Chapter 1: Undergraduate Programs

Undergraduate programs supported by IBBME continued to grow in the 2016-2017 academic year. Registrations in the Biomedical Engineering Minor increased by 55 per cent and our Undergraduate Summer Research Program reached an all-time high of 80 students in 2017.

Our emergent student outreach programs also engaged more than 100 pre-university students from across the Greater Toronto Area.

Our growth in undergraduate programming strengthens the pipeline for our graduate programs and serves as a solid indicator of interest in our field and Institute.

Biomedical Engineering Minor

Enrolment in our biomedical engineering minor has continued to increase since its launch in 2014. Developed to expose undergraduate students to the field of engineering applications in health care, this program culminates in an opportunity for students to engage in one of two fourth-year courses that provide hands-on experiential learning in faculty research labs and at the Hospital for Sick Children through the Innovation, Hammers & Nails initiative.

A total of five courses are required for students to complete this minor. Students can declare the minor in their first year with courses concentrated in third and fourth year. All students in the Faculty of Applied Science & Engineering, with the exception of Engineering Science students in the Biomedical Systems Engineering Major, may enrol in this minor.

Figure 1.1  Biomedical Engineering Minor Enrolment

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>ChemE</th>
<th>CivE / MinE</th>
<th>ECE</th>
<th>EngSci</th>
<th>MIE</th>
<th>MSE</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-2015</td>
<td>7</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>8</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>2015-2016</td>
<td>15</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>16</td>
<td>5</td>
<td>51</td>
</tr>
<tr>
<td>2016-2017</td>
<td>19</td>
<td>1</td>
<td>21</td>
<td>2</td>
<td>30</td>
<td>6</td>
<td>79</td>
</tr>
</tbody>
</table>

1) Enrolment figures in this table have been updated to more accurately reflect the number of students enrolled in the Biomedical Engineering Minor in each academic year.

Biomedical Systems Engineering Major

Enrolment in the Biomedical Systems Engineering Major has remained robust and continues to serve as one of eight areas of upper-year study for Division of Engineering Science students.

Figure 1.2a Biomedical Engineering Systems Major Enrolment, Years 3 & 4

2) The Biomedical Engineering Option was phased out between 2012 to 2014 and replaced with the Biomedical Engineering Systems Major by 2014-2015. Student enrolment reflects total headcount in both programs during the transition period.

3) Enrolment figures do not include students conducting internships in the Professional Experience Year (PEY) program.

Figure 1.2b Biomedical Engineering Systems Major Students on Professional Experience Year (PEY) Internships
Undergraduate Summer Research Program (USRP)

Registration in our Undergraduate Summer Research Program (USRP) reached a record high for 2017. At a total count of 80 students, this year’s program continued to experience unprecedented trainee participation from students that attend U of T, but also institutions across Canada, the USA and for the first time, Turkey.

IBBME continued to provide student funding through our Director’s Summer Research Opportunities (DSRO) program. This year, we supported 20 students at $2,400 each that helped leverage close to $350,000 for all 80 USRP students through matched funding from NSERC’s Undergraduate Student Research Awards (USRA), U of T’s Undergraduate Research Opportunity Program (UROP) and faculty supervisors.

Figure 1.3 Undergraduate Summer Research Program Enrolment

<table>
<thead>
<tr>
<th></th>
<th>U of T</th>
<th>Ontario 4</th>
<th>Canada 4</th>
<th>USA &amp; Int’l</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>15</td>
<td>N/A 5</td>
<td>N/A 5</td>
<td>N/A 4</td>
<td>23</td>
</tr>
<tr>
<td>2014</td>
<td>20</td>
<td>N/A 5</td>
<td>N/A 5</td>
<td>N/A 4</td>
<td>31</td>
</tr>
<tr>
<td>2015</td>
<td>49</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>2016</td>
<td>55</td>
<td>13</td>
<td>2</td>
<td>2</td>
<td>72</td>
</tr>
<tr>
<td>2017</td>
<td>55</td>
<td>16</td>
<td>5</td>
<td>4</td>
<td>80</td>
</tr>
</tbody>
</table>

4) Ontario figures are exclusive of U of T students while rest of Canada figures are exclusive of both U of T and Ontario figures.

5) Additional data not recorded prior to 2015.
Undergraduate Programs Highlights

Course innovations spur students to create award-winning capstone design solutions

For the 2016-2017 academic year, innovations in teaching and course delivery were exemplified through outstanding successes in the two capstone design courses: BME 489—Biomedical Systems Engineering Design, and BME 498—Biomedical Engineering Capstone Design.

With the opening of the expanded Design Studio, the added space provided a new environment to offer biomedical engineering design instruction to students in an open, collaborative environment that supports active, experiential hands-on learning through open-ended design projects.

In the single-semester BME 489 course, client-driven design projects enable students to learn how to work effectively in teams to design and implement solutions for clinical challenges. The Innovation, Hammer & Nails program sourced projects from the Hospital for Sick Children, giving students opportunities to interact with clinicians, nurses, staff and fellows to develop design solutions for real-world biomedical problems identified by these experts.

One of the BME 489 student teams, Xpan, took advantage of the new rapid prototyping capabilities in the Design Studio and developed an “adjustable trocar”—an expandable instrument used for insertion of instruments and cameras during minimally-invasive surgery. Presented as a problem by SickKids surgeon Dr. Priscilla Chiu, the team’s design addressed an issue faced by surgeons who sometimes discover that they must remove the instrument mid-surgery and replace it with a larger one—an inefficient method that exposes patients to additional risk.

The Xpan team was invited to present their design at the American Society for Artificial Internal Organs (ASAIO) annual conference in Chicago in June 2017, and was selected as the second-place recipient in the Student Design Competition.

Xpan consequently participated in The Hatchery Nest, a four-month accelerator program, and won the $10,000 Lacavera Prize at U of T Engineering’s Hatchery Demo Day in September 2017. Xpan also received another $5,000 from a U of T Health Innovation Hub (H2i) pitch competition, and was recognized with the 2017 IBBME Director’s Biodesign Award as the top biodesign project team in BME 489 and BME 498.

In the full-year BME 498 course taught by Professor Christopher Bouwmeester, open-ended, student-driven design projects enable students to learn how to identify an important biomedical engineering problem as a critical first step toward inventing, designing and implementing solutions for clinical challenges. An inverted classroom approach encourages students to use pre-class assignments to come to class prepared, be engaged with relevant topics, brainstorm ideas, and develop and test their design ideas in a hands-on way in collaborative groups during class in the Design Studio.

MoveQ, a student design team from BME 498, designed MusiKinesia—a wearable electronic device constructed to help Parkinson’s patients by providing auditory cues to help them practice certain movements. The team interviewed physiotherapists with expertise in Rhythmic Auditory Stimulation (RAS), a form of
therapy that provides auditory cues that enable patients to synchronize and better control their movements. They also were inspired by observing a class at the National Ballet School for Parkinson’s patients. MoveQ received U of T Engineering’s 2017 John W. Senders Award for Imaginative Design.

Enrolment in the Undergraduate Summer Research Program keeps growing

Enrolment in our Undergraduate Summer Research Program (USRP) rose to a record high of 80 students in 2017. Participants included 10 students from the Translational Biology and Engineering Program (TBEP), the U of T component of the Ted Rogers Centre for Heart Research (TRCHR).

This year’s theme was Community in Undergraduate Research and promoted the fostering of collaborative relationships and networking outside students’ labs. Workshops and additional professional development activities were held throughout the 16-week program. These workshops included industry speakers, faculty research talks, laboratory skills sessions and tours of local biomedical facilities. Students also wrote abstracts and peer-reviewed the work of others, and disseminated their studies through scientific poster presentations at a final symposium.

USRP placements were held in faculty labs across U of T and at partner health-care institutions, including Holland Bloorview Kids Rehabilitation Hospital, the Hospital for Sick Children, Toronto Rehabilitation Institute, Toronto Western Hospital and the Princess Margaret Cancer Centre.

Professor Alison McGuigan gave the keynote address for the closing symposium, titled “Tissue-engineered culture platforms for therapy discovery.”

Outreach programs inspire pre-university students

IBBME’s two student outreach programs engaged students in Grades 7 to 8 and 11 to 12.

Discovery, led by Professor Dawn Kilkenny and PhD candidate Locke Davenport Huyer, was launched and completed a successful pilot year. This unique student outreach initiative introduced senior high school students to the field of biomedical engineering by creating an immersive semester-long educational experience around IBBME’s four research themes.

The 2016-2017 program theme, The Science Behind Prosthetics, was developed for approximately 60 Grade 11 and 12 science students from the Toronto District School Board’s (TDSB) George Harvey Collegiate Institute (GHCI), in collaboration with their science teachers.

Teams of four GHCI students were created and each group was guided by an IBBME graduate student mentor to develop experimental protocols that merged prosthetics design with topics presented in the biology, chemistry or physics class they were enrolled in. GHCI students were hosted in IBBME’s Teaching Laboratory and Design Studio three times during the semester-long program to execute their work. During the program, IBBME graduate students had opportunity to develop professional skills that support their thesis work. These included opportunities in curriculum creation, delivery of lectures, communication with students and high school educators, as well as oversight of practical, hands-on learning activities.

Discovery culminated in a symposium hosted at U of T where GHCI students presented their work in scientific poster format. Student presentations were
evaluated by USRP participants engaging in development of peer-assessment skills, with their recommendations contributing to the selection of three winning high school teams. Professor Jan Andrysek delivered a keynote address at the symposium, titled “Rehabilitation technologies targeting physical activity and mobility globally.”

IBBME Biomedical Engineering and Me (iBEAM) is another outreach program that engages students in Grades 7 and 8 from across Toronto.

Led by Professor Penney Gilbert and executed primarily during the summer months of July and August, iBEAM hosted a total of 75 students in 2016-2017 for one-day field trips to learn about tissue engineering, medical devices and biomedical lab research in our Teaching Laboratory, Design Studio and partner facilities at U of T.

Participating students were hosted from four organizations: Big Brothers Big Sisters of Peel, Crawford Adventist Academy, TDSB’s First Nations School of Toronto and Visions of Science Network for Learning.