Materials
14.0301	1132	Agricultural
14.9999	842	Engineering, Other
14.2501	831	Petroleum
14.2701	784	Systems
14.0401	769	Architectural
14.1201	688	Engineering Physics
14.3301	590	Construction
14.1301	549	Engineering Science

The BME will be administered in the existing Department of Chemical and Biological Engineering (CBE) and supported by the Departments of Electrical and Computer Engineering, Materials Science and Engineering and Mechanical Engineering. A biomedical engineering minor is currently offered to engineering students, and it has demonstrated student and employer interest as well as enabled faculty and campus leadership to design the proposed major in a manner informed by experience with the minor.

The BME will prepare students for careers serving society through understanding, designing, and manufacturing biomedical systems that improve health. Graduates will also be prepared for medical school, and other health-related professional programs. In addition to fundamental principles, students will learn applications in biomaterials, biomechanics, bioinstrumentation, and nanotechnology. Over 50 biomedical affiliated companies already recruit Iowa State engineering graduates at the engineering career fair. Multiple companies, ranging from large global corporations to start-ups, express their support for the BME in the letters of the appendix.

Students will additionally learn through interaction and collaboration with faculty and students in the human sciences and veterinary medicine, for instance,

providing unique opportunities to explore animal models for physiology and disease. Iowa State is a national leader in the One Health initiative, and the BME is well-aligned. One Health is a collaborative, multisectoral and transdisciplinary approach—working at the local, regional, national and global levels—with the goal of achieving optimal health outcomes recognizing the interconnection between people, animals, plants and their shared environment. Students will interact with regionally and nationally recognized laboratories and centers including the Veterinary Diagnostic Lab, Nanovaccine Institute, Virtual Reality Application Center and the National Animal Disease Center.

The curriculum will offer concentration in three emphasis areas, and multiple applications. This structure allows students to assemble, in collaboration with academic advisors, the curriculum that best fits their goals. The emphasis areas are biomaterials, biomechanics and bioinstrumentation (with biocomputation as a possible future expansion area). The emphasis areas will be delineated by specific sets of foundational science and engineering courses. In addition, they will map to application areas such as disease therapeutics, prosthetic rehabilitation, medical devices and a pre-vet/pre-med area. These application areas will lead to senior-level technical electives.

Academic objectives. The objectives of the BME are to educate graduates who will:

- Excel in careers as professional biomedical engineers in industries aimed at understanding, designing and manufacturing biomedical systems that improve human health.
- Successfully pursue research and advanced studies in biomedical engineering, other health related areas or in related professional fields such as medicine, patent law and business.

Graduates will have acquired a broad and deep understanding of the fundamental principles of biomedical engineering as well as their applications in disease therapeutics, advanced diagnostics, prosthetic rehabilitation, organ biomechanics, medical devices and biosensors in order to address healthcare challenges in injury prevention and recovery, next generation personal protective equipment, neurodegenerative disorders, antibiotic resistance and infectious diseases.

Need for program. The need for the program was identified through an analysis of 1) opportunities to increase synergy between academic programs and research areas of growth/expertise; 2) opportunities to meet student and employer interest; 3) opportunities to enhance the diversity of the college; and 4) opportunities to maintain and strengthen national position of the college.

Faculty across the College of Engineering have been successful at establishing and growing research programs with strong collaborations with colleagues across campus in veterinary medicine and the sciences as well as medical institutions in the state and beyond. Tangible examples include the Nanovaccine Institute and programs in computational medicine, biosensors and theranostics and human factors. These high impact research areas provide an opportunity to offer an undergraduate major in the biomedical engineering area that leverages the unique expertise and resources currently at ISU. One of the strategic goals for the engineering college is to continue to diversify its student body. According to data from the American Society of Engineering Education (ASEE), the biomedical engineering major has the second largest percentage, 48%, of women students receiving a degree among all engineering majors. The current percentage of women receiving engineering degrees at ISU is about 18%. The proposed BME major offers a tangible pathway to build a more diverse and talented engineering workforce.

Iowa State's engineering college has a successful track record of recruiting students from Illinois and Minnesota, both of which have entire departments of biomedical engineering within their public colleges of engineering. It is anticipated the BME program will be attractive to many students from these two states, as well as other states. Other universities, including Wisconsin, Texas A&M, N.C. State, Colorado State, Michigan Tech, Ohio State, Tennessee, Arizona State and Purdue also have biomedical engineering departments, schools or programs. ISU successfully recruits a significant number of engineering students from many of the states where these institutions are located.

Relationship to existing programs at the institution. The BME will complement other health and biology-related programs currently being offered at ISU including biological systems engineering, bioinformatics/computational biology, biochemistry, biophysics, biological/pre-medical illustration, and kinesiology and health. A collaborative cross-campus task force with members from the Colleges of Agriculture and Life Sciences, Human Sciences, Liberal Arts and Sciences and Veterinary Medicine in addition to key engineering faculty members were involved in developing the curriculum for this degree program.

Relationship to existing programs at other colleges and universities. The University of Iowa offers a Bachelor of Science in Biomedical Engineering. The proposed degree at ISU differs from, and complements, the University of Iowa's degree in a number of ways. Fundamentally, the BME strengths are oriented to biosensing, drug delivery, devices and manufacturing, as supported by electives that ISU already offers. Focus areas at the University of Iowa are in bioimaging, bioinformatics and cardiovascular biomechanics. ISU also has several unique features including early exposure to biomedical engineering and design problems in the freshman and sophomore year courses; opportunities for students to take cadaver anatomy labs through the College of Veterinary Medicine; a bioethics requirement; and design projects and research/independent study opportunities that leverage interactions with both human and animal models.

The University of Iowa was engaged in the development of the ISU proposal and has provided a letter of support. Dean Easterling, Associate Dean Sundararajan and Prof. Schneider (Chemical and Biological Engineering) from the College of Engineering at ISU presented the proposed program to Dean Nembhard and Associate Dean Grosland of the College of Engineering and Prof. Reinhardt, Chief Executive Officer of the Roy J. Carver Department of Biomedical Engineering at the University of Iowa in Fall 2021. They shared the proposal with key faculty, and provided constructive feedback. Multiple opportunities exist for collaboration on electives and further enhancing current joint research programs. Specifically, there are opportunities in how elective courses that leverage institutional strengths could be offered for students in either program.

Resources to establish a high-quality program. The College of Engineering has existing competencies and strengths in bioengineering, and as a result, an initial core group of faculty is in-place with the expertise to begin delivering the curriculum with existing facilities, including:

- Balaji Narasimhan - nanovaccines (CBE)
- Surya Mallapragada, neural tissue engineering and bionanomaterials (CBE)
- Ian Schneider - cellular mechanobiology (CBE)
- Nigel Rueul – biomanufacturing (CBE)
- Rizia Bardhan – nanophotonics, molecular imaging, and cancer therapy (CBE)
- Molly Kozminsky – DNA-based technologies and tumor microenvironments (CBE)
- Jing Wang – drug delivery and immunotherapy (CBE)
- Sarah Bentil – soft tissue biomechanics and brain injuries (ME)

- Ming-Chen Hsu – computational mechanics for vascular fluid structure interaction and cardiac modeling (ME)
- Adarsh Krishnamurthy – patient specific cardiac modeling (ME)
- Jonathan Claussen – biosensing (ME)
- Carmen Gomes – hybrid nanostructured materials for disease diagnostics (ME)
- Juan Ren – nanoscale biomechanics (ME)
- Cris Schwartz – Biotribology (ME)
- Tim Bigelow – ultrasound (ECPE)
- Sid Pathak – mechanics of biomaterials (MSE)
- Gary Mirka – physical ergonomics and biomechanics (IMSE)
- Liang Dong, Long Que, and Nastaran Hashami - biolabs on a chip (ECPE, ME)

Student demand. ISU anticipates attracting new undergraduate students who might otherwise not have considered engineering due to a lack of a BME degree. Biomedical engineering is among the top disciplines of interest expressed by prospective engineering students who ultimately do not enroll at Iowa State. Fall 2021 national estimates were about 33,000 such prospective students including about 3,000 for pre-med programs. With the launch of this degree program, ISU will be more effective in recruiting students.

Workforce need/demand. The Bureau of Labor Statistics predicts a 10% job growth (above the average growth rate across all occupations) for biomedical engineers with bachelor's degrees over the next decade. The median salary is approximately \$97,000/annually. Illinois and Minnesota, from which the engineering college draws many students, are among the top 10 states in the country with the highest concentration and need for Biomedical Engineers. In addition, Biomedical engineering is a popular major for graduate and pre-med students – and the proposed curriculum is designed to meet pre-med track requirements.

Funding and Cost. Initial resources to launch the program have already been incorporated into the engineering college's budgeting plan and process. No reallocations from other programs or areas are needed. The estimated personnel, facilities and equipment necessary to establish and maintain a high-quality program include the elements listed below. ISU expects program growth to result in additional financial resources which will flow to the college via tuition through the university's budget model as enrollment grows.

- Faculty: Based on the proposed curriculum and projection of initial new core courses needed, the number of new faculty across the college in the first three years is estimated to be six tenured/tenure track faculty: two in chemical and biological engineering, two in mechanical engineering, one each in electrical and computer engineering and materials science & engineering. These faculty lines will help support new course development in biomedical engineering as well as in their home department, and additionally enable increased extramural research funding.
- Salary support for the professor in charge of the program.
- Staff needs: One full-time academic advisor (with advising load up to about 200 students), one full time equivalent laboratory coordinator to support laboratory development and functioning.
- Teaching Assistant support: Up to five TA lines/per year for years 1-3 to support the laboratory and design courses.
- Laboratory: Additional equipment for the three laboratory core courses.

As the program grows, it is expected that resource flow to the college from via the university's budget model (Resource Management Model) will help support future needs. Although not

needed to launch the program, the dean's office will also pursue opportunities with ISU Foundation and other external agencies to augment or enhance resources to this program.

Projected student enrollment.

	Y1	Y 2	Y3	Y4	Y5
Undergraduate	25	60	100	150	200

Accreditation. As with all ISU engineering programs, the proposed program will seek accreditation by ABET, which is the primary accreditation body for engineering programs nationwide. The college will apply for accreditation the term that the first student graduates from the program. ISU anticipates this to be in 2027.

Date of implementation. Fall 2023.

Letters of Support



January 23, 2023

To the Board of Regents:

The Council of Provosts discussed the Iowa State University proposal for a Bachelor of Science in Biomedical Engineering and reviewed associated documentation. There is sufficient evidence for the benefits of this program to Iowa State University and its College of Engineering, as well as workforce benefit in the state of Iowa and throughout the Midwest. The plan indicates due diligence, significant engagement with employers and stakeholders at the University of Iowa. The Council of Provosts appreciates the collaboration between the deans and departments involved at SUI and ISU. Based on the evidence and documentation, this program is likely to benefit the state of Iowa.

The Council of Provosts is supportive of the program and wishes Iowa State University the best in its implementation.

DocuSigned by:
Jonathan Wickert
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1/23/2023

Jonathan Wickert
Sr. Vice President and
Provost

DocuSigned by:
Kevin Kregel
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1/26/2023

Kevin Kregel
Exec. Vice President and
Provost

DocuSigned by:
Jose Herrera
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1/23/2023

José Herrera
Exec. Vice President and
Provost



College of Engineering

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Engineering Arts and Sciences
Iowa City, Iowa 52242-1527
319-335-5764
engineering.uiowa.edu

November 17, 2021

W. Samuel Easterling
Dean of Engineering
Iowa State University
4100 Marston Hall
533 Morrill Road
Ames, IA 50011-2103

Dear Dean Easterling:

Thank you for briefing me on your plans to offer a new degree program in Biomedical Engineering at Iowa State University.

I look forward to future collaborations between the University of Iowa and Iowa State University and the potential for pipeline programs for our advanced degrees. The field of biomedical engineering is an important area to Iowans and the nation. We will need a larger workforce in the future and this new degree will provide a broader set of opportunities to fill the demand in human health.

We look forward to continuing to work with you to increase educational opportunities for aspiring engineers everywhere.

Sincerely,

A handwritten signature in blue ink that reads "Harriet B. Nembhard".

Harriet B. Nembhard
Dean, College of Engineering
Roy J. Carver Professor of Engineering



BioTherapeutics Pharmaceutical Sciences
Pfizer Inc
875 Chesterfield Pkwy W
Chesterfield MO 63017

**BioTherapeutics Pharm Sci
Bioprocess R&D**

January 12th, 2023

W. Samuel Easterling
James L. and Katherine S. Melsa Dean of Engineering
Iowa State University
4100 Marston Hall
533 Morrill Road
Ames, IA, 50011

Dear Dean Easterling,

As a recruiter at Pfizer, I am delighted to provide this letter in strong support of the proposed biomedical engineering (BME) program at Iowa State University. Pfizer hires a large number of engineers, including biomedical engineers, who are a critical component of our workforce based on our focus areas in cell and gene therapy, novel delivery technologies and medical devices.

In particular, Iowa State engineers have brought high value to our organization, and we would benefit from the ability to hire biomedical engineering majors from ISU in the future. We have strong linkages with multiple ISU departments and the Nanovaccine Institute. The establishment of the BME major will enhance our strong connections with ISU and the college of engineering.

Sincerely,

Brenda Carrillo Conde

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W. Samuel Easterling
James L. and Katherine S. Melsa Dean of Engineering
Iowa State University
4100 Marston Hall
533 Morrill Road
Ames, IA 50011

January 12, 2022

Dear Dr. Easterling,

BMS Cell Therapy Process
Development Demand for
Biomedical Engineering
Undergraduates

Biomedical engineering graduates are critical members of the BMS Cell Therapy Development Organization, and most importantly, provide essential scientific contributions to serve our patients.

Our organization develops the manufacturing processes for CAR-T cell therapies. Our work requires strong foundational knowledge in cellular engineering, metabolics, and engineering principles to enable successful scale-up of cell culture and effective separation of impurities with high product recoveries. We specifically need talented scientists with rigorous academic training in fluid, heat, and mass transfer to fulfill the unmet medical needs of future patients. Our organization recruits undergraduate BME majors with education centered around chemical engineering first principles.

ISU engineers bring value to our organization, as evidenced by two of our scientific leaders in Gene Delivery Process & Analytical Development beginning their scientific careers at Iowa State University (Matthew Stebbins, Ph.D. - B.S. '11 and Derek Ma, Ph.D. - B.S. '08). We would benefit from hiring future ISU BME majors with chemical engineering first principles and cell engineering/nucleic acid delivery expertise. We look forward to your future graduates' journeys to advance new medicines for patients.

Sincerely,

John Moscariello, Ph.D.
Vice President
Drug Product Process Development
Cell Therapy Development Organization

Itzcoatl Pla, Ph.D.
Executive Director
Gene Delivery Process & Analytical Dev
Cell Therapy Development Organization

John Moscariello, Ph.D.
Vice President | Cell Therapy PD

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12 January 2023

To:
Dr. W. Samuel Easterling
James L. and Katherine S. Melsa Dean of Engineering
Iowa State University

RE: Biomedical Engineering Program at Iowa State University

Dear Dr. Easterling,

NanoSpy, Inc. is a biotech startup company headquartered in Ames, IA. NanoSpy is developing a rapid detection biosensor platform based on new science and technology in nanomanufacturing that interface biology and surface chemistry with advanced materials for real-time infield detection and diagnostics. The versatility of this biosensor platform allows it to be functionalized for a variety of applications in industries such as food & agriculture, healthcare, and biodefense.

I would like to strongly express my support for the Biomedical Engineering Program at Iowa State University. The intersection of biology and engineering in our biosensor development requires a specific skill set that can visualize and manifest the synergy of life science and hard science in a single unit. As NanoSpy continues to grow and expand its product portfolio, ready access to a talent pool for internships and full-time scientists will surely be a significant factor in the company's success.

Sincerely,

A handwritten signature in black ink that reads "Darin Heisterkamp". The signature is fluid and cursive, with a large loop at the end.

Darin Heisterkamp
President
NanoSpy, Inc.

Additional Support

Iowa State University received additional letters of support for the Bachelor of Science in Biomedical Engineering from the businesses listed below. Each noted strong support and desire to hire graduates from the program in the future.

3M
Medtronic
Spark Therapeutics
Merck
CIVCO Medical Solutions
Carestream Health
Skroot Laboratories, Inc.
Nanospy, Inc.
PPD, part of Thermo Fisher Scientific
Imbed Biosciences