



# Department of Biomedical Engineering





## PREAMBLE

The engineering departments, school and centers of the College of Engineering at Penn State have developed robust and forward-looking strategic plans over the past year. Since the strategic planning effort was initiated, there have been considerable developments at the University on strategic planning. A new University-wide plan is currently under development, the latest graphical representation of which is included in the appendix. There is also a desire to establish institutional priorities at the College of Engineering where focus is placed on creating new opportunities for education and research that are aligned with global challenges and mesh with the university priorities. It is equally important to maintain the flexibility of supporting individual and small group initiatives as the College has done in the past.



# VALUES

## **Excellence**

Strategic growth of the Department of Biomedical Engineering (BME) will ensure that Penn State biomedical research and education programs achieve a critical mass that fosters campus-wide interactions in engineering applications applied to the life sciences.

## **Innovation**

We seek innovation through synergy, new hires and new collaborations between engineering, life science and medical science faculty. Innovation through collaboration will be the focus of activities of the Intercollege Graduate Degree Program (IGDP) in Bioengineering at the Graduate level, and through the Biomedical Engineering minor at the undergraduate level. These programs will enhance the link between the College of Engineering and Penn State Health Science-related colleges (College of Medicine, College of Science, College of Human Health and Development), umbrella organizations (Huck Institutes for Life Sciences, Materials Research Institute, Institute for Cyber Science), and other institutes/centers across the University.

## **Professionalism**

We conduct all our tasks ethically and with integrity, enhance the diversity of our community, exercise good judgment, protect the environment, share information, and respect others. We will also institute program changes aimed at enhancing professionalism in our students. These efforts will include courses on responsible conduct of research, professional development, and communication through speaking and writing. In addition, we will aim to dedicate funds for student travel to professional society meetings and to support research experiences for undergraduates.

## **Collaboration**

We enthusiastically collaborate across disciplinary boundaries to attract and integrate expertise and experiences complementary to ours. As far as our strategic planning, we will expand collaboration to include more clinical collaborators, increased industry collaborations, and increased collaborations with researchers from other universities.

## **Sustainability**

Our goal is to promote a culture of sustainability, including integration of sustainability vocabulary and practice in the classroom (*teaching*), incorporation of sustainability in the design of experiments and in the engineering design aimed at supporting healthcare infrastructure (*research*), and the integration of outreach and dissemination practices in proposals among student groups (*outreach*).



### **Diversity**

We will continue to work toward maintaining demographic and intellectual diversity among our faculty as well as graduate and undergraduate students. The Department plans to continue to build upon this foundation for our next five-year planning period.

### **Ethics**

We will expand ethics and professional development training in both the graduate and undergraduate curricula. Faculty, students and staff will learn the connection between ethical philosophies and modern rules, guidelines and laws, and understand how core competencies necessary for success in science education and research can be instilled throughout our courses and advising.

## VISION

Biomedical engineering has rapidly developed into an increasingly important profession in the national context, serving as the focal point for applying engineering to life and medical sciences, and industry, in both research and educational activities. The Department of Biomedical Engineering at Penn State is both the youngest and smallest department within the College of Engineering. Strategic growth of the Department will enable Penn State Biomedical Engineering research and education to be competitive with top programs nationally.

## MISSION

The Department of Biomedical Engineering engages and shares interests with the College of Medicine, College of Science, the College of Health and Human Development, as well as University-wide institutes, such as the Huck Institutes for Life Sciences, Materials Research Institute, and the Institute for CyberScience. Biomedical Engineering is poised for future growth to advance into a premier Department and represent its planned synergistic role in support of the Provost's healthcare strategic development pillar at Penn State.



# STRATEGIC OBJECTIVES



## Education

Provide solid and balanced fundamental knowledge, engineering and life science skills, build adaptive expertise, encourage academic excellence and integrity, and develop diversified options. We will also ensure academic excellence; foster a positive learning environment; create a supportive system among students, faculty, and staff; and provide supplementary programs for professional and personal development.



## Research

Provide high-caliber interdisciplinary research, develop a collaborative research community, include a healthy balance of basic and applied research, and promote the advancement of technology, innovation, and transformative ideas.



## Service

Contribute to and provide leadership in our respective professional organizations. We encourage faculty and student involvement in biomedical engineering-related events and societies (e.g., Biomedical Engineering Society), provide input on significant research in the field, and pass on engineering knowledge and passion to the future generations.



## Institutional Governance

Create and nurture structures and procedures that balance due process and agility to achieve financial stability and shared governance. Enhance the sense of community and institutional investment among staff and faculty. Build a flexible and efficient governance model that is able to respond to ever-changing regional, national and international operational conditions..



# STRATEGIC GOALS



## In Education

Strategic goals in education include immediate strategies to meet our rapid increase in undergraduate enrollments and strengthen the graduate program in biomedical engineering/bioengineering. The graduate program in the Biomedical Engineering Department is currently still part of the IGDP in Bioengineering. The 2012-13 IGDP Task Force recommended a new budget model (not yet implemented) that would significantly increase resources for fostering Biomedical Engineering partnerships with the IGDP-Bioengineering faculty to expand graduate enrollment and the number of PhD graduates in IGDP-Bioengineering.

These goals will be achieved by taking the following actions:

1. Strengthen our undergraduate and graduate programs by significantly expanding our faculty size in focused biomedical engineering strategic areas. This expansion assures that the core curriculum will include sufficient content and rigor to practice biomedical engineering; challenges students with innovated design projects that test and develop their problem solving skills; provides exposure to current topics and leaders in the field; and fosters collaborative work with outside entities such as medical schools and industry.
2. Secure needed resources from the University for the IGDP in Bioengineering, increase IGDP faculty opportunities with support of more PhD graduate students.
3. Define and develop a new initiative for an establishment of one-year non-thesis MS degree program in Biomedical Engineering, and enhance the graduate enrollment.
4. Clearly outline key knowledge groups and build them into the curricula. Despite the fast pace in academic research and industrial innovation, knowledge of first-principles is still the cornerstone of good academic training and all engineering practices including biomedical engineering. Key foundational knowledge areas will be identified and built into the undergraduate and graduate curricula, and metrics will be established and reviewed annually.
5. Develop strong partnerships with local, national, and global industries to make sure our course offerings match their needs. Match students with industry or academic mentors to help prepare them for jobs or further education after graduation.
6. Build supportive communities of alumni and professionals, where the educational goals can be tracked and feedback can be collected for continuous improvements.



### In Research

Strategic goals in research include the development of six focused strategic interdisciplinary and translational research areas that meet our Biomedical Engineering undergraduate and graduate curriculum development and support the Provost's healthcare strategic development pillar at Penn State. These areas include (not ranked by priority):

- **Biomedical imaging** as applied to brain- and/or cardiovascular-related basic research or clinical applications, including those that leverage computational, statistical, and informatics approaches
- **Computational bioengineering** in which mathematical, computational, informatics, statistical tools and/or multi-scale modeling are used to find solutions to fundamental questions in biology at the network, tissue, cellular and molecular levels
- **Tissue engineering/regenerative medicine** aimed at strategies that incorporate biomaterials, stem cells, and/or bio-manufacturing for the repair or regeneration of damaged or diseased tissues and organs
- **Biomedical devices and bio-nanotechnology** in which innovative micro/nano techniques or sophisticated tools in chemistry, are used to develop platforms for biosensing, live-cell imaging, implantable devices for disease treatment and smart diagnosis, or integrated devices for point-of-care in vitro diagnosis
- **Nano-medicine** aimed at advancing areas of drug delivery for diagnosis and treatment of cancer, cardiovascular disease, or diabetes
- **Cellular and molecular engineering** that includes quantitative experiments, development of novel instrumentation and leveraging tools from synthetic biology with applications to cell biology, metabolic engineering, and drug production

These target areas were chosen because they represent current grand challenges in the biomedical engineering profession. While some of these target areas overlap with concentration areas of other leading Biomedical Engineering programs across the country, there exists unique infrastructure at Penn State that Biomedical Engineering can leverage, in terms of strengths and priorities across College of Medicine, College of Science, College of Human Health and Development, Huck, Materials Research Institute, Institute for Cyber Sciences, and many other umbrella units. Furthermore, because they are recognized as grand challenges that span multiple disciplines, failing to advance these areas will result in Penn State Biomedical Engineering losing its competitiveness nationally.



These goals will be achieved by taking the following actions:

7. Expand the faculty and faculty research in a way that protects the success and diversity of the current comparatively small faculty, and bring Penn State Biomedical Engineering up to the national average in critical mass of both faculty and PhD students in order to enhance research productivity and provide students with a specific basis in the field across the array of specialties within biomedical engineering.
8. Submit joint-hire faculty proposals and launch faculty searches in the highlighted strategic areas by forming search committees that include representation from the collaborating units, advertising broadly and searching widely for excellence in biomedical engineering and related fields.
9. Increase development activities designed to create chairs and endowments for Biomedical Engineering in order to attract top faculty recruits in those identified strategic research areas.
10. Align research goals with the fast-paced evolution of technologies, innovation and transformative ideas, and patentable products.
11. Develop projects in conjunction with physicians at Hershey or other medical institutions to address direct needs of patients and the medical industry.
12. Engage Biomedical Engineering faculty in the College's Innovation grants, increase the number of multi-PI grants, and broaden attempts beyond NIH and NSF funding sources.
13. Establish strong partnerships with industry for product development, student training through internships and co-ops, and encouraging and enabling faculty start-up companies and technology translation.



### **In Service**

Strategic goals in service to the technical community and society aim to create a sense of community of Penn State students and their colleagues at other institutions; foster a matriculation of students to their professional organizations and future colleagues in the workplace; expose students to public relations efforts to communicate the efforts of the Department of Biomedical Engineering with the local and regional communities.

The following actions will support the accomplishments of our service strategic goals:

14. Invest time into creating relationships between faculty and student organizations.





15. Foster mentoring relationships between students and professional members of their society to answer questions, discuss the mentors' professional activities, and create a bridge from college to professional life.
16. Organize local and regional events that require student participation and highlight exciting areas of research in biomedical engineering. Recognize the value of student involvement in school and community organizations.



### **In Governance**

Strategic goals in institutional governance help to create organizational structures and management procedures that combine due-process, achieve efficiency and agility to respond to ever-changing operational conditions, promote fiscal responsibility, ensure financial stability, encourage shared governance, further the careers of the staff, and enhance the sense of community and investment.

These goals will be achieved by taking the following actions:

17. Develop a new traceable mechanism for closely working with our IPAC to implement recommendations, and institute a semi-annual video conference with our IPAC.
18. Incorporate University and College-required sustainability/diversity/ethics into the Biomedical Engineering governance.
19. Develop a better mentoring program for new faculty members, and ensure that, while pursuing individual work, individuals are regularly presenting and discussing their work with colleagues, seeking input and directions.
20. Expand facilities/equipment to support the increasing demands of undergraduate and graduate lab-based teaching, and an improved environment for student education and networking.

The above 20 actions for advancing the Department in education, research, governance, and service form the basis of the implementation plan that will be developed in the next phase of strategic planning.