

LIFE SAVING SOLUTIONS. REAL WORLD LEARNING.

Strategic Plan 2014 – 2019



DREXEL UNIVERSITY

School of

**Biomedical
Engineering, Science
and Health Systems**

On the cover: "Convergence" by Mike Fields (<http://mikefieldsbronzes.com/>).

FOUNDERS' MESSAGE

This Strategic Plan captures the spirit that moved Prof. Hun H. Sun, in 1961, to create the nation's first Biomedical Engineering and Science Institute. He envisioned the importance of merging distinct disciplines and cultures and believed in the power of engineering fused with the life sciences and medicine to lead to solutions that save lives. These visionary views were also shared by Dr. Dov Jaron and allowed the Institute to flourish under his leadership from 1980 to 1996.

The undersigned faculty upheld the legacy of Drs. Sun and Jaron by transforming the Institute into the free-standing, college-level interdisciplinary School of Biomedical Engineering, Science and Health Systems (BIOMED) in 1997. This legacy is also embedded in our academic culture. In research, we advance interdisciplinary frontiers of biomedical engineering and sciences in our strategic thrust areas built on our core competences and enabling technologies. In education, we strive to endow the future generations of 'renaissance engineers' with the knowledge and the educational experiences relevant to the emerging trends in life sciences, medicine and biomedical technologies.

Since its inception, BIOMED has embraced Drexel University's role as a driver of innovation. Our Coulter Translational Partnership Endowment was inspired by and stands as a testament to the enduring legacy of Dr. Sun and our enterprising and risk-taking faculty who humbly attempt to walk in his footsteps.

This document represents the dawn of a new era. With a renewed sense of purpose and vision shared by our students, faculty, staff and stakeholders, we seek to mold the future of biomedical engineering. With our local, regional, national and global academic and innovation partners sustaining and enhancing our enterprise, we are convinced that the future is bright and full of exciting possibilities.

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MISSION, VISION, CHARACTERISTICS AND VALUES

Mission

The School of Biomedical Engineering, Science and Health Systems (BIOMED) promotes health and quality of life through education, research and innovation that integrates engineering and life sciences in a global context.

Vision

The vision of the School of Biomedical Engineering, Science and Health Systems is to accelerate its role as the University's incubator for developing cutting edge programs that enhance the University's position as a national leader in education and research.

BIOMED is a leader at Drexel University, regionally, and nationally in research and translation of discoveries that impact human health and well-being. It engages students across Drexel's campus in a unique combination of cooperative (Co-op) and experiential learning, multi-disciplinary research, and exposure to entrepreneurship. Faculty and students within BIOMED possess a spirit of innovation that is built on a deep understanding of fundamental scientific principles; hands-on experience both in the laboratory and in service to others; and recognition of the synergistic impact that occurs through partnerships, globally and locally, with industry, academia, policymakers, clinicians and social-service providers. Moving forward, BIOMED will cultivate "Renaissance Biomedical Scientists and Engineers" who adapt easily to changing technologies, environments and problems.

Distinguishing Characteristics and Values

BIOMED differentiates itself from other programs of biomedical engineering nationally through the following characteristics and shared values.

- 1. An independent, college-level interdisciplinary academic unit that is positioned to lead cutting-edge university wide initiatives.** BIOMED employs an innovative approach to education, basic and translational research, and outreach that recognizes and anticipates changes in the world. As a relatively small and agile unit, BIOMED is able to easily take advantage of new opportunities that benefit its students and the University as a whole.

2. **A rich integration of engineering and the life sciences.** This is reflected in our curriculum, degree programs, and faculty composition, which stimulate interdisciplinary approaches. Our ability to include students from across the University in research and for our students to participate in research in most other academic units positions us to provide a unique experience for our students and to be supportive of interdisciplinary programs across the University.
3. **Involvement of every student in experiential learning through Drexel's Co-op program.** The shared experience of Co-op recognizes that problem solving skills are best developed through practice in diverse settings that extend beyond the classroom to the labs, offices and fieldwork available to students through our many industry partnerships. BIOMED's emphasis on translational research and its interdisciplinary approach prepares students for the challenges of biomedical engineering and instills the ethos of applying one's talent for the improvement of human health and quality of life.

These qualities helped create BIOMED and will inform and guide Drexel's next generation of biomedical engineers.



STRATEGIC GOALS

GOAL I: Be a Driver and Catalyst for Drexel's Transformation into "One University"

The University's Strategic Plan recognizes that Drexel – possessing all the pieces necessary to define the great, modern, urban university of the future – must now ensure that it is more than the sum of these parts. The School of Biomedical Engineering, Science and Health Systems serves as a prototype interdisciplinary academic unit, founded to link, leverage and orchestrate futuristic and strategic initiatives in partnership with allied units. The founding students and faculty anticipated the power of the One University concept, and the success of the school validates the strategy of forming interdisciplinary units to drive innovation in focused research thrusts that engage multiple units across the University.

A recent report of the National Research Council identifies the critical need for 'convergence' – an approach to problem solving that 'integrates knowledge, tools, and ways of thinking from life and health sciences, physical, mathematical, and computational sciences, engineering disciplines, and beyond to form a comprehensive synthetic framework for tackling scientific and societal challenges that exist at the interfaces of multiple fields.'¹ This strategy is reflected by the identification of partner units for each initiative throughout this Strategic Plan.

In this context, the history, mandate and values of BIOMED – its ethos of taking risks and crossing disciplinary boundaries to build partnerships and collaborative ventures to solve problems and advance knowledge – provide it the opportunity to serve as a leader of Drexel's transformation into One University.

- 1. Strengthen the integration of academic programs** between BIOMED and other units such as the Colleges of Medicine (DUCOM), Engineering (COE), Arts and Sciences (COAS), Computing and Informatics (CCI), the Westphal College of Media Arts and Design (COMAD), LeBow College of Business (LCOB) and the Close School of Entrepreneurship (CSE) by:
 - Promoting interdisciplinary undergraduate education and interdepartmental BS/MS degree programs with partner academic units;

¹ Convergence: Facilitating Transdisciplinary Integration of Life Sciences, Physical Sciences, Engineering, and Beyond. (2014) Committee on Key Challenge Areas for Convergence and Health; Board on Life Sciences (BLS); Division on Earth and Life Studies (DELS); National Research Council

- Promoting interdisciplinary graduate programs in Bioinformatics and Computational Bioengineering, Neuroengineering, and Regenerative Bioengineering in partnership with DUCOM and the new School of Biomedical Science & Professional Studies (SBSPS), COAS, COE and CCI.
2. **Bring to bear BIOMED’s strategic research thrusts** – *Neuroengineering, Regenerative Bioengineering and Bioinformatics and Computational Bioengineering* – to enhance collaborative research in emerging frontiers:
- *Cellular Engineering and Bionanotechnology* in partnership with COE, COAS and DUCOM;
 - *Nano-Genomics and Personalized Medicine* in partnership with the CCI, DUCOM and COE;
 - *Human Systems Integration* with emphasis on cognitive performance in aerospace in partnership with the Human-Centered Computing program and Applied Informatics Group of CCI, Applied Cognitive and Brain Science Program of COAS, the Gaming program of COMAD, the Expressive and Creative Interaction Technologies (ExCITe) Center, and leveraging the ongoing partnership with FAA William J. Hughes Tech Center;
 - *Neuro-Business* in partnership with LCOB, the Applied Cognitive and Brain Science Program in COAS, and SBSPS of DUCOM.
3. **Establish collaborative initiatives with new units of the University** that pursue academic goals complementary to BIOMED, such as DUCOM’s Clinical and Translational Research Institute, the ExCITe Center, and CSE.



GOAL II: Develop Prominence in Research Addressing Critical Unmet Health and Medical Challenges

BIOMED's three strategic research thrusts are **Neuroengineering**, **Bioinformatics and Computational Bioengineering** and **Regenerative Bioengineering**. Each builds on our historical core competences in bio-sensing and bio-imaging, biomechanics, biomaterials, and drug delivery, and each is enabled by biomedical ultrasound and optics and bio-nanotechnology platforms. The overlap among these areas and related fronts pursued at partner colleges and schools will lead, over the next five years, to the emergence of new fields, such as Immunoengineering. This evolution, along with increased collaboration with other colleges and with industry, position biomedical engineering at Drexel to have significant impact on several of society's most critical health and medical challenges.

- 1. Foster basic discovery in biomedical science and the development of innovative approaches to the detection, prevention, and treatment of diseases that constitute healthcare's greatest challenges, particularly cancer, cardiovascular disease, neurological disorders, and musculoskeletal diseases.**
 - Catalyze the formation of interdisciplinary teams that bring to bear the core expertise of Drexel researchers to understand the pathogenesis of these diseases and to develop novel strategies to restore health and improve quality of life.
 - Strengthen BIOMED's basic research capacity through strategic faculty hiring in concert with collaborating units to build critical mass in focused research areas, providing resources and mentoring to ensure successful development of junior faculty, and developing shared biomedical research infrastructure that will enhance research capabilities and foster interdisciplinary collaboration.

- 2. Continue to employ approaches characterized by an emphasis on translational research and innovation in medical device, biomedical technology and instrumentation development.**
 - Strengthen connections and collaboration among translational research activities at Drexel, in particular between the Coulter-Drexel Translational Research Partnership program and the Clinical and Translational Research Institute of DUCOM.
 - In partnership with DUCOM, COMAD and national BioDesign Partners (Case Western Reserve University, University of Minnesota and Stanford University) establish the Drexel BioDesign program.

- In partnership with Children’s Hospital of Philadelphia and University of Pennsylvania, lead the FDA sponsored Philadelphia Pediatric Device Consortium.
 - Participate in Drexel Ventures and promote biomedical translational research as a key component of Drexel’s Innovation Neighborhood.
- 3. Enhance BIOMED’s global prominence in research and innovation by expanding international partnerships.**
- Build on Drexel’s strong partnerships with Israeli universities (*e.g.*, the Institute for Drug Research of Hebrew University) to expand current faculty and post-doctoral exchanges with Technion and Tel Aviv universities to increase collaborative grants, start-ups, patents, and publications.
 - Build on the current success of the dual doctoral degree in Neuroengineering with Shanghai Jiao Tong University to integrate translational research and technology commercialization. Explore similar academic partnerships with Shanghai Technology University founded by the Shanghai Advanced Research Institute (SARI).
 - Serve as the U.S. hub for R&D and innovation for partner science and technology parks in China, Israel and Turkey.



GOAL III: Establish a Flexible and Boundaryless Learning Environment

Collaborative and interdisciplinary skills are fundamental to the future of biomedical engineering education and to the success of our students in today's industry, academic, research and public policy environments. Obtaining these skills, as well as those of design, innovation and entrepreneurship, requires a setting that pierces disciplinary silos, transcends boundaries between academic units and provides students the freedom and flexibility to take charge of their own education – while they are at Drexel and as lifelong learners.

1. Revise the undergraduate curriculum to provide a stronger foundation and provide greater flexibility for students to personalize their educational program.

- Create a comprehensive core curriculum that provides the foundation for upper-level courses in more specialized areas of biomedical engineering.
- Develop a modular upper level curriculum design that provides the flexibility to combine multiple specialty areas while ensuring depth in each one. Provide opportunities for students to pursue more elective coursework, minors among the other Drexel colleges, study abroad, and relevant co-curricular activities.
- Develop innovative pedagogical approaches, in partnership with the School of Education, that are adaptable to different student learning styles, as well as tools for assessing student learning styles.
- Create a competency-based curriculum that incorporates the Drexel Student Learning Priorities (DSLPs) by defining a clear set of core competencies required for the biomedical engineering degree and by creating mechanisms to assess these competencies.

2. Provide exceptional doctoral training and enhance research productivity.

- Enhance, update and revise the core doctoral curriculum to provide consistent course content, reduce redundancy, and clearly articulate learning goals that tie explicitly to the competencies students are expected to achieve during their doctoral program.
- Reinforce the “Applied” Biomedical Science graduate programs by active coordination and collaboration with DUCOM-SBSPS in growth strategies, offerings and resources.
- Collaborate with partner academic units to encourage a pan-University view of research opportunities and student capabilities that will facilitate student-lab placements.

- Develop resources to provide full funding for every first-year doctoral student.
- Enrich the menu of doctoral degree opportunities to make them more attractive to promising students pursuing non-academic careers by facilitating certification and/or curricular emphasis on translational research, innovation, legal or business studies.

3. Refocus the master’s degree program on the development of professional, career-focused expertise.

- Engage Drexel’s extensive network of industry, local, federal and community partnerships to identify skills and training in demand by the biomedical and biotechnology industry and expand Co-op opportunities for master’s students.
- Identify and adopt best practices in professional master’s programs and partner with Drexel University Online to explore offering such programs in online and or hybrid formats that are also suited to adult learners.
- Collaborate with DUCOM-SBSPS, LCOB and CSE to develop new professional master’s degrees and other advanced coursework in professional fields that address the needs of industry, including non-traditional sectors such as business analytics, big data, sales and marketing.

4. Integrate industry experience into the curriculum and expand and enrich Co-op opportunities.

- Create “professor of practice” positions that attract current and retired industry executives and professionals to campus for short and long-term involvements in teaching and mentoring. Leverage the cadre of executives, experts and entrepreneurs-in-residence who currently support our translational research activities in achieving educational goals.
- Work with Steinbright Career Development Center to grow the number and variety of Co-op experiences by:
 - Engaging greater numbers of Drexel biomedical engineering alumni to identify potential opportunities in their companies;
 - Expanding the number of research Co-ops and international Co-op opportunities;
 - Leveraging the University’s commitment to the Innovation Neighborhood and Drexel Ventures to establish new Co-op partnerships.

- Develop courses and provide laboratory experiences that better prepare students for Co-op positions; identify ways in which students' Co-op experiences might be incorporated into the curriculum in a meaningful and productive way. Create forums in which students share their Co-op experiences with other BIOMED students as well as students from other Drexel colleges.

5. Promote “design thinking,” translational research and entrepreneurship in academic programs.

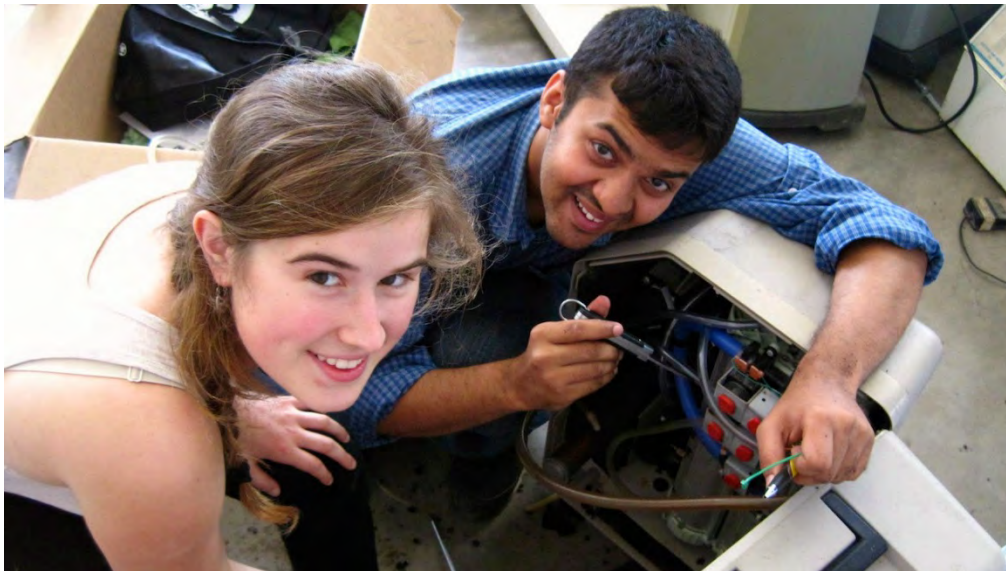
- Provide hands-on experiences in research, design, prototyping, product development and entrepreneurship throughout the curriculum (*e.g.*, the student Medical Device Entrepreneurship Association), and in partnership with other Drexel units (*e.g.*, the Product Design Program of COMAD), the ExCITe Center, the Close School of Entrepreneurship and regional design and prototyping partners (*e.g.*, NextFab Studios).
- Encourage and enable the enrollment of biomedical engineering students in courses in the Close School of Entrepreneurship.
- Enhance course offerings in the economic and regulatory issues related to translational research and product development working in partnership with regional economic development agencies such as the University City Science Center, Ben Franklin Technology Partners-SEP and regional angel investor groups.

6. Enhance student academic advisement and mentoring.

- Build on the University's emphasis on student lifecycle management by gathering and analyzing data about biomedical engineering students and using the results to modify advisement, curricular design, and student services in ways that improve student retention, academic progress and timely graduation.
- Increase faculty and alumni mentorship of students, focusing on academics, research, and careers to encourage students to assume greater responsibility for their education while at Drexel and throughout their lives.

7. Maintain the diversity of the faculty and students while striving to grow the number of underrepresented minorities.²

- Expand participation of Drexel biomedical engineering students in the NSF’s “Bridge to the Doctorate Program”³ and in the National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM).⁴
- Work with the academic advisors and the graduate and undergraduate admissions offices to identify and recruit underrepresented minority students with an interest in biomedical engineering.
- Provide outreach/service opportunities for biomedical engineering students to engage local schools with significant numbers of underrepresented minority students in order to introduce biomedical engineering as a potential field of study and careers.



² While there is strong gender balance and solid racial/ethnic/national diversity, there is still room for improvement among groups that are historically underrepresented in the STEM fields, notably African-Americans and Latinos.

³ <http://drexel.edu/provost/aard/resources-programs/bridge-doctorate/>

⁴ http://www.drexel.edu/fellowships/search/fellowships/GEM_Fellowship/

GOAL IV: Strengthen Physical, Financial and Human Resources

In order to achieve the vision articulated in this strategic plan and serve its students by offering an excellent education, BIOMED must significantly enhance its physical infrastructure, grow its financial resources, and invest in the development of its people.

1. Expand the BIOMED faculty.

- Commensurate with the current and projected increase in enrollment, the number of BIOMED faculty must increase significantly over the time horizon of this strategic plan from approximately 33 to 50 in order to reduce the student-faculty ratio below its current 30:1 level with a longer term goal of approximately 20:1.
- Focus tenure/tenure-track faculty hiring at the junior and mid-career levels on:
 - Strengthening BIOMED's current strategic research thrusts: Neuroengineering, Bioinformatics and Computational Bioengineering, and Regenerative Bioengineering;
 - Building critical mass in emerging areas such as Immunoengineering, Biomanufacturing, and Bioelectronics;
 - Maintaining broad coverage of core competency areas of Biomechanics, Biomaterials, Biosensing and Imaging, Biomedical Signals and Systems.

2. Expand and renovate laboratory and office space.

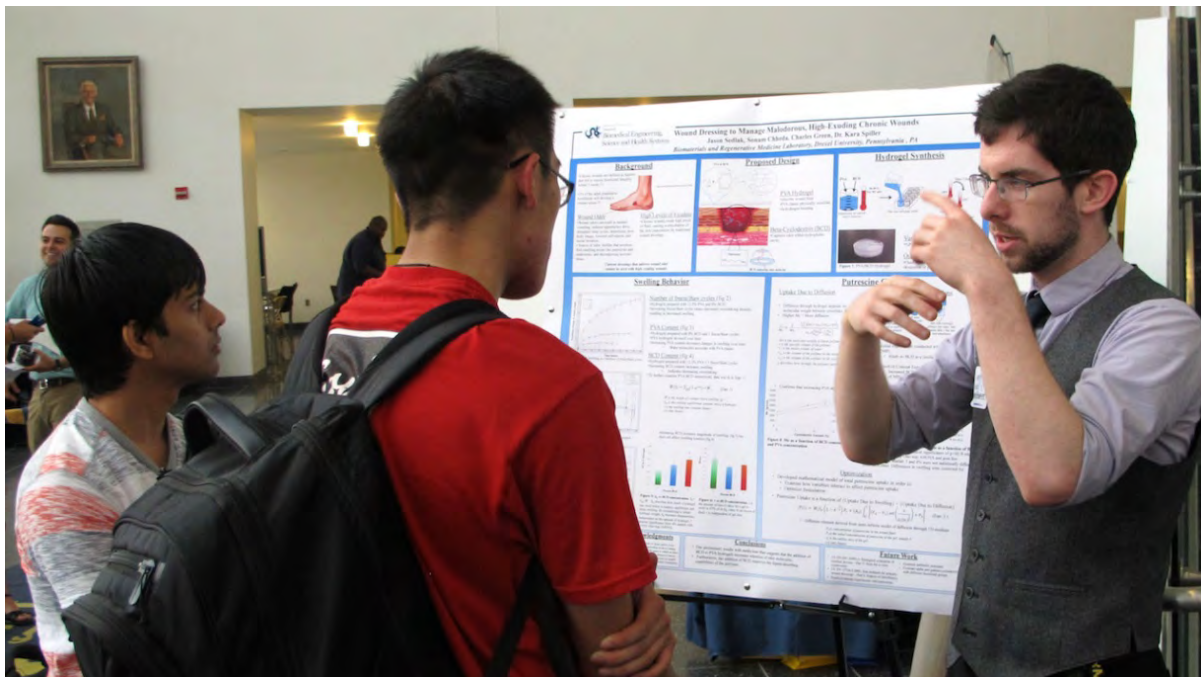
- Increase laboratory, office and gathering space for faculty, staff and students consistent with the current and projected increase in enrollment, attendant faculty and staff recruitment, and in conformance with norms for research intensive academic units.
- Enhance research infrastructure and promote collaboration by:
 - Actively participating in the planning and design of new integrated research facilities;
 - Building additional shared laboratory space with partner academic units and programs;
 - Investing in a nucleus of contiguous core biomedical engineering laboratories, specialized equipment, and the staff necessary to maintain, manage and upgrade them.

- Develop a highly visible and active biomedical engineering presence in the University's planned Innovation Neighborhood.
- 3. Create attractive and comfortable communal spaces that promote biomedical engineering to diverse audiences.**
- Create spaces that encourage interaction – academic, co-curricular and social – among biomedical engineering students, faculty and staff, and of these groups with their counterparts at partner academic units.
 - Develop modern, functional and attractive facilities that celebrate biomedical engineering and encourage Drexel as well as surrounding communities to learn more about biomedical engineering and its impact on society and their lives.
- 4. Expand research funding.**
- Double the level of federally funded research in BIOMED from \$4 million to \$8 million between 2015-2019.
 - Increase corporate sponsored research expenditures by building on BIOMED's reputation for translational research and leveraging its relationships with corporate entities regionally, nationally and internationally.
- 5. Identify an optimal enrollment in BIOMED and its corresponding net revenue potential.**
- Stabilize undergraduate enrollment between 1,000 and 1,200 students and grow the graduate programs to approach the 60:40 ratio typical of research intensive academic programs.
 - Identify the potential return on investment from expanded professional master's level degrees and certificates.
- 6. Increase alumni giving and other private philanthropy.**
- Create a varied menu of opportunities for alumni and friends of BIOMED to contribute in addition to financial donations, including such activities as mentoring current students, providing internship and career opportunities, aiding in the identification and recruitment of prospective students, and the like.
 - Identify tangible and appealing targets for fundraising (*e.g.*, the Calhoun Endowment to support promising biomedical engineering graduate students).

- Engage faculty and students more fully with the University Office of Institutional Advancement to build a fundraising program focusing on all areas of development, including the annual fund, communications, alumni relations, corporate and foundation relations, planned giving and major gifts; to strengthen affiliation with Drexel BIOMED among current students; and to emphasize the importance of giving back as alumni.

7. Build administrative capacity.

- Foster the development of administrative skills by providing greater development opportunities in management and leadership for faculty and professional staff at all levels.
- Expand promotional and public relations activities and fundraising capacity to develop resources and gain recognition for biomedical engineering activities across the University.



CONCLUSION AND NEXT STEPS

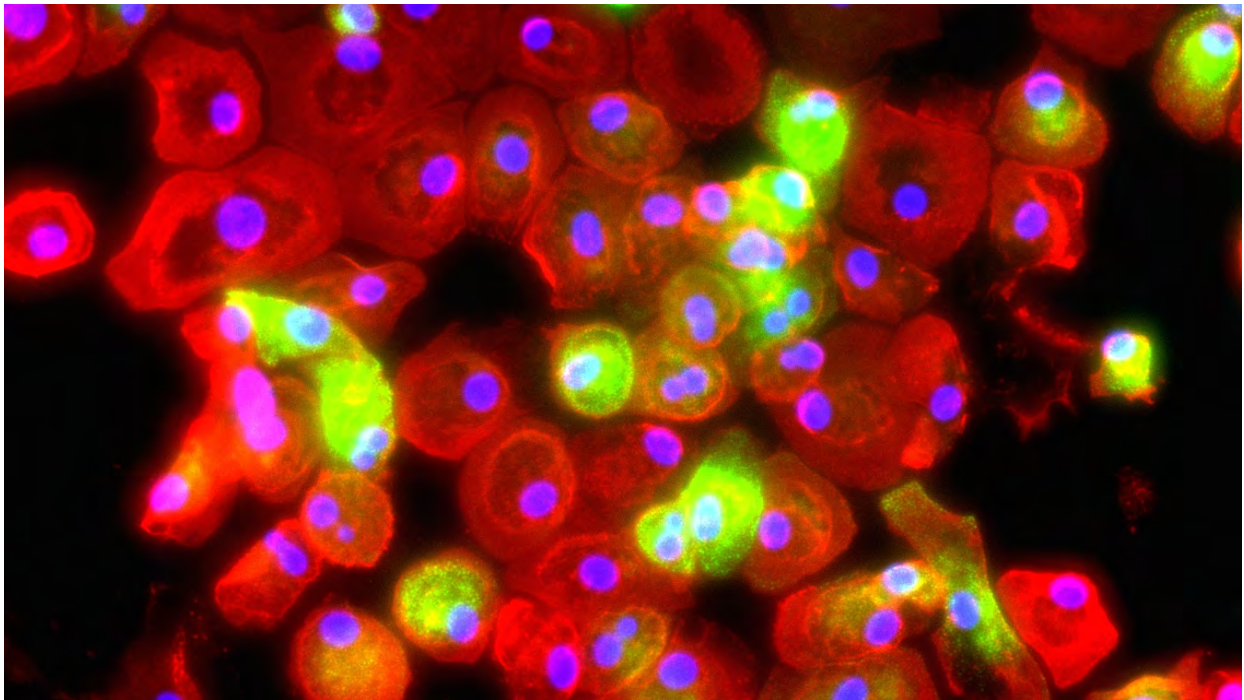
As it concludes its strategic planning process, BIOMED’s real work begins: reshaping “on the ground” its program, research, and infrastructure to allow the school to move steadily toward its new vision. BIOMED will be a leader in the research and translation of discoveries that impact human health and an enabler of multidisciplinary, experiential education that produces innovative and adaptable “Renaissance Engineers.”

To achieve this vision, BIOMED dedicates itself to *Being a Driver and Catalyst for Drexel’s Transformation into “One University”*; *Developing Prominence in Research Addressing Critical Unmet Health and Medical Challenges*; *Establishing a Flexible, Boundaryless Learning Environment*; and *Strengthening its Physical, Financial and Human Resources*. These four goals are interconnected: each stakes out an important aspect of biomedical engineering at Drexel while contributing to moving the school as a whole to a new level of accomplishment and recognition.

Critical to realizing its vision will be BIOMED’s prompt development of an implementation plan, continued communication with its constituencies, and creation of a system of monitoring and accountability, through the following actions:

- Develop an action plan and performance dashboard that addresses how BIOMED will operationalize each of the initiatives it has identified to achieve the goals of the strategic plan. Such a plan should prioritize the many initiatives and identify for each: key tasks that must occur, time frame, responsible parties and their roles, key individuals/entities to consult or involve, key metrics and milestones, and resource requirements and their sources.
- Create a plan to communicate the strategic plan to BIOMED’s numerous stakeholders, inside the school, among the other Drexel colleges and centers, alums, and to external BIOMED partners and other interested parties. Such an effort should consider different formats and emphases for the Plan appropriate to its different audiences.
- Review and update the BIOMED website, brochure and other marketing and communication materials to reflect the vision and goals of the strategic plan.

- Annually, put together a brief summary of the status of the BIOMED plan, noting progress on each initiative, identifying new opportunities and changed circumstances, and outlining steps to respond to such changes.
- At the midpoint of the school's strategic plan's term (roughly, early in calendar 2017), undertake a more comprehensive review of progress in meeting the goals of the plan. The term of the current Drexel Strategic Plan will come to a close at the end of 2019. The mid-point review of the BIOMED strategic plan is an opportune moment to consider the evolving direction of the University and what modifications that may suggest for the BIOMED plan.



ACKNOWLEDGMENTS

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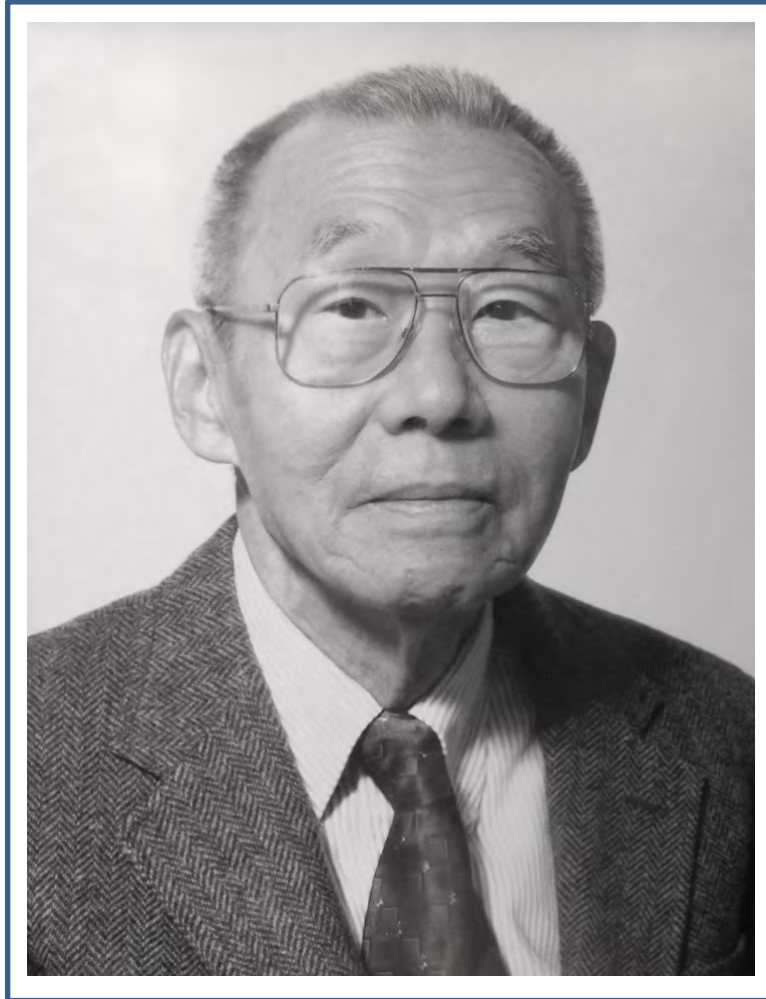
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Dedicated to the memory of Dr. Hun H. Sun (1925-2015)

