

IBBME

ANNUAL

REPORT

2015-2016



Institute of Biomaterials & Biomedical Engineering
UNIVERSITY OF TORONTO

Message from the Director

Welcome to the Institute of Biomaterials and Biomedical Engineering's (IBBME) 2015-2016 annual report.

I am delighted to present this new format that emphasizes numerical data, mirrored after the Faculty of Applied Science & Engineering's *Annual Report of Performance Indicators*. Our intention with this presentation style is to accurately showcase our accomplishments and growth each year over the last five academic years.

IBBME experienced a significant amount of progress in the 2015-2016 period. Only in its second year since its launch in 2014, enrolment in our Biomedical Engineering Minor grew by 36 per cent, while registration in our Undergraduate Summer Research Program reached an all-time high of 72 students in 2016.

Enrolment in our graduate programs also reached a historic high, with 272 students registered in 2015-2016. We also launched our Master of Engineering (MEng) program in September 2016, a professional program that focuses on the design and commercialization of biomedical engineering devices. We anticipate that this will be a program of significant growth over the next several years.

The research strength and leadership of our faculty members continued to resonate across the biomedical engineering community. Two of our professors were appointed to lead initiatives spanning the entire University and its partner hospitals—the U of T Translational Biology & Engineering Program (TBEP) in the Ted Rogers Centre for Heart Research and Medicine by Design. Publishing more than 200 scientific papers this past year, our researchers secured an astonishing \$8 million in research funding while our graduate students attracted more than \$6 million in scholarships and grants.

The *Innovation, Hammers & Nails* program was also launched this past year in collaboration with the Hospital for Sick Children. With an aim to provide our students with experiential learning opportunities, this partnership with SickKids provided a range of hospital-based challenges for undergraduate student projects in upper-year biomedical engineering courses, as well as thesis and internship opportunities for our Master of Health Science (MHSc) in Clinical Engineering students. This program will continue to flourish as it delivers additional hands-on opportunities for our MEng students.

Thanks to the generosity of our philanthropic supporters, we were also able to establish the new Wildcat Fellows Program, a scholarship that will fund a limited number of new PhD students to conduct rotations in several research labs during their first year. This award will not only provide new doctoral students with diverse exposure to IBBME, but also help us draw the brightest minds to our program through this attractive and unique opportunity.

This past year marks only the beginning of a period of growth for IBBME. Our Design Studio was expanded to include a Collaboration Suite for optimal biomedical engineering design instruction, and further renovations are planned for the Teaching Laboratory and existing research spaces in the Rosebrugh Building.

I am extremely proud of how far we have come in such a short time. On behalf of IBBME, I thank you for your support and continued engagement.

Christopher M. Yip
Professor & Director

IBBME Leadership, 2015-2016

Director

Christopher M. Yip

Associate Director, Graduate Programs

Julie M. Audet

Associate Director, Research

Craig A. Simmons (*until June 30, 2016*)

Jonathan V. Rocheleau (*effective July 1, 2016*)

Associate Director, Undergraduate Programs

Dawn M. Kilkenny

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Facts & Figures, 2015-2016

124

Undergraduate students¹

272

Graduate students

8

MD / PhD candidates

70

New graduate students

10

Direct-entry PhD students

43

Total graduate degrees awarded

200+

Papers published

\$8M

Research funding

\$6M

Student funding

1) This figure represents total enrolment in the Biomedical Engineering Minor and the Division of Engineering Science's Biomedical Engineering Systems Major in the 2015-2016 academic year. IBBME does not currently offer direct-entry undergraduate degree programs.

Chapter 1: Undergraduate Programs

Undergraduate programs supported by IBBME continued to grow in student enrolment and program development for the 2015-2016 academic year. Registrations in the Biomedical Engineering Minor increased by 36 per cent while the Division of Engineering Science's Biomedical Engineering Systems Major maintained a steady headcount. And, our Undergraduate Summer Research Program grew to a record-high of 72 students in 2016.

Our experiential learning and co-curricular programs also grew in the 2015-2016 year. Our BME 498Y1 – Biomedical Engineering Capstone Design course was expanded to include experiential learning through access to the Hospital for Sick Children while Co-Curricular Record (CCR) validation increased for students participating in our Undergraduate Seminar Series and Mentorship Program.

This continued growth in our undergraduate programs 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 increased by 36 per cent since its launch in 2014. Developed to expose undergraduate students to the field of engineering applications in health care, this program culminates in 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.

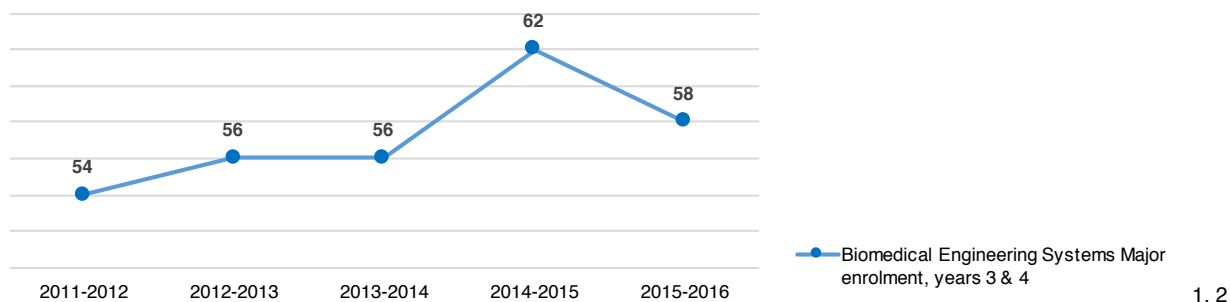
Figure 1.1 Biomedical Engineering Minor Enrolment

Academic Year	ChemE	CivE	ECE	EngSci	MIE	MSE	General 1 st Year	Total
2014-2015	15	2	9	1	9	3	1	40
2015-2016	20	2	14	1	19	6	4	66

Biomedical Systems Engineering Major

Enrolment in the Division of Engineering Science’s Biomedical Systems Engineering Major has remained robust since 2014-2015. The BME 489H1 – Biomedical Systems Engineering Design capstone course was integrated with the new *Innovation, Hammers & Nails* initiative, and the Hospital for Sick Children facilitated a total of four projects for the course.

Figure 1.2 Biomedical Engineering Systems Major Enrolment



- 1) The Biomedical Engineering Option was phased out and replaced with the Biomedical Engineering Systems Major by 2014-2015. Student enrolment reflects total headcount in both programs during the transition period.
- 2) Enrolment figures do not include students conducting internships in the Professional Experience Year (PEY) program.

Undergraduate Summer Research Program (USRP)

The demand for our Undergraduate Summer Research Program (USRP) reached a record high for 2016. At a total count of 72 students, this year’s program experienced unprecedented trainee participation from U of T, across Canada and the USA.

IBBME continued to provide student funding through our Director’s Summer Research Opportunities (DSRO) program, supporting 20 students at \$2,400 each that helped leverage more than \$300,000 for all 72 USRP students through matched funding from faculty supervisors, U of T’s Undergraduate Research Opportunity Program (UROP) and NSERC’s Undergraduate Student Research Awards (USRA).

Figure 1.3 Undergraduate Summer Research Program Enrolment

	U of T	Ontario ³	Canada ³	USA	Total
2012	24	N/A ⁴	N/A ⁴	N/A ⁴	31
2013	15	N/A ⁴	N/A ⁴	N/A ⁴	23
2014	20	N/A ⁴	N/A ⁴	N/A ⁴	31
2015	49	5	1	0	55
2016	55	13	2	2	72

- 3) Ontario figures are exclusive of U of T students while Canada figures are exclusive of both U of T and Ontario figures
- 4) Additional data not recorded prior to 2015.

Undergraduate Programs Highlights

Enriching experiential learning through capstone courses

For the 2015-2016 academic year, the two flagship courses in the Biomedical Engineering Minor, BME 498Y1 — Biomedical Engineering Capstone Design and BME 499— Applied Research in Biomedical Engineering, were expanded to provide greater student exposure to current medical research and technology.

BME 498Y1 was revamped and expanded from a half-year to a full-year course while enrolment grew to seven students from three in the previous year. As part of the *Innovation, Hammers & Nails* initiative, students in the course were introduced to real-world challenges faced by clinicians, nurses, staff and fellows at the Hospital for Sick Children, and offered the opportunity to work closely with clinicians and hospital staff to design new devices, systems and solutions to help address these issues.

Two of the teams from the course were accepted to present their final designs at the IEEE Engineering in Medicine and Biology Society (EMBS) International Student Conference (ISC) 2016.

Laboratory research placements in BME 499Y1 grew to include facilities at University Health Network (UHN), MaRS Discovery District and Sunnybrook Health Sciences Centre in addition to campus-based labs. Each student in this course was exposed to unique research experiences by rotating through two different labs at U of T and hospital-based facilities over the academic year.

Co-curricular education and mentorship

In 2015-2016, the Biomedical Engineering Undergraduate Seminar Series hosted six sessions, up from four in the previous academic year. These talks featured diverse speakers to present unique biomedical engineering research themes, as well as student-centric topics such as “How to succeed in your capstone design course,” and “Applying for graduate school.” Biomedical Engineering Minor students who attend more than half of the seminars are eligible for Co-Curricular Record (CCR) validation.

The IBBME Mentorship Program continued to experience a successful year, pairing students with faculty members for focused discussions on biomedical engineering research interests and career paths. More than 70 per cent of participating students had their CCR successfully validated for completing four meetings with their faculty mentor, submitting a goals worksheet and attending four supplemental seminars over the academic year.

A record year for our Undergraduate Summer Research Program

Enrolment in the Undergraduate Summer Research Program (USRP) rose to a record high of 72 students in 2016.

Over the 16-week period, USRP students conducted research projects at labs across U of T and at partner health-care institutions, including a total of 40 placements at Holland Bloorview Kids Rehabilitation Hospital, the Hospital for Sick Children, Toronto Rehabilitation Institute,

Toronto Western Hospital and the Princess Margaret Cancer Centre.

A Director's Choice category was introduced as a new initiative for the closing symposium. Research abstracts were reviewed by the USRP team, with eight projects selected as semi-finalists. One final winner was chosen at the event from four finalists designated by the director, with an additional four selected as winners of their respective presentation categories through peer evaluation.

2016 TED Fellow and University of Ottawa professor Andrew Pelling gave the keynote address for the closing symposium. Pelling's topic, "Augmented Biology: A new frontier inspired by cheesy sci-fi movies," highlighted the importance of recapturing the pure curiosity we develop as children and seeking ideas from uncommon places to bring transformative change to the world.

Chapter 2: Graduate Programs

Enrolment

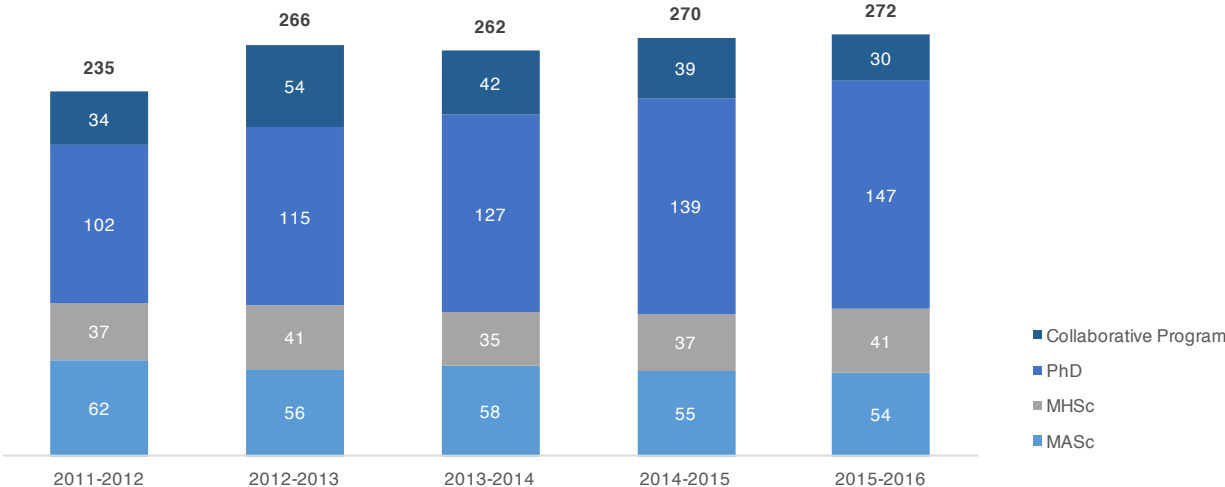
Our graduate student enrolment continued to increase in 2015-2016 as our programs attracted top students from across Canada and around the world. A total of 272 students pursued one of our three graduate degrees in IBBME, representing a 37 per cent growth since 2011.

The number of students pursuing the MD / PhD program also reached a record high of eight candidates in 2015-2016. This growth continues to strengthen our interdisciplinary relationship with the Faculty of Medicine and our ongoing commitment to clinician-scientist training.

Our PhD enrolment also reached a notable milestone in 2015-2016. The number of PhD candidates in IBBME surpassed the Faculty of Applied Science & Engineering’s average across its seven graduate units. This trend continues to solidify our strength and leadership in training highly-qualified persons in biomedical engineering.

The launch of our Master of Engineering (MEng) program will continue to enhance and broaden our leadership in the field, as we pioneer the first professional graduate degree in Canada with a focus on biomedical device design, development and commercialization.

Figure 2.1 Total Graduate Student Headcount by Academic Year



Academic Year	MASc	MHS	PhD	Collaborative Program	Domestic		Total Students
					MASc / MHS / PhD	MASc / MHS / PhD	
2011-2012	62	37	102	34	189	12	235
2012-2013	56	41	115	54	198	14	266
2013-2014	58	35	127	42	200	20	262
2014-2015	55	37	139	39	212	19	270
2015-2016	54	41	147	30	221	21	272

Figure 2.2 Collaborative Program Headcount by Academic Year

Year	Arts & Science		Dentistry	Engineering				Medicine					Pharmacy	Total	
	CHM	PHY		ChemE	ECE	MIE	MSE	BCH	IMS	LMP	MBP	PSL			RSI
11-12	0	0	0	11	9	8	1	0	0	0	0	1	2	2	34
12-13	0	0	5	20	10	9	1	2	0	0	0	1	5	2	54
13-14	0	0	3	17	5	7	2	1	0	0	0	1	5	1	42
14-15	0	0	3	19	3	6	1	2	0	0	0	1	3	1	39
15-16	0	0	3	14	3	5	1	1	0	0	0	0	3	0	30

BCH—Department of Biochemistry; ChemE—Department of Chemical Engineering & Applied Chemistry; CHM—Department of Chemistry; ECE—Edward S. Rogers Sr. Department of Electrical & Computer Engineering; IMS—Institute of Medical Science; LMP—Department of Laboratory Medicine & Pathobiology; MBP—Department of Medical Biophysics; MIE—Department of Mechanical & Industrial Engineering; MSE—Department of Materials Science & Engineering; PHY—Department of Physics; PSL—Department of Physiology; RSI—Rehabilitation Sciences Institute

Figure 2.3 IBBME Students in MD/PhD and External Collaborative Programs by Academic Year

Academic Year	Cardiovascular Sciences	Institute of Medical Science	MD / PhD	Neuroscience	Total
2011-2012	0	0	2	0	2
2012-2013	0	1	2	1	4
2013-2014	2	1	6	1	10
2014-2015	2	0	7	4	13
2015-2016	2	0	8	7	17

Figure 2.4 Comparison of IBBME with the Faculty of Applied Science & Engineering, 2015-2016

	IBBME	APSC Average ¹	APSC Total
Professional Master's (MEng & MHSc)	41 ²	116	815
Research Master's (MASc)	54	80	563
Doctoral (PhD)	147	126	881
All Students	242	322	2,259

- 1) This figure represents the average number of students across the Faculty of Applied Science & Engineering's (APSC) seven graduate units.
- 2) IBBME is the only unit offering the MHSc in Clinical Engineering program. This figure accounts for 100 per cent of the Faculty of Applied Science & Engineering's MHSc student headcount.

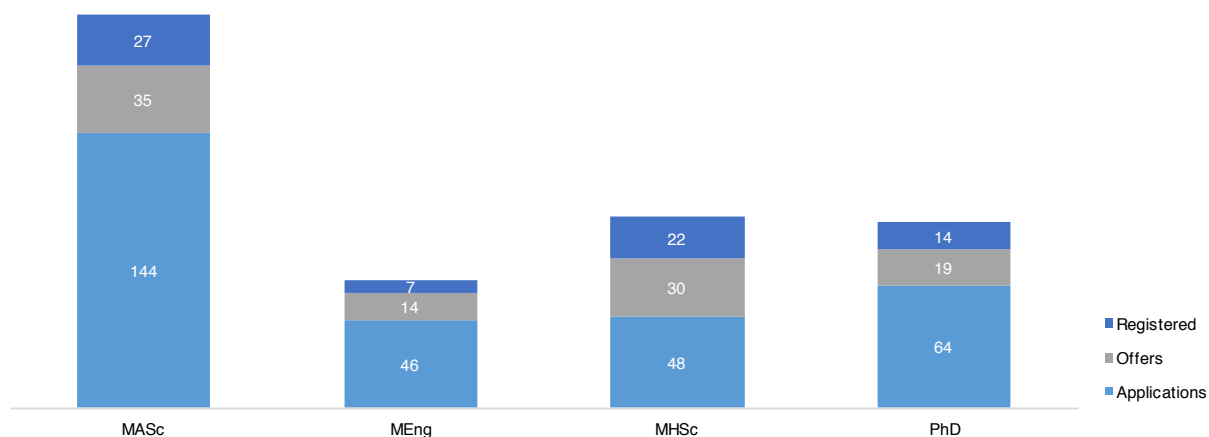
Admissions

Applications to our graduate programs continued to reflect growing demand for degrees that offer advanced skills and training in biomedical engineering.

The total number of applications to our programs increased by 33 per cent in 2015-2016 over the previous academic year. Notably, IBBME registered 10 direct-entry PhD candidates in 2015-2016—the highest number of directly-admitted doctoral students for a single graduate unit in the Faculty of Applied Science & Engineering.

Our new Master of Engineering program also received 46 applications for a target of 10 spots, signifying strong interest in biomedical device training. We anticipate this program to increase in enrolment over the next few years.

Figure 2.5 Admissions Summary for the 2015-2016 Academic Year



	Applications	Offers	Registered ³	Yield
MAsC	144	35	27	89%
MEng	46	14	7	50%
MHSc	48	30	22	73%
PhD	64	19	14	89%
Total	302	98	70	71%

3) Registered students as of November 1, 2016.

Research Programs Admissions—MAsc & PhD

Figure 2.6a Master of Applied Science (MAsc) in Biomedical Engineering,
DOMESTIC & INTERNATIONAL

Academic Year	Applications		Offers		Registered		Yield	
	Domestic	International	Domestic	International	Domestic	International	Domestic	International
2011-2012	83	50	33	2	30	1	91%	50%
2012-2013	105	47	22	4	20	2	91%	50%
2013-2014	86	42	30	4	26	3	87%	75%
2014-2015	91	38	33	2	25	2	84%	100%
2015-2016	102	42	31	4	25	2	81%	50%

Figure 2.6b Doctor of Philosophy (PhD) in Biomedical Engineering,
DOMESTIC & INTERNATIONAL

Academic Year	Applications		Offers		Registered		Yield	
	Domestic	International	Domestic	International	Domestic	International	Domestic	International
2011-2012	44	31	23	5	20	4	87%	80%
2012-2013	27	48	14	3	13	3	93%	100%
2013-2014	27	33	12	6	10	6	83%	100%
2014-2015	25	34	13	4	9	4	69%	100%
2015-2016	27	37	13	6	11	3	85%	50%

Figure 2.6c Number of Direct-Entry PhD Students,
DOMESTIC & INTERNATIONAL

Academic Year	IBBME	APSC Average ⁴
2011-2012	8	2
2012-2013	7	2
2013-2014	7	1
2014-2015	3	1
2015-2016	10	3
Total	35	9

4) This figure represents the average number of direct-entry PhD students across seven graduate units in the Faculty of Applied Science & Engineering (APSC).

Professional Programs Admissions—MEng & MHSc

Figure 2.7a Master of Engineering (MEng) in Biomedical Engineering,
DOMESTIC & INTERNATIONAL

Academic Year	Applications		Offers		Registered		Yield	
	Domestic	International	Domestic	International	Domestic	International	Domestic	International
2015-2016	30	16	10	4	4	3	40%	75%

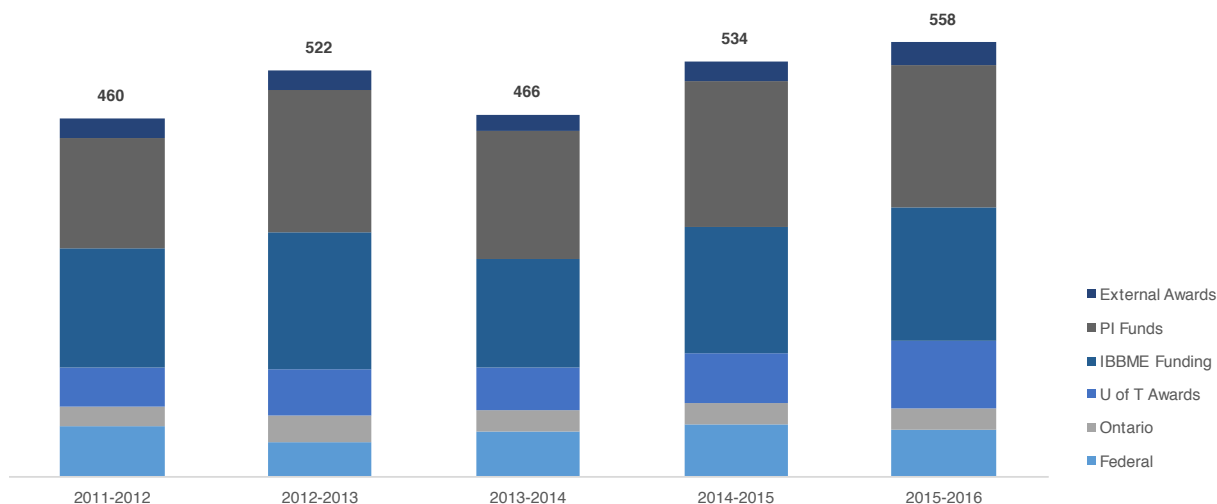
Figure 2.7b Master of Health Science (MHSc) in Clinical Engineering,
DOMESTIC & INTERNATIONAL

Academic Year	Applications		Offers		Registered		Yield	
	Domestic	International	Domestic	International	Domestic	International	Domestic	International
2011-2012	43	7	20	1	15	1	75%	100%
2012-2013	27	2	20	1	15	1	75%	100%
2013-2014	30	8	23	2	17	0	74%	0%
2014-2015	32	7	26	3	17	1	65%	33%
2015-2016	39	9	28	2	21	1	75%	50%

Student Scholarships & Funding

Our graduate students received a record number of scholarships and awards in 2015-2016, acquiring more than \$6 million in total student funding. Approximately one-third of our research-stream students held federal tri-council awards, which include the prestigious Vanier Canada Graduate Scholarships, reflecting the calibre of our students among their peers.

Figure 2.8 Number of Student Awards & Scholarships by Source



Academic Year	Federal ⁵	Ontario ⁶	U of T Awards ⁷	IBBME Funding ⁸	PI Funds ⁹	External Awards ¹⁰	Total
2011-2012	65	25	51	152	142	25	460
2012-2013	44	34	60	175	185	24	522
2013-2014	58	27	56	139	164	22	466
2014-2015	67	28	64	161	188	26	534
2015-2016	59	29	87	170	183	30	558

5) Federal figures represent funding from the Canadian government, including award programs issued by the Canadian Institutes of Health Research (CIHR) and the Natural Sciences & Engineering Research Council of Canada (NSERC).

6) Ontario figures represent scholarships funded by the provincial government, including the Ontario Graduate Scholarship (OGS) program, the Queen Elizabeth II Graduate Scholarships in Science & Technology (QEII-GSST) program, and the Ontario Trillium Scholarships (OTS) program.

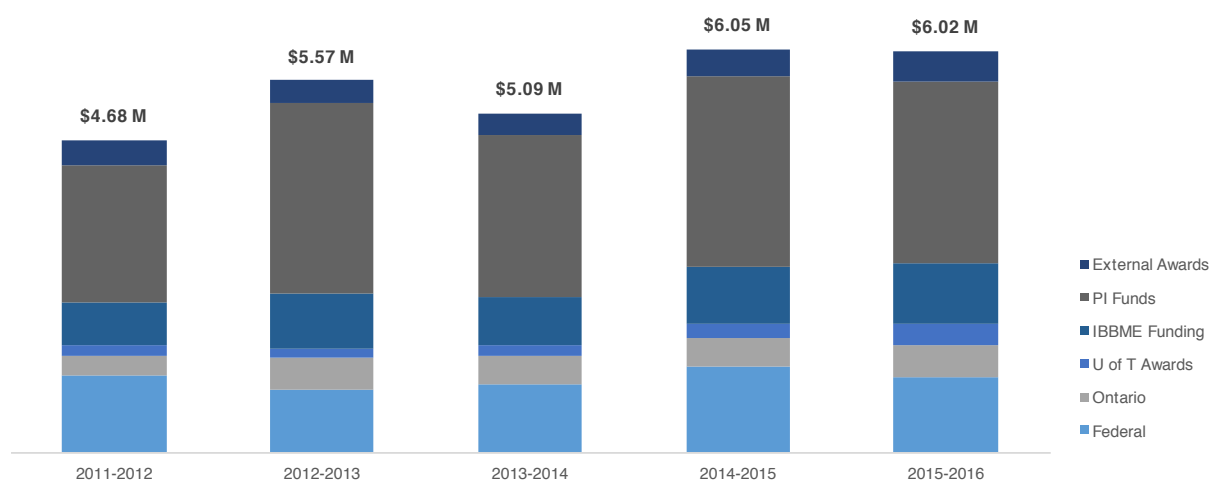
7) U of T awards represent funding administered by the School of Graduate Studies and awarded to IBBME students.

8) IBBME funding represents scholarships and financial support issued by the Institute for biomedical and clinical engineering students.

9) Principal investigator (PI) funds represent financial support for IBBME students from research grants awarded to faculty supervisors.

10) External awards include support for students from partner hospitals or other outside organizations and processed through IBBME.

Figure 2.9 Student Funding by Source



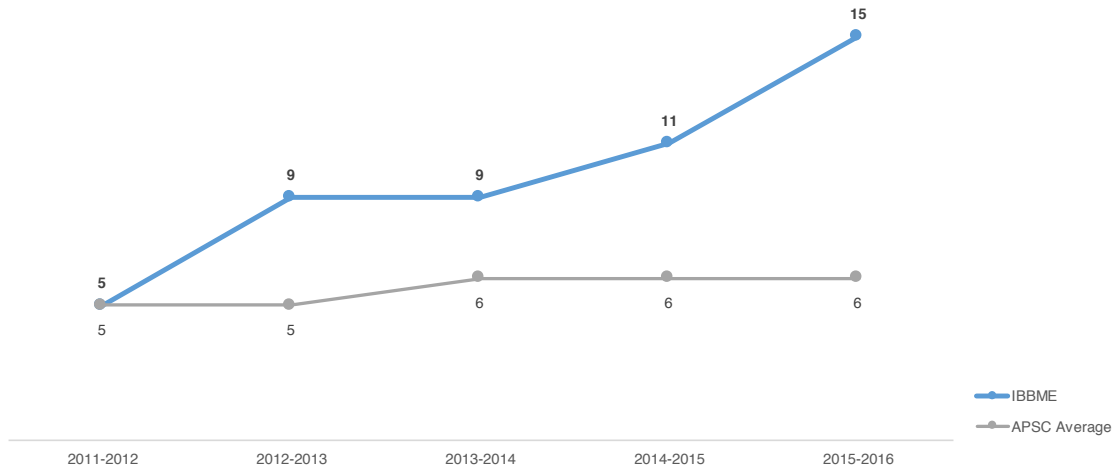
Academic Year	Federal ⁵	Ontario ⁶	U of T Awards ⁷	IBBME Funding ⁸	PI Funds ⁹	External Awards ¹⁰	Total
2011-2012	\$1,164,895	\$268,701	\$167,236	\$642,261	\$2,049,192	\$392,421	\$4,684,706
2012-2013	\$943,985	\$481,667	\$139,138	\$816,119	\$2,851,345	\$341,101	\$5,573,355
2013-2014	\$1,017,583	\$424,920	\$154,745	\$734,665	\$2,419,866	\$338,071	\$5,089,850
2014-2015	\$1,287,303	\$414,267	\$216,909	\$861,878	\$2,853,474	\$412,939	\$6,046,770
2015-2016	\$1,137,918	\$474,897	\$326,770	\$885,184	\$2,744,817	\$454,265	\$6,023,852

- 5) Federal figures represent funding from the Canadian government, including award programs issued by the Canadian Institutes of Health Research (CIHR) and the Natural Sciences & Engineering Research Council of Canada (NSERC).
- 6) Ontario figures represent scholarships funded by the provincial government, including the Ontario Graduate Scholarship (OGS) program, the Queen Elizabeth II Graduate Scholarships in Science & Technology (QEII-GSST) program, and the Ontario Trillium Scholarships (OTS) program.
- 7) U of T awards represent funding administered by the School of Graduate Studies and awarded to IBBME students.
- 8) IBBME funding represents scholarships and financial support issued by the Institute for biomedical and clinical engineering students.
- 9) Principal investigator (PI) funds represent financial support for IBBME students from research grants awarded to faculty supervisors.
- 10) External awards include support for students from partner hospitals or other outside organizations and processed through IBBME.

Graduate Degrees Completion

The number of fast-tracking students from MASc to PhD programs has increased three-fold since 2011. This trend continues to emphasize the value of a PhD degree in biomedical engineering as the best option for students pursuing a career in research.

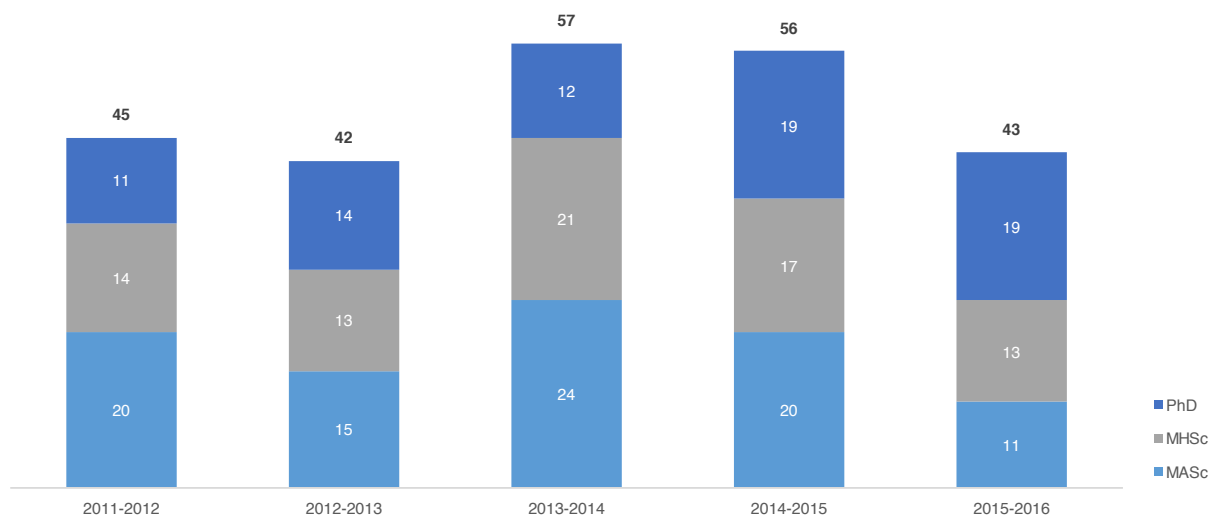
Figure 2.10 Number of Students Fast-Tracked from MASc to PhD



Academic Year	IBBME	APSC Average ¹¹
2011-2012	5	5
2012-2013	9	5
2013-2014	9	6
2014-2015	11	6
2015-2016	15	6
Total	49	28

11) This figure represents the average number of students fast-tracked from MASc to PhD across seven graduate units in the Faculty of Applied Science & Engineering (APSC).

Figure 2.11 Degrees Awarded by Academic Year



Academic Year	MSc	MHSc	PhD	Total
2011-2012	20	14	11	45
2012-2013	15	13	14	42
2013-2014	24	21	12	57
2014-2015	20	17	19	56
2015-2016	11	13	19	43

Figure 2.12 Average Time to Completion in Years for MSc, MHSc and PhD Students¹²

Academic Year	MSc	MHSc	PhD
2011-2012	2.0	2.0	5.7
2012-2013	2.0	2.0	5.0
2013-2014	2.0	2.0	5.0
2014-2015	2.3	2.0	6.0
2015-2016	2.0	2.0	5.7

12) Time to completion represents the number of years between a student's initial enrolment in a graduate program and meeting all the requirements for graduation. This data only represents terms in which a student is registered and excludes leaves, lapses and (in most cases) the term in which convocation occurs. Where a student is fast-tracked from the MSc into a PhD, the total time for both programs is counted.

Professional Program Internships

In 2015-2016, our Master of Health Science (MHSc) in Clinical Engineering students held 36 internship placements in Canada, parts of the U.S. and in Europe. This type of experiential learning maintains our position as one of the most well-rounded clinical engineering master's programs in the field.

Our ongoing relationships with internship employers will be expanded to facilitate placements that are also core to our new Master of Engineering program in the coming years.

Figure 2.13 Canadian and International Internship Placements for MHSc Clinical Engineering Students

Academic Year	Canada	USA	International	Total
2011-2012	22	5	0	27
2012-2013	32	8	1	41
2013-2014	31	7	1	38
2014-2015	33	2	2	37
2015-2016	32	3	1	36

Listing of MHSc Internship Placement Partners, 2015-2016

3BC Inc.	St. Michael's Hospital
Baylis Medical	Thunder Bay Regional Research Institute
Dymaxia Inc.	Trillium Health Partners
Children's Hospital of Michigan	University Health Network
eHealth Ontario	Healthcare Human Factors
Hospital for Sick Children	Toronto Western Hospital
Massachusetts General Hospital	Toronto Rehabilitation Institute
Neuroscience Inc.	Centre for Global eHealth
OtoSim Inc.	Techna Institute for the
Pathway Communications	Advancement of Technology for
Perimeter Medical Imaging	Health (TECHNA)
Pillsy Inc.	University Medical Centre Utrecht
Quanser Inc.	

Graduate Programs Highlights

Enabling a unique, rotational first-year PhD experience

The new Wildcat Fellows Program was established as a result of a philanthropic gift, enabling the launch of a unique rotational opportunity for select, direct-entry PhD students to conduct research projects with two to three different supervisors during their first year of studies.

This funding program will allow first-year doctoral candidates to gain a fuller appreciation of the scope, breadth and depth of the research enterprise in IBBME. It also provides both fellows and potential supervisors with the opportunity to align their expectations and potential research programs before committing to a multi-year, in-depth research project.

Two to three candidates will be selected starting in the 2016-2017 year.

Pioneering a professional master's program focused on biomedical devices

Our Master of Engineering (MEng) program launched in September 2016. Forty-six applications for a target of 10 spots were received with seven students enrolled. Focusing on the design and commercialization of biomedical devices, students in this accelerated, full-time program will complete the degree in one year while taking on applied design challenges through a four-month internship in industry, an academic lab or hospital.

Strategic recruitment of domestic graduate students

In February 2016, IBBME hosted 13 top prospective students from Canadian universities outside of the Greater Toronto Area as part of the second Graduate Research Days event. This initiative, executed across the Faculty of Applied Science & Engineering, hosted more than 100 students and provided them with opportunities to meet one-on-one with potential faculty supervisors, visit research facilities and interact with current students and alumni over a three-day period.

IBBME successfully enrolled seven students for the 2016-2017 year from this event—five into the master's program and two into the PhD program.

Equipping PhD students with entrepreneurship skills

The Training Program in Organ-on-a-Chip Engineering & Entrepreneurship (TOeP) was launched as the result of a \$1.65-million NSERC Collaborative Research & Training Experience (CREATE) program announcement in April 2016.

Led by Professor Milica Radisic in collaboration with 11 principal investigators across U of T and the University Health Network, the university-wide program will launch in 2016-2017 and provide students and post-doctoral fellows conducting microfluidics and tissue engineering research with applicable knowledge to commercialize their results.

Chapter 3: Research

In 2015-2016, our faculty and students continued to play key roles in initiatives at the intersection of engineering, medicine and dentistry, impacting new advances and innovations in health care.

Leading Regenerative Medicine and Heart Research Initiatives

Professor Craig Simmons— Translational Biology & Engineering Program (TBEP)

In July 2015, Professor **Craig Simmons** became scientific director of the Translational Biology and Engineering Program (TBEP), which unites leading experts from U of T Engineering, Medicine and Dentistry to enhance discoveries and accelerate new treatments for cardiovascular disease.

TBEP is the U of T component of the Ted Rogers Centre for Heart Research, which was created in November 2014 as a result of an unprecedented \$130-million gift from the Rogers family.

The program advances heart research, diagnostics, and regeneration using a comprehensive approach that includes systems and developmental biology, technology innovation and clinical translation.

IBBME faculty members in TBEP include professors **Hai-Ling Margaret Cheng**, **Rodrigo Fernandez-Gonzalez** and **Paul Santerre**.

University Professor Peter Zandstra—Medicine by Design

University Professor **Peter Zandstra** was named executive director of Medicine by Design (MbD) in January 2016.

MbD is the leading regenerative medicine initiative at the University of Toronto that is designing and manufacturing cells, tissues and organs that can be used in research, drug discovery and clinical treatments.

Supported by a \$114-million federal grant from the Canada First Research Excellence Fund—the largest single research grant in U of T’s history—Medicine by Design brings together more than 90 high-calibre researchers to form a globally competitive hub focused on regenerative medicine and cell therapy.

Grants are designed to support new ideas through to clinical trials and commercialization, with an initial round awarded to researchers from U of T Engineering, Medicine, Arts & Science and Pharmacy, as well as Sunnybrook Health Sciences Centre, Mount Sinai Hospital, the Hospital for Sick Children and the University Health Network.

MbD also focuses on recruiting new faculty, enhancing training opportunities for graduate students and post-doctoral fellows, and creating new national and international partnerships in regenerative medicine.

Research Highlights

Over the last academic year, our faculty and students published more than 200 scientific papers, pushing boundaries in and beyond the biomedical engineering field. Here are several highlights of their research.

Understanding a key roadblock behind nanoparticle cancer drug delivery

The emerging field of nanomedicine holds great promise in the battle against cancer. Tiny particles similar in size to protein molecules can be customized to carry tumour-targeting drugs and destroy cancer cells without harming healthy tissue.

But, when nanoparticles are administered into the body, more than 99 per cent of them become trapped in non-targeted organs, such as the liver and spleen. These nanoparticles are not delivered to the tumour to carry out their intended function.

Professor **Warren Chan**, Canada Research Chair in Bionanotechnology, and recent MD/PhD graduate Dr. **Kim Tsoi** (IBBME PhD 1T6) partnered with researchers from the University of Toronto's Faculty of Medicine, Department of Physics and the University Health Network to figure out how the liver and spleen trap intact nanoparticles as they move through the organ.

The team discovered that as nanoparticles move through the liver sinusoid, the flow-rate slows down 1,000 times, which increases the interaction between the nanoparticles and all types of liver cells. This was a surprising finding because the thought at the time was that Kupffer cells, responsible for toxin breakdown in the liver, would be the ones that gobble up the particles. In contrast, this study found that liver B-cells and liver sinusoidal endothelial

cells are also involved and that the cell phenotype also matters.

The results of their four-year study, titled "Mechanism of hard-nanomaterial clearance by the liver" was published on August 15, 2016 in the journal *Nature Materials*.

Novel MRI approach gives heart failure patients new hope

Professor **Hai-Ling Margaret Cheng** and her collaborators developed a novel magnetic resonance imaging (MRI) method that will help shed new light on the effectiveness of stem cell therapy for heart failure patients.

Despite their great promise, only a small proportion of stem cells are able to survive implantation and start regenerating damaged organs, such as hearts or lungs. The ability to track which stem cells are living and which are dying or where they are located in the body could help scientists adjust therapeutic strategies to maximize their effectiveness in fighting certain diseases.

Working with University of Toronto Scarborough chemistry professor **Xiao-an Zhang**, Professor **Craig Simmons**, and undergraduate summer research student **Sadi Loai**, they developed a unique contrast agent that can be injected into cells to track them using MRI. While conventional contrast agents only last a few days, their compound is designed specifically to stay within these cells throughout their lifespan, allowing researchers to conduct longer-term analysis and monitoring of stem cell therapy

effectiveness, such as where they are going in the body or if they integrate into the appropriate host tissue over time.

Their contrast agent was demonstrated to be able to stay within embryonic stem cells, the precursor of full cardiac cells, and were successfully grown into mature heart cells.

The team's study, titled "Positive-contrast cellular MRI of embryonic stem cells for tissue regeneration using a highly efficient T1 MRI contrast agent" was published on May 17, 2016 in the *Journal of Magnetic Resonance Imaging*.

Stem cell therapy reverses age-related osteoporosis in mice

Osteoporosis affects over 200 million people worldwide and is responsible for an estimated 8.9 million fractures per year. Fractures of the hip—one of the most common breaks for those suffering from age-related osteoporosis—lead to a significant lack of mobility and, for some, can be deadly.

Having previously demonstrated a causal effect between mice that developed age-related osteoporosis and low or defective mesenchymal stem cells (MSCs) in these animals, University of Ottawa professor William Stanford (cross-appointed in IBBME) partnered with Professor **John E. Davies** and post-doctoral fellow **Jeffrey Kiernan** (IBBME PhD 1T5) to see if the introduction of healthy stem cells could prevent or treat this type of osteoporosis.

To test that theory, the researchers injected osteoporotic mice with MSCs from healthy mice. Stem cells are "progenitor" cells, capable of dividing and changing into all the different cell types in the body. Able to become bone cells, MSCs have a second unique feature, ideal for the development of human therapies: these stem cells can be transplanted from one person to another

without the need for matching (needed for blood transfusions, for instance) and without being rejected.

After six months post-injection, a quarter of the life span of these animals, the osteoporotic bone had astonishingly given way to healthy, functional bone.

The full results of their work, titled "Systemic Mesenchymal Stromal Cell Transplantation Prevents Functional Bone Loss in a Mouse Model of Age-Related Osteoporosis" were published on March 17, 2016 in the journal *Stem Cells Translational Medicine*.

Battery-sized microscope gives new insights into brain activity during seizure

PhD candidates **Illya Sigal** and **Dene Ringuette** from Professor Ofer Levi's lab developed a miniature microscope—about the size of a triple-A battery—that can be used to peer into a rodent's brain during an epileptic seizure without anaesthesia. The technique allows for concurrent monitoring of brain blood flow and blood oxygenation in awake, freely-behaving rats, and could lead to more effective drug testing and treatment development.

In partnership with researchers at the Sunnybrook Research Institute and the University Health Network's Krembil Research Institute, they designed and built a scaled-down optical microscope comprising of a skull adapter plate, an imaging tube and a laser light source.

The microscope, measured 40 millimeters in length and 12 millimeters in diameter, and weighed 15 grams including the base plate, representing less than five per cent of the animal's total body mass. It was affixed to its head via a skull adapter plate, which allowed for the device to be attached and

removed at will. Imaging on the rodent's brain surface was then performed with the microscope through a minimally-invasive, surgically-implanted cranial glass window.

Sigal and his colleagues were able to successfully record the brain during seizures, measuring blood flow and metabolism without anaesthetic disruption over a period of six weeks.

Their design and methodology was summarized in a paper entitled, "Imaging brain activity during seizures in freely behaving rats using a miniature multi-modal imaging system," and was published on August 22, 2016 in the journal *Biomedical Optics Express*.

[‘Organ-on-a-chip’—lab-grown heart and liver tissue for drug testing and more](#)

Professor **Milica Radisic** and PhD candidate **Boyang Zhang** led the development of *AngioChip*, a lab-grown human tissue platform for discovering and testing new drugs that could eventually be used to repair or replace damaged organs.

Radisic, Zhang and their collaborators created a fully three-dimensional structure with blood vessels and a lattice for other cells to attach and grow. Zhang built the scaffold out of POMaC, a polymer that is both biodegradable and biocompatible. The scaffold is made from a series of thin layers, stamped with a pattern of channels that are each about 50 to 100 micrometres wide. The layers, which resemble computer microchips, are then stacked into a 3D structure of synthetic blood vessels and cross-linked using UV light. When the structure is finished, it is bathed in a liquid containing living cells, which quickly colonize the channels and begin growing just as they would in the human body.

Their work, performed in partnership with University Professor **Michael Sefton**, Professor **Aaron Wheeler** and their lab groups, as well as researchers from the University Health Network, was titled "Biodegradable scaffold with built-in vasculature for organ-on-a-chip engineering and direct surgical anastomosis." It was published on March 7, 2016 in the journal *Nature Materials*.

[Apollo-NADP+: a new cell imaging technique for diabetes, cancer and more](#)

Graduate students **William Cameron** and **Cindy Bui** from Professor **Jonathan Rocheleau**'s Quantitative Microscopy, Microfluidics and Metabolism Lab spearheaded a new way to visualize biochemical reactions in cells. By offering new insight into how human cells work—or, in the case of diseased cells, how they malfunction—the technique could advance the study of diabetes, cancer and other conditions.

In collaboration with investigators from the Toronto General Research Institute, they invented a biological sensor based on fluorescent proteins that glow in response to laser light. Specifically, it is a kind of molecular tag that binds to and illuminates NADP⁺, a molecule in our cells involved with many biological functions, from breaking down fats and proteins to protecting against stress. When NADP⁺ doesn't work properly, it can trigger undesired effects that result in conditions such as diabetes and arthritis.

The novelty in the team's new sensor, called Apollo-NADP⁺, is that it responds using a single colour while previous techniques typically takes two different-colours to conduct proper tracking. Prior to their invention, tracking two molecules would require four colours, and three would require six, resulting in microscope slides

that resembled an incomprehensible kaleidoscope.

Apollo-NADP⁺ responds with a change in polarization of light emitted, as opposed to a change in colour when a molecule increases in concentration, and can be detected using light filters similar to those found in 3D movie eyeglasses. The team can also tune the single colour output into a variety of wavelengths, allowing for more flexibility in how responses are measured within the cell, paving the way for new types of observations that can be made about how cells use or misuse their NADP⁺ supply.

Their work, titled “Apollo-NADP⁺: A spectrally tunable family of genetically encoded sensors for NADP⁺” was published on February 15, 2016 in the journal *Nature Methods*. The team also subsequently released their sensor design in open source as a blueprint for other investigators to adapt to their own research.

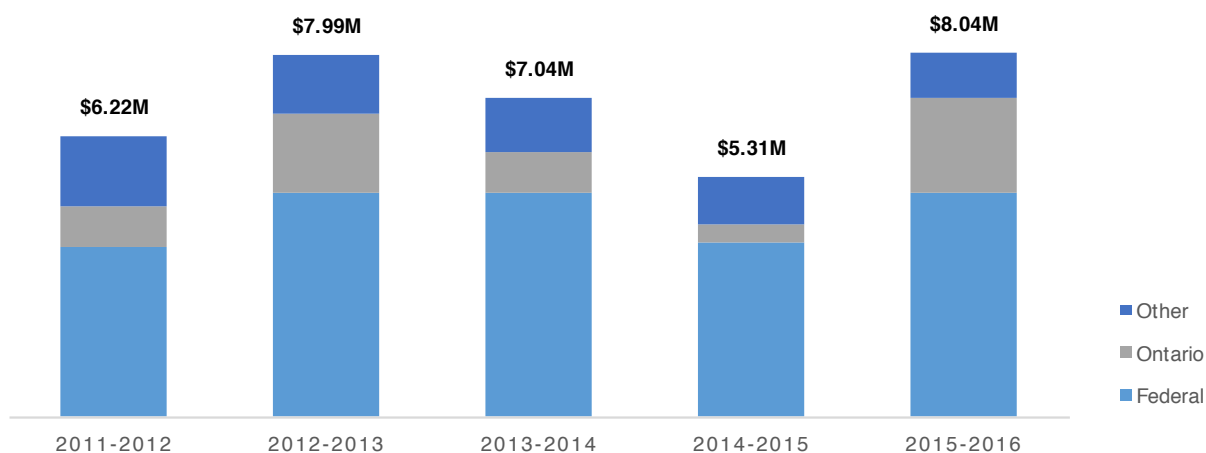
Research Funding

In 2015-2016, IBBME attracted more than \$8 million in research funding—a 66 per cent increase from the previous academic year. This was also the highest annual total in the last five academic years.

The increase can be attributed to an eight percent growth in the number of grants received, from 64 to 78 this year, particularly from federal sources, such as NSERC and CIHR.

This additional funding is a testament of our faculty’s strength in biomedical and clinical engineering research. It will help us advance our collaborations and multidisciplinary work with our partners and continue to grow our world-class academic programs for our students.

Figure 3.1 Total Research Funding



Academic Year	Federal ¹	Ontario ²	Other ³	Number of grants ⁴	Total PIs ⁵	Average per PI ⁶	Total
2011-2012	\$3,774,548	\$872,157	\$1,571,579	64	19	\$327,278	\$6,218,284
2012-2013	\$4,947,467	\$1,754,994	\$1,291,634	83	25	\$319,764	\$7,994,095
2013-2014	\$4,943,371	\$893,878	\$1,203,646	77	27	\$260,774	\$7,040,894
2014-2015	\$3,864,796	\$417,792	\$1,023,422	64	26	\$204,077	\$5,306,011
2015-2016	\$4,934,986	\$2,132,553	\$975,805	78	28	\$287,262	\$8,043,345

1) Federal figures represent all sources of national government funding, including the Canada Foundation for Innovation (CFI), Canada Research Chairs (CRC) program, Canadian Institutes of Health Research (CIHR), Natural Sciences & Engineering Research Council of Canada (NSERC), and the Networks of Centres of Excellence of Canada (NCE).

2) Ontario figures represent all sources of provincial funding, including the Ministry of Research & Innovation and the Ontario Centres of Excellence.

3) Other sources of research funding include corporate partnerships, foundations support, hospital research partnerships, internal University grants, professional organizations, and research partnerships with peer institutions.

4) Total number of grants administered through IBBME.

5) Total number of core and cross-appointed faculty members who administered their research grants through IBBME.

6) Average funding per PI calculated by the total annual funding divided by the number of faculty members who administered their research grants through IBBME during the academic year.

Chapter 4: Experiential Learning, Community Integration & Recognition

Our dedication to educating future generations of biomedical and clinical engineers extends beyond our classroom and laboratory walls. Our commitment to world-class training includes initiatives that place our students at the heart of health-care institutions where they can be exposed to real-world challenges.

In 2015-2016, we launched the *Innovation, Hammers & Nails* initiative in partnership with the Hospital for Sick Children. Through this program, IBBME students are provided with opportunities to design solutions for challenges identified by clinicians, nurses, staff and fellows at Canada's most research-intensive pediatric health-care institution.

Providing experiential learning opportunities also align with our efforts to integrate trainees into their professional community by introducing them to leaders in the field. In 2015-2016, our Distinguished Seminar Series hosted lectures by four renowned researchers, where students and faculty members had the opportunity to attend a talk and subsequently share discoveries, ideas and methodologies with each other.

Our faculty members continued to garner widespread recognition for outstanding achievements in research, teaching and community service. This sustained acknowledgement continues to elevate the profile of the Institute, creating exposure that helps create new opportunities for both faculty and students alike.

Innovation, Hammers & Nails

In partnership with the Hospital for Sick Children, this initiative offers hospital-based projects and opportunities for three undergraduate courses, the Undergraduate Summer Research Program (USRP), thesis projects for the Master of Health Science (MHSc) in Clinical Engineering program and internships for MHSc and Master of Engineering (MEng) students.

In 2015-2016, the Hospital enabled five undergraduate projects, three Undergraduate Summer Research Program (USRP) placements, along with three Master of Health Science (MHSc) in Clinical Engineering internships and four MHSc thesis projects.

Experiential learning opportunities enabled by the Hospital for Sick Children

5

Undergraduate
research projects

3

USRP
placements

3

MHSc
internships

4

MHSc
thesis projects

Selected Awards & Honours Received by Core Faculty

The following is a selected list of honours and awards received by IBBME core faculty in the 2015-2016 academic year.

International

**European Society for Biomaterials:
International Award**

Michael Sefton

**National Academy of Engineering (U.S.):
Foreign Member**

Molly Shoichet

**Terumo Foundation for Life Sciences &
Arts: Terumo Global Science Prize**

Michael Sefton

**Tissue Engineering & Regenerative
Medicine International Society (TERMIS):
Lifetime Achievement Award**

Michael Sefton

National

**Canadian Academy of Engineering:
Fellow**

Milica Radisic

**Canadian Society for Chemical
Engineering: Hatch Innovation Award**

Milica Radisic

**Canadian Society for Mechanical
Engineering: Fellow**

Lidan You

**March of Dimes Canada:
Jonas Salk Pioneer Award**

Tom Chau

**Royal Canadian Institute:
Fleming Medal & Citation**

Molly Shoichet

**Sandford Fleming Foundation:
Wighton Fellowship**

Dawn Kilkenny

U of T & Partner Hospitals

University Professor

Peter Zandstra

**Distinguished Professor of
Mechanobiology**

Craig Simmons

**University Health Network:
Inventor of the Year Award**

Milos Popovic

Distinguished Seminar Series

The IBBME Distinguished Seminar Series invites global leaders in biomedical and clinical engineering research to share their discoveries and methodologies with our community. Speakers are selected and confirmed by a faculty committee in consultation with the Biomedical Engineering Students' Association (BESA).

The 2015-2016 series committee was chaired by Professor **Penney Gilbert**. Below is a listing of invited guests over the past academic year.

September 15, 2015

Robot assisted neurorehabilitation: toward a computational approach

David Reinkensmeyer, Professor

Department of Mechanical & Aerospace Engineering, and
Department of Biomedical Engineering, University of California, Irvine

November 2, 2015

Bioengineering of direct cellular reprogramming

Kam Leong, Professor of Biomedical Engineering,

The Fu Foundation School of Engineering & Applied Science, Columbia University

April 4, 2016

Microscale tools enable functional and mechanistic insights in cancer

David Beebe, John D. MacArthur Professor & Claude Bernard Professor

Department of Biomedical Engineering, College of Engineering,
University of Wisconsin-Madison

May 16, 2016

Temporal pattern of stimulation as a new dimension of therapeutic innovation

Warren Grill, Edmund T. Pratt, Jr. School Professor of Biomedical Engineering

Pratt School of Engineering, Duke University

Chapter 5: Advancement

Over the last five years, philanthropic contributions made directly to IBBME from our alumni and friends have enabled us to grow and support our academic programs, particularly in the area of graduate student funding and scholarships.

In 2016, the Wildcat Fellows Program was established as a result of a \$180,000 gift—matched by IBBME—enabling the launch of a unique rotation opportunity for select, direct-entry PhD students to conduct research projects with two to three different supervisors during their first year of studies.

Professor **Jonathan Rocheleau** was named the inaugural Percy Edward Hart Professor in Biomaterials & Biomedical Engineering. The \$20-million transformational bequest from the estate of alumnus Erwin Edward Hart allowed the Faculty of Applied Science & Engineering to create seven Percy Edward Hart and Erwin Edward Hart Professorships—supporting researchers within the first 10 years of their careers with \$75,000 per year for three years for research and graduate student support.

Philanthropic Support

\$650,000	5	42
Philanthropic contributions to IBBME since 2011	Philanthropic scholarships established since 2011	Number of student recipients since 2011

IBBME has attracted close to \$650,000 in new philanthropic gifts over the last five years. The generosity of our alumni and friends have contributed to the growth of our academic programs, and provided opportunities for student support in the form of scholarships and awards.

Student awards established in IBBME as a result of recent philanthropic gifts include the Wildcat Graduate Scholarships (2011), the Loo Geok Eng Foundation Graduate Scholarship (2011), the Paul Santerre Undergraduate Biomedical Engineering Legacy Scholarship (2013), the Wildcat Voyager Scholarships (2014) and the Wildcat Fellows Program (2016).

Wildcat Fellows Program

This past year, the new Wildcat Fellows Program was established as a result of a \$180,000 gift. The initiative provides select, direct-entry PhD students with a one-year, non-renewable funding to hold rotation opportunities between several research labs and supervisors during the first year of doctoral studies.

This unique program allows fellows to gain a fuller appreciation of the scope, breadth, and depth of the research enterprise in IBBME and provide both fellows and potential supervisors with the opportunity to align their expectations and potential research programs.

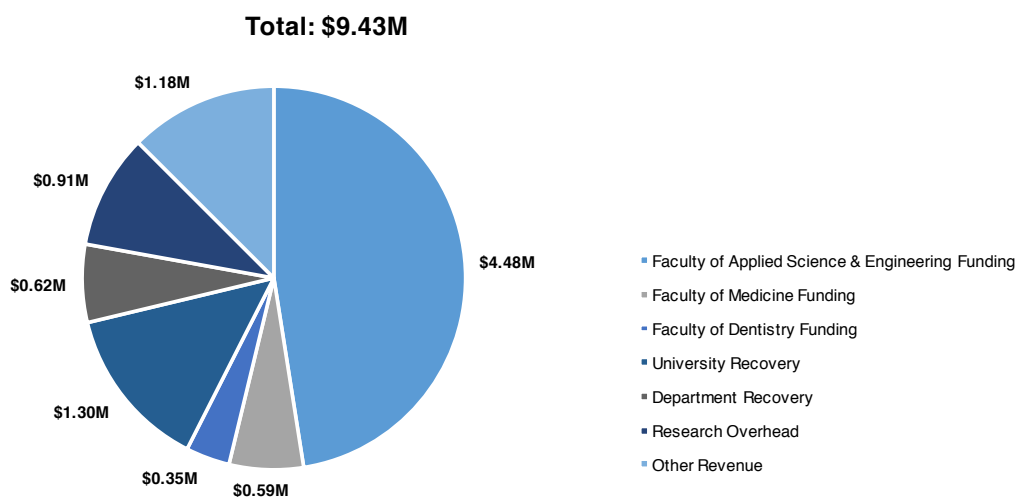
Chapter 6: Financial and Physical Resources

IBBME’s total revenue and associated costs are reflected in Figures 6.1 and 6.2. Our 2015-2016 budget was approximately \$9.43 million.

The Design Studio expansion was completed to include the Collaboration Suite. This added space can now house an additional 32 students, and increases our ability to offer biomedical engineering design instruction in an open, collaborative environment to students across the Faculty of Applied Science & Engineering.

Additional renovations are planned, including the expansion of the Teaching Lab and improvements to research spaces in the Rosebrugh Building. Approximately \$2 million of our budget has been earmarked for these projects.

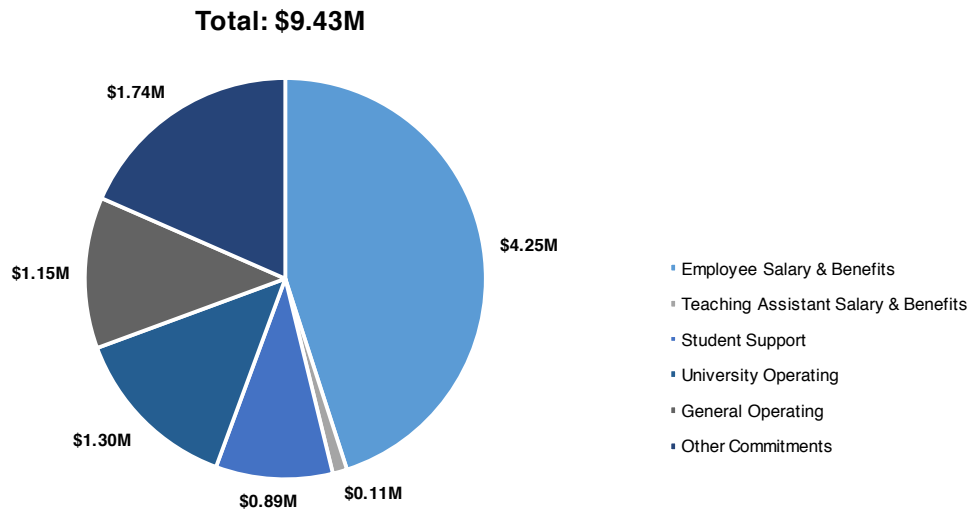
Figure 6.1 Total Revenue by Source



Fiscal Year	Engineering Funding	Medicine Funding	Dentistry Funding	University Recovery ¹	Department Recovery ²	Research Overhead	Other Revenue ³	Total Revenue
2015-2016	\$4,479,705	\$588,832	\$350,431	\$1,296,755	\$623,213	\$914,920	\$1,180,345	\$9,434,201

- 1) University recovery includes funding from Ontario’s Basic Income Unit (BIU) and teaching budget revenue.
- 2) Department recovery includes faculty salary recuperations from the Canada Research Chairs (CRCs) program, partner hospitals and other administrative support-related costs.
- 3) Other revenue sources include endowed scholarships and trusts.

Figure 6.2 Breakdown of Operating Expenses



Fiscal Year	Employee Salary & Benefits	Teaching Assistant Salary & Benefits	Student Support	University Operating ⁴	General Operating	Other Commitments ⁵	Total Expenses
2015-2016	\$4,249,492	\$114,433	\$885,184	\$1,296,755	\$1,147,358	\$1,740,979	\$9,434,201

4) University operating expenses include space costs and research taxes.

5) Other commitments include anticipated capital projects and faculty hires.

Project Highlights

Projects Completed

New Collaboration Suite enhances instruction and group-based design work

In 2015-2016, the IBBME Design Studio was expanded to include a Collaboration Suite. Located in the basement of the Lassonde Mining Building (MB) in room 78, this technology-enabled space houses interactive tools including a smart board, networked display screens and modular work surfaces.

The Collaboration Suite can seat up to 32 students and is ideal for design and team project work. The space is configured with tables that allow students to work together

on group projects in a classroom setting. Students can also access the suite when classes are not in session and use the equipment and space to work on course assignments and design projects.

The Design Studio’s new addition allows IBBME to serve more students and offer more courses in an open teaching, learning and group design environment. The expanded studio is expected to serve more than 500 students in the 2016-2017 academic year. More than 10 biomedical engineering courses are being offered in the collaboration space, providing students with improved learning opportunities in physiology as well as the design, fabrication

and implementation of high-throughput bioanalytical platforms.

Future Projects

Larger and improved Teaching Lab space

The IBBME Teaching Lab will undergo an expansion, starting in the spring of 2017. Located on the third floor of the Lassonde Mining Building (MB), room 322 will be converted from a research facility into teaching lab space to offer students additional lab space, equipment and classrooms.

The renovation and expansion of the teaching lab will double our current capacity, allowing IBBME to serve more students and offer multiple courses simultaneously.

Renovate and rejuvenate existing laboratories to foster advanced collaborative research

Research lab spaces at the north and west end of the Rosebrugh Building (RS) will be renovated and upgraded to dramatically improve the quality of the facilities and create a more open, collaborative space for work. Funding for this vital and extensive renovation project is being provided through the federal government's Post-Secondary Institutions Strategic Investment Fund (SIF). The planned renovations will include removing interior walls, improving lighting and accessibility, and installing collaborative research stations to facilitate open, cooperative work. Power and cooling systems will be upgraded to support researchers' existing and future computational needs.

This renovation and modernization project will improve the scale, usability and

flexibility of existing computational bioengineering, neural engineering and neurological biology lab spaces. The renovated facilities will also accommodate more graduate student researchers and allow our investigators to acquire new research equipment needed to advance research themes being undertaken in IBBME.

Appendix I: Core Faculty

Jan Andrysek, PhD, PEng

(1) Scientist, Holland Bloorview Kids Rehabilitation Hospital, (2) Assistant Professor & Clinical Engineering Program Coordinator (IBBME)

Julie M. Audet, PhD, PEng

Associate Professor (IBBME, CCBR, ChemE) & Associate Director, Graduate Programs (IBBME)

Berj L. Bardakjian, PhD, PEng

Professor (ECE, IBBME)

Elaine A. Biddiss, PhD, PEng

(1) Scientist, Holland Bloorview Kids Rehabilitation Hospital, (2) Assistant Professor (IBBME)

Warren C. W. Chan, PhD

Professor & Canada Research Chair, Bionanotechnology (IBBME, CCBR, ChemE, CHM, MSE)

Tom Chau, PhD, FAIMBE, PEng

(1) Senior Scientist, Raymond Chang Foundation Chair in Access Innovations & Vice President, Research, Holland Bloorview Kids Rehabilitation Hospital, (2) Professor (IBBME, ECE, RSI), (3) Adjunct Scientist, Toronto Rehabilitation Institute, UHN

Hai-Ling Margaret Cheng, PhD, PEng

(1) Assistant Professor (IBBME, ECE, PHM), (2) Adjunct Scientist, Hospital for Sick Children

John E. Davies, PhD, DSc, FSBE

Professor (DEN, IBBME)

Anthony Easty, PhD, PEng

Adjunct Professor (IBBME)

Moshe Eizenman, PhD

(1) Professor (OPT, IBBME), (2) Affiliate Scientist, Krembil Research Institute, UHN

Rodrigo Fernandez-Gonzalez, PhD

(1) Assistant Professor (IBBME, CSB), (2) Adjunct Scientist, Hospital for Sick Children

Geoffrey Fernie, PhD, FCAHS, CEng, PEng

(1) Senior Scientist & Director, Research Institute, Toronto Rehabilitation Institute, UHN, (2) Professor (SRG, IBBME)

Penney M. Gilbert, PhD

Assistant Professor (IBBME, BCH, CCBR)

Marc D. Grynbas, PhD

(1) Senior Scientist, Samuel Lunenfeld Research Institute, Mount Sinai Hospital, (2) Professor (LMP, IBBME, MSE, SRG)

Rita Kandel, MD, FRCPC

(1) Clinician-Scientist & Chief, Pathology & Laboratory Medicine, Mount Sinai Hospital, (2) Professor (LMP, IBBME)

Dawn M. Kilkenny, PhD

Assistant Professor, Teaching Stream & Associate Director, Undergraduate Programs (IBBME)

Azadeh Kushki, PhD

(1) Scientist, Holland Bloorview Kids Rehabilitation Hospital, (2) Assistant Professor (IBBME)

Ofer Levi, PhD

Associate Professor (IBBME, ECE)

Kei Masani, PhD

(1) Scientist, Toronto Rehabilitation Institute, (2) Assistant Professor (IBBME)

Naomi Matsuura, PhD, PEng

Associate Professor (MSE, IBBME, MRAD)

Alison McGuigan, PhD

Associate Professor (ChemE, IBBME)

Alex Mihailidis, PhD, PEng

(1) Senior Scientist & Barbara G. Stymiest Research Chair in Rehabilitation Technology, Toronto Rehabilitation Institute, (2) Associate Professor (OCT, IBBME, CSC, RSI), (3) Scientific Director, AGE-WELL

Milos R. Popovic, PhD, PEng

(1) Senior Scientist, Toronto Rehabilitation Chair in Spinal Cord Injury Research & Associate Scientific Director, Research, Toronto Rehabilitation Institute, UHN, (2) Professor (IBBME, ECE, MIE, IMS, RSI)

Milica Radisic, PhD, FAIMBE, FCAE, PEng

(1) Professor & Canada Research Chair, Functional Cardiovascular Tissue Engineering (IBBME, ChemE), (2) Affiliate Scientist, Toronto General Research Institute, UHN

Jonathan V. Rocheleau, PhD

(1) Percy Edward Hart Professor & Associate Director, Research (IBBME—*effective July 1, 2016*), (2) Scientist, Toronto General Research Institute, UHN

Paul Santerre,

PhD, FAAAS, FAIMBE, FBSE, PEng
Professor (DEN, IBBME, ChemE)

Michael V. Sefton,

ScD, FAAAS, FCIC, FBSE, FRSC, PEng
University Professor & Michael E. Charles Professor (ChemE, IBBME, CCBR)

Molly S. Shoichet, PhD, FAAAS, FBSE, FCAHS, FCAE, FRSC, FTERM

University Professor & Canada Research Chair, Tissue Engineering (ChemE, IBBME, CCBR, CHM, IMS)

Craig A. Simmons, PhD, FCSME, PEng

(1) Distinguished Professor of Mechanobiology (MIE, IBBME, DEN) & Associate Director, Research (IBBME—*until June 30, 2016*), (2) Scientific Director, U of T Translational Biology & Engineering Program (TBEP), Ted Rogers Centre for Heart Research

Eli D. Sone, PhD

Associate Professor (IBBME, MSE) & Collaborative Graduate Program Coordinator (IBBME—*effective July 1, 2016*)

David A. Steinman, PhD, FASME, PEng

Professor (MIE, IBBME)

Kien (Kevin) Truong, PhD, PEng

Associate Professor (ECE, IBBME)

Aaron R. Wheeler, PhD

Professor & Canada Research Chair, Bioanalytical Chemistry (CHM, IBBME)

Willy Wong, PhD

Associate Professor (ECE, IBBME) & Collaborative Graduate Program Coordinator (IBBME—*until June 30, 2016*)

Christopher M. Yip,

PhD, FAAAS, FEIC, PEng
Professor (ChemE, IBBME, BCH, CCBR) & Director (IBBME)

Paul B. Yoo, PhD, PEng

Assistant Professor (IBBME, ECE)

Lidan You, PhD, FCSME, PEng

Associate Professor (MIE, IBBME)

Peter Zandstra,

PhD, FAAAS, FAIMBE, FRSC, PEng
University Professor, Canada Research Chair, Stem Cell Bioengineering (IBBME) & Executive Director, Medicine by Design

José Zariffa, PhD, PEng

(1) Scientist, Toronto Rehabilitation Institute, (2) Assistant Professor (IBBME)

Jinzi Zheng, PhD

(1) Scientist, Institute for the Advancement of Technology for Health (TECHNA), UHN, (2) Assistant Professor (IBBME)

Glossary

BCH	Department of Biochemistry
CCBR	Donnelly Centre for Cellular & Biomolecular Research
ChemE	Department of Chemical Engineering & Applied Chemistry
CHM	Department of Chemistry
CSB	Department of Cell & Systems Biology
CSC	Department of Computer Science
DEN	Faculty of Dentistry
ECE	Edward S. Rogers Sr. Department of Electrical & Computer Engineering
IBBME	Institute of Biomaterials & Biomedical Engineering
IMS	Institute of Medical Science
LMP	Department of Laboratory Medicine & Pathobiology
MIE	Department of Mechanical & Industrial Engineering
MRAD	Department of Medical Imaging
MSE	Department of Materials Science & Engineering
OCT	Department of Occupational Science & Occupational Therapy
OPT	Department of Ophthalmology & Vision Sciences
PHM	Leslie Dan Faculty of Pharmacy
RSI	Rehabilitation Sciences Institute
SRG	Department of Surgery
UHN	University Health Network

Appendix II: Staff

Academic Programs

Brittany Lauton

Acting Undergraduate Programs Assistant

Brittany Lawrence

Undergraduate Programs Assistant

Jeffrey Little

Graduate Programs Administrator

Rhonda Marley

Professional Programs &
Research Office Assistant

Administration & Finance

Elizabeth Flannery

Human Resources Administrator &
Finance Officer

Judy Gilligan

Operations Assistant

Angela Rosa

Finance Officer, Research

Sandra Walker

Manager of Operations

Nefeteria Wickham

Acting Manager of Operations

Communications & External Relations

Luke Y. H. Ng

Communications & External Relations Officer

Director's Office

Jody Prentice

Executive Assistant to the Director

Information Technology

Derek Boodoosingh

Information Technology Systems Coordinator

David Seto

Information Technology Support Specialist,
Web & Audio-Visual

Teaching Facilities

Andrey Shukalyuk

Teaching Laboratory Coordinator

Larissa Schudlo

Interim Design Studio Coordinator

Sabine Weyand

Design Studio Coordinator

Data Sources

Data and information presented in this report were obtained from the sources below.

2016 Annual Report of Performance Indicators

Faculty of Applied Science & Engineering, University of Toronto

Academic Programs Office

Institute of Biomaterials & Biomedical Engineering, University of Toronto

Administration & Finance Office

Institute of Biomaterials & Biomedical Engineering, University of Toronto

Director's Office

Institute of Biomaterials & Biomedical Engineering, University of Toronto

Division of Engineering Science

Faculty of Applied Science & Engineering, University of Toronto

Office of Advancement

Faculty of Applied Science & Engineering, University of Toronto

PubMed.gov

US National Library of Medicine, National Institutes of Health

IBBME Annual Report, 2015-2016

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