



**MEETING OF FACULTY COUNCIL
OF THE FACULTY OF MEDICINE**

A meeting of Faculty Council will be held on **Monday, April 24, 2017**, from 4:00 p.m. to 6:00 p.m. in the **Red Room, Donnelly Centre**, University of Toronto.

AGENDA

1	Call to Order	Speaker
2	University of Toronto Institutional Strategic Research Plan	V. Goel
3	Minutes of the February 13, 2017 meeting of Faculty Council	Speaker
	3.1 Business Arising	
4	Report from the Speaker	Speaker
5	Reports from the Dean's Office	
	5.1 Report from the Dean's Office	T. Young
	5.2 Vice Dean, Research and Innovation	R. Hegele
	5.3 Vice-Dean, Partnerships	L. Wilson
	5.3 Vice-Deans, Education	A. Kaplan
6	Items for Approval	
	6.1 The Education Committee of Faculty Council recommends the approval of the following motions:	
	“THAT the proposal to establish a new Master of Health Science in Medical Genomics be approved as submitted.”	L. Cowen
	“THAT the physics and biology streams in the MSc and PhD curriculum in the Department of Medical Biophysics be modified as submitted effective September 2017.”	J. Sled M. Casci
7	Standing Committee Annual Reports	
	Education Committee	J. Maniate
	Research Committee	M. Ostrowski
8	Faculty Council Forum	I. Witterick
	Task Force Report on Research Integrity	A. Kaplan
9	Adjournment	Speaker

NEXT MEETING: October 2017



UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

**FACULTY COUNCIL
FACULTY OF MEDICINE**

Meeting Materials – April 24, 2017

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UNIVERSITY OF
TORONTO

Institutional Strategic Research Plan

Divisional Consultations
Spring 2017

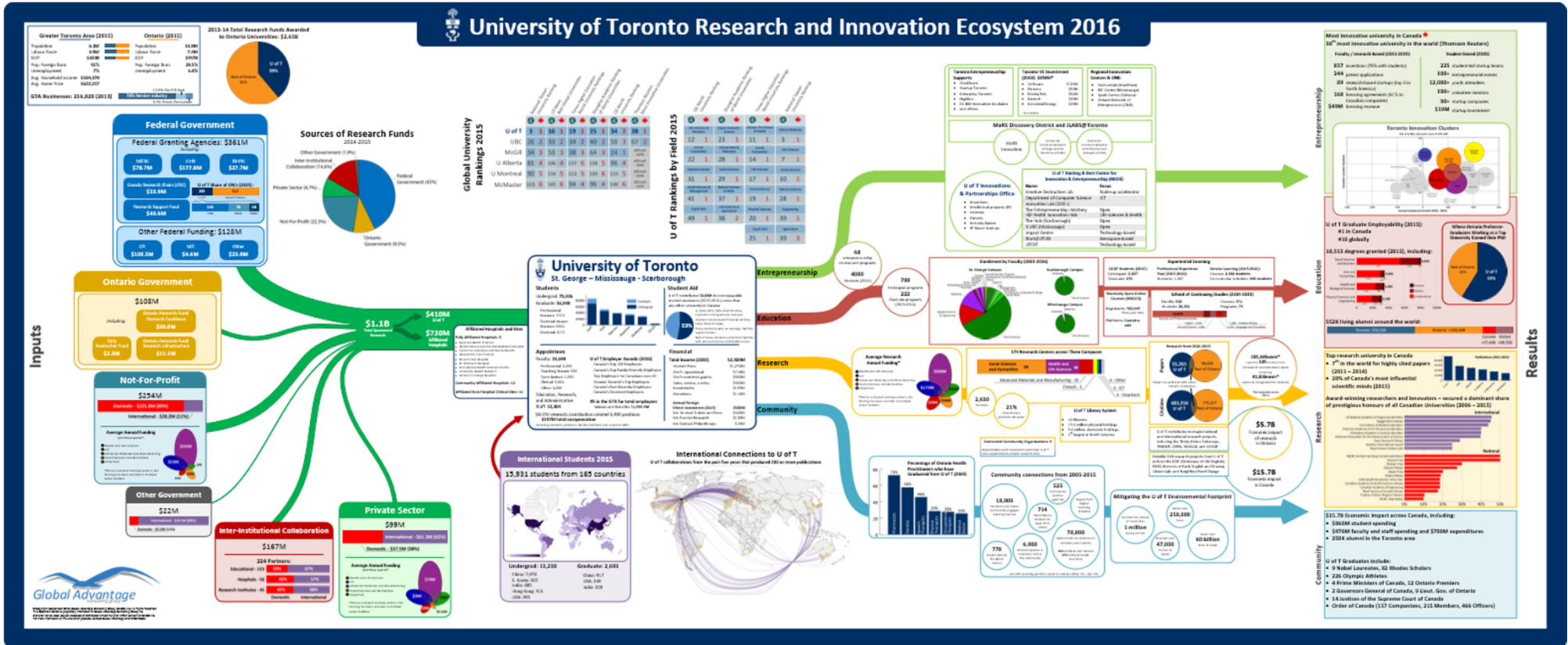
Vivek Goel

Vice-President, Research & Innovation

BOUNDLESS

The UofT Research & Innovation Ecosystem

.... is complicated.



http://www.research.utoronto.ca/wp-content/uploads/2016/10/uoft-ecosystem-2016_final.pdf

Division of the Vice-President, Research & Innovation

Our mission is to create the most supportive environment possible so that our researchers, innovators and learners can do what they do best — advance understanding and apply new knowledge.

Serving the UofT research & innovation community

RESEARCH FUNDING

2,800

principal investigators

900+

sponsors including

3,500

new funding applications

300+

private sector partners

\$400M

in funding awarded

1,700

funding programs

9,000

research funds

INNOVATION & ENTREPRENEURSHIP

150

invention disclosures

225

student-led startup teams

90+

new startup companies

50

priority patent applications

100+

entrepreneurial events

\$19M

in startup investment

40

licensing agreements

12,000+

youth attendees

\$2.5M

in startup sales

250

commercialization projects

100+

volunteer mentors

ACCOUNTABILITY & REPORTING

85

external audits

7,000

financial reports

1,200

new human ethics protocols

550

new animal ethics protocols

100

post-approval reviews & visits

Supporting Institutional Priorities, for example:

- President's 3 priorities
 - Reimagining undergraduate education
 - Leveraging our urban location
 - International impact
- U of T Response to the Truth and Reconciliation Commission – Research Ethics
- Report of the President's Advisory Committee on Divestment from Fossil Fuels
- Equity and diversity

Operational Improvements

- RAISE: An integrated suite of automated web-enabled tools for research administration



Why a Strategic Research Plan?

Key institutional document that, ideally, should:

- Reflect the breadth of U of T research within a flexible framework
- Provide direction for how to support university scholarship
- Provide support and direction but not limit faculty members research programs or divisional research priorities
- Meet internal and external community needs

Current ISRP – Scope and structure



- Broad Research Thematic areas with examples of subthemes
- Strategic Research Objectives
- Enabling Actions

<http://www.research.utoronto.ca/about/strategic-research-plan/>

Institutional Strategic Research Plan (ISRP)

- Current ISRP: 2012-2017
- ISRP 2018-2023:
 - Opportunity for us to review research themes
 - Assess emergent themes/areas
 - Identify areas in which we need to apply/support research and innovation
 - Ensure we continue to meet external requirements (CRC, CERC, CFI)

Current ISRP – Research Themes

- 1) Explore: Our place in the universe
- 2) Sustain: Humanity and the environment
- 3) Promote: Healthy people, communities, world
- 4) Engage: Mind, language, culture, values
- 5) Advance: Institutions, peace and prosperity
- 6) Enable: Technologies for the 21st century
- 7) Build: Community and liveable societies

Current ISRP – Strategic Objectives

- 1) Strive for global leadership
- 2) Address questions of local, provincial, national and international importance
- 3) Provide world-class training through the integration of research and teaching
- 4) Maximize the application of research and the innovation of creative concepts
- 5) Facilitate intra- and inter-divisional collaboration within U of T and across institutions, Canada-wide and internationally
- 6) Create a culture of scholarship where interaction, collaboration and community are valued and facilitated

Current ISRP – Enabling Actions

- 1) Attract, fund and retain the world's best talent
- 2) Develop research leadership skills
- 3) Encourage bold and innovative inquiry
- 4) Advocate and communicate strength and successes
- 5) Develop new integrated governance models for research across the university and with key partners
- 6) Acquire and maintain state-of-the art infrastructure
- 7) Maintain a competitive and sustainable research funding base
- 8) Develop performance indicators and benchmarks

ISRP – Timeline & Process

- Spring Consultations and discussions on scope
 - Academic divisions; special sessions
 - Town halls on the 3 campuses
 - Online Survey
- Summer Preparation of draft
- Fall Consultation draft – feedback, revisions
- Late Fall Presentation to governance (P&B, AB)
- Jan Circulation internal/external

Research Advisory Board (RAB) as key reference group

ISRP – Discussion

- Has the current ISRP structure served our community well?
- Are the broad research themes, priorities and enabling actions still relevant? Are there others that should be included?
- What supports can we provide to facilitate research and innovation at UofT?

ISRP – Further input

Info about Town Halls and divisional meetings

+

Online survey

<http://www.research.utoronto.ca/ISRP>

Questions:

vpri.reports@utoronto.ca



UNIVERSITY OF TORONTO

FACULTY OF MEDICINE

Faculty Council of the Faculty of Medicine
Minutes of the February 13, 2017 meeting
4:00 p.m.
Red Room, Donnelly Centre

Members Present: L. De Nil (Speaker), T. Coomber, I. Witterick, S. Spadafora, R. Hegele, V. Waters, T. Bressman, P. Burns, A. Emili, P. Berger, L. Nickell, D. Templeton, R. Forman, A. Salahpour, D. Tweed, P. Kim, K. Hanneman, M. Farkouh, A. Levinson, C. Gillan, S. Myrehaug, L. Tate, J. Davis, J. Barkin, A. Rachlis, P. Poldre, A. Kaplan, P. Houston, L. Wilson, C. Chrystoja, Shima Sakory

Call to Order

The Speaker called the meeting to order and noted that there was a quorum.

1 Minutes of the previous meeting of Faculty Council – October 17, 2016

The minutes of the meeting of October 17, 2016 had been previously circulated. They were approved on a motion from J. Barkin and seconded by S. Spadafora. There was no business arising.

2 Report from the Speaker

The Speaker indicated that he did not have any items on which to report at this time.

3 Reports from the Dean's Office

3.1 Dean's Report

Dean Young indicated there are currently a number of searches and reviews underway. There are a number of strong candidates including for the Chairs of Medical Biophysics and Anesthesia. Otolaryngology Head and Neck Surgery, Ophthalmology and Vision Sciences, Medical Imaging, and Radiation Oncology reviews are under way with Obstetrics and Gynaecology, and Biochemistry will soon follow.

The MD Program is more than half way through the first year of the new curriculum. The Faculty is listening to feedback and applying real-time changes. The Dean noted that the Black Student Application Program is a very exciting item that Dr. Robinson will be speaking about shortly. In addition, he noted that members of all search committees must take unconscious bias training.

3.2 Vice Dean, Research & Innovation

Dr. Richard Hegele indicated that the Vice Dean, Research & Innovation's Office has been looking inward to ensure the office aligns with the University's priorities. Dr. Hegele indicated his office has three new members: Jeremy Knight has been hired as the Manager, Research Administration and Operations; Dan Harney, has been hired as the Grants and Awards Editor; and Hajer Abid has been hired as Administrative Coordinator.

Dr. Hegele noted that the Vice Dean portfolio used to include international relations but this has been replaced by innovation which will be a priority in the year ahead. The office will also be looking at increasing CIHR success rates. There is currently a leadership change taking place at CIHR. An Acting President will be named shortly and a search for the next president will get underway. There are currently a number of CFI applications being evaluated as well as a number of renewals of Canada Research Chairs.

3.3 Vice-Dean, Partnerships

Dr. Lynn Wilson indicated that the Office of the Vice Dean, Partnerships oversees the Faculty's outward-facing relationships including affiliated hospitals, Canadian and international institutions and organizations, and with all levels of government.

The guiding principles for the office have been to leverage location to increase collaboration between the University and the Greater Toronto Area health care sector; maintain the Faculty's position as a leading destination for researchers, educators, and learners; strengthen and sustain national and international partnerships in areas of strategic importance; and advocate for patients, families and communities by translating knowledge on health, well-being, and illness prevention.

In the 13 months that the Office of the Vice Dean, Partnerships has been running the office has hired three staff members (an Executive Assistant, Legal Counsel and a Senior Partnerships Advisor); Established close ties with Clinical Affairs and the Office of the Assistant Vice Provost; and developed strong working relationships across and beyond the University.

Dr. Wilson indicated that her office has developed efficiencies for assessing and responding to a variety of requests, both internal and external, for things such as contract guidelines, institutional partnership requests, student Placement agreement requests, and delegation requests.

Dr. Wilson's work with the provincial government has included: hosting a two-day visit from Ontario Ministry of Health and Long-Term Care in September 2016; increasing communication between the Faculty and the Ministry; improving education around the opioid crisis; and provided an advisory role for the Toronto Central Local Health Integration Network with regards to primary care renewal and data analytics.

With respect to the federal government, the Office of the Vice Dean, Partnerships has visited with the Minister of Health and maintained contact specifically around mental health strategy.

The office's international strategy focuses on three key areas: student recruitment, academic partnership, and capacity building. Work is being done to promote the Faculty's programs to international markets, with current specific attention to the US and Macau. Academic partnerships are being developed with Zhejiang University, Guangzhou Medical University, and Tel Aviv University while long standing partnerships are being maintained with Addis Ababa University and the Karolinska Institute.

Dr. Wilson and Senior Partnerships Advisor, Meera Rai, have been meeting department Chairs one-on-one to learn about their activities with respect to government relations, relations with healthcare institutions, and international relations. There's varying levels of activity and a desire on the part of many to learn more about the areas in which they're not very active.

3.4 Vice-Deans, Education

Dr. Allan Kaplan indicated that Education Vice-Deans opted to provide a brief verbal report for this meeting rather than the fuller written report provided in the past.

Dr. Kaplan noted that Dr. Rob Silver is the recipient of The Association of Faculties of Medicine of Canada Clinical Teacher Award. This year's Education Achievement Celebration at Hart House on May 15 with a keynote address from Dr. Arno Kumagai, Vice-Chair Education, Department of Medicine.

In Post-MD, Director of Education and Research, Dr. Susan Glover Takahashi, and two of her staff have been redeployed to work on the implementation of the competency based medical education program. Anesthesia and Otolaryngology Head and Neck Surgery are moving from time based residency training to competency based training and will roll out to other programs over the next five years. There has been a reduction by 9 residency positions with a goal to reduce the number by 45 by 2020. There is a new medical humanities fund with awards up to \$5000 per project. Finally, there has been a search committee struck to replace Dr. Susan Edwards as the Director of Resident Wellness.

With respect to CPD, the Standardized Patient Program is moving from the Post-MD portfolio to the MD Program portfolio. The transition will take place over several months and a new director will be recruited. Dr. Anna Banerji has been named Director, Global and Indigenous Health.

In the MD Program, the Foundations curriculum will be implementing a week long fall term break in years one and two. This does not change the 36 week curriculum. The interim accreditation of the MD Program is coming up. There are six working groups conducting the institutional self-study. There is a new professionalism working group to make review and make recommendations about the assessment of medical student professionalism.

The PA Program made changes to its admissions standards which lead to an increase in applications with 244 last year and 413 this year. The retention rate since the program began has gone from the 70s to close to 100%.

In Graduate and Life Sciences, the Graduate Teaching Awards for 2017 have been awarded: Early Career Excellence in Graduate Teaching and Mentorship have been awarded to Dr. Ana Andrezza, Pharmacology and Toxicology and Dr. Julie Claycomb, Molecular Genetics; the Mid-Career Excellence in Graduate Teaching & Mentorship have been awarded to Dr. Anthony Gramolini, Physiology and Dr. Krista Lanctot, Pharmacology and Toxicology; and the Sustained Excellence in Graduate Teaching & Mentorship have been awarded to Dr. Howard Mount, Psychiatry, Medicine, Physiology, Institute of Medical Science and Dr. Rachel Tyndale, Pharmacology and Toxicology.

Dr. Kaplan noted that the Faculty is engaged with UTM in the development of a Bachelor of Health Science degree. The hope is to have students in seats in 2019.

Dr. Kaplan noted that the Dean's Task Force on Research Integrity has completed its report and will be presenting this to Faculty Council for information at the next meeting.

4 Standing Committee Annual Reports

4.1 Appeals Committee

Dr. Douglas Templeton indicated that the Appeals Committee heard one case since his report last year. The appeal came from the Physician Assistant program. The case centered on both academic and professionalism concerns and the Appeals Committee upheld the original decision.

Dr. Templeton noted that the number of appeals has dropped dramatically in recent year. In 1994, when Dr. Templeton first served on the Appeals Committee, there were 4-6 appeals per year. In recent years, there has been one appeal every 2-3 years. There have been slight up ticks during the startup of the MRS and PA programs but the overall trend is toward fewer appeals. Dr. Templeton attributes this to three factors: better documentation from the programs, better accommodation of students before the appeal process, and more thorough remediation.

5 Discussion Items

5.1 Black Student Application Program

Drs. Lisa Robinson, David Latter, and Mahan Kulasegaram presented the new Black Student Application Program (BSAP). The Faculty of Medicine has identified three underrepresented groups for priority attention: indigenous people, people of African ancestry, and the economically disadvantaged. The foundation of the new program is equity (or fairness) rather than equality (or sameness). Equity recognizes that differences can often create barriers which must be addressed.

The purpose of the Black Student Application Program is to increase the number of Black (Black African, Black Caribbean, Black North American, multi-racial students who have and identify with their Black ancestry, etc.) medical students at U of T. The hope is to increase the annual Black student applicant pool and the annual admissions offers to successful Black students within five years. Ideally, the program will create a medical student population that better reflects the demographics of Toronto.

The Faculty already has two specialized application programs: the Indigenous Student Application Program (ISAP) and the MD/PhD. In all cases applicants self-identify (proof of ancestry required for ISAP) and must meet all existing admissions requirements. There are no quotas. Applicants must complete an additional essay, the file review and interview include members of specific community (Black community members in the case of BSAP), and have separate oversight (though all oversight committees report to the Admissions Committee).

The admissions decision making will be done with a variety of information. Using raw data scores only means a small change in raw score results in a large change in percentile ranking. The admission threshold currently varies widely between the regular applicant pool and the specialized programs. Admissions decisions will be based on assessment of applicants against their peers in each pool (MD/PhD, BSAP, ISAP) as well as their overall standing compared to all applicants.

The BSAP will publically launch on March 8, 2017 with applications opening in July 2017. The first intake will be in August 2018. In addition to the BSAP, the Faculty will continue to develop a culturally safe and welcoming community in the MD Program and curriculum enhancement featuring the inclusion of Black Health themes.

Dr. Robinson provided a brief update on the ISAP. There has been some fluctuation in the number of applicants since the program launched (increases in the first few years with recent decreases). The number of qualified candidates remains small and increased outreach and recruitment is needed. Some admission requirements still remain a barrier for many students and there is competition for qualified candidates with other institutions who have specialized application programs for Indigenous students.

6 Faculty Council Forum

Dr. Lisa Robinson presented a Forum discussion on Diversity and Unconscious Bias.

7 Adjournment

The meeting was adjourned at 6:00pm

Council of Education Vice Deans Faculty Council Report

April 24, 2017

Submitted by:

Patricia Houston, Vice Dean, MD Program

Allan S. Kaplan, Vice Dean, Graduate and Academic Affairs

Salvatore Spadafora, Vice-Dean, Post MD Education (PGME & CPD)

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A. Education Vice-Deans, Integrative Activities

1. External Education and Teaching Awards – Call for Nominations

Each spring and fall, the Faculty's Teaching and Education Awards Committee has the privilege of recognizing individuals who are making significant contributions to medical education.

We are currently calling for nominations for the following awards:

[AFMC - John Ruedy Award for Innovation in Medical Education](#)

[AFMC – May Cohen Equity, Diversity & Gender Award](#)

[AFMC - President's Award](#)

[AFMC - Young Educators Award](#)

[CAME - Meridith Marks Award](#)

[CMA - Award for Young Leaders](#)

[CMA - May Cohen Award for Women Mentors](#)

[RCPSC - Donald R. Wilson Award](#)

[RCPSC – The Duncan Graham Award](#)

[STLHE – Alan Blizzard Award](#)

[UofT – President’s Teaching Award \(University of Toronto\)](#)

Please submit [the online nomination form](#) and supporting documentation by 5PM on Saturday, May 27, 2017. Nominations require a one-page letter of support from the nominator; this should be emailed, along with the nominee's current CV and Teaching and Education Report, to

edicine.awards@utoronto.ca. It is strongly recommended that the nominee's Department Chair be in support of the nomination. For more information, contact the Office of the Education Vice-Deans at medicine.awards@utoronto.ca or at (416) 946-8067.

2. Award Announcements

This year's recipients of the [Excellence in Community-based Teaching Awards](#) are:

Dr. Yvonne Chan, Dr. David Eisen and Dr. Sid Feldman

Dr. Yvonne Chan (Otolaryngology – Head and Neck Surgery), **Dr. David Eisen** (Family & Community Medicine) and **Dr. Sid Feldman** (Family & Community Medicine) have been awarded the Faculty of Medicine's 2017 Community Based Teaching Awards. They are recognized for their significant contributions to the education of University of Toronto medical students and residents, and for excellence in community-based clinical teaching.

This year's recipients of the [CAME Certificate of Merit Award](#) are:

Dr. Cynthia Whitehead, Dr. Maria Mylopolous and Dr. Paolo Campisi

Dr. Cynthia Whitehead (DFCM), **Dr. Maria Mylopolous** (Paediatrics) and **Dr. Paolo Campisi** (Otolaryngology) will each receive a 2017 Canadian Association for Medical Education (CAME) Certificate of Merit. This award, given annually, recognizes faculty for their commitment to Canadian medical schools and for their significant contributions to medical education.



3. Annual Education Achievement Celebration

The Faculty of Medicine's **15th Annual Education Achievement Celebration** will be held on **Monday, May 15th, 2017** from **5:30–7:30pm** in the **Great Hall at Hart House**. The C.I. Whiteside Education Achievement Keynote Address will be presented by **Dr. Arno Kumagai**, Vice-Chair Education, Department of Medicine. Doors will open at 5:00 pm. The event itself will get underway at approximately 5:30 PM.

Please [RSVP here](#) no later than Monday May 1, 2017.

4. Office Staffing

We look forward to welcoming Lindsey Fechtig back to her role as Administrative and Project Manager in the Office of the Education Vice-Deans as of May 8th. She can be reached at lindsey.fechtig@utoronto.ca. Elizabeth Murray completes the administrative complement for the

Education Vice-Deans in her role as Administrative Assistant, Office of the Education Vice-Deans. Thank you to Morag Paton for her contributions over the last year.

B. MD Program

5. CaRMS – 2017 Match Results

92.97% (225 of 242) of UofT class of 2017 students who applied to Canadian residency positions were matched in the first iteration of CaRMS, which is consistent with both our 2016 first iteration match rate (92.94%) and the 2017 national average 93.47%.

Of the UofT class of 2017 students who were matched in the first iteration of CaRMS:

- 27% of the overall class and 26% of MAM students matched to Family Medicine
- 48.35% matched to UofT residency programs
- 70.25% matched in Ontario

We are actively working with our students who did not match in the first iteration to help them prepare for the second iteration. It is important to note that, based on the information available, those students who did not match do not look significantly different than those who did. The match process is a complex system, and the reasons for not matching are multi-factoral.

An option available to students who remain unmatched is the MD Extended Clerkship (MEC), which is intended to support students to maximize their opportunities for their future career. For the past several years the Faculty offered a post MD non-degree program for students who remained unmatched after their CaRMS cycle. While that program will continue to be offered, the format has changed to meet CPSO requirements. Under this new format, students that take part in the MD Extended Clerkship will be required to delay graduation until June of the following year, but will be eligible to pursue a more fulsome suite of elective opportunities.

Efforts have been initiated on a number of fronts (both locally at the UofT and nationally by the AFMC) to better understand and address the concerning national trend regarding students who remain unmatched after the second iteration, which doubled in 2012 and has remained high ever since.

6. Admissions

Interviews of candidates for September 2017 entry were held on February 26, March 25 and 26, and April 8 and 9.

MD Program

	Sept 2015 entry	Sept 2016 entry	Sept 2017 entry
Applicants	3488	3118	3167
In-depth/ full file review	1777	1934	2107
Interviews	599	599	599*

* 9 international applicants were interviewed in addition to the 599 domestic applicants for 2017 entry.

MD/PhD Program

	Sept 2015 entry	Sept 2016 entry	Sept 2017 entry
Applicants	193	169	178
In-depth/ full file review	83	82	78
Interviews	47	37	48

7. Black Students Application Program (BSAP)

The [Black Students Application Program \(BSAP\)](#) was formally launched on March 8, 2017. BSAP aims to increase and support Black (Black African, Black Caribbean, Black North American, etc.) medical student representation at the University of Toronto. It will be in place for the 2017/2018 admissions cycle. BSAP is modeled after the [Indigenous Student Application Program \(ISAP\)](#), which promotes and supports the entry of Indigenous students into the MD Program. Since ISAP launched in the 2012-2013 academic year, there has been an increase in the number of applications from students who self-identify as being of Aboriginal descent. We hope to see a similar impact on applications submitted by Black students resulting from BSAP.

8. Longitudinal Integrated Clerkship (LInC)

In 2017-18 there will be a total of 34 LInC students, comprised of eight students at the FitzGerald Academy, nine at the Mississauga Academy of Medicine, five at the Peters-Boyd Academy, and 12 at the Wightman-Berris Academy.

9. Interim Accreditation Review

The site visit for the MD Program's [Interim Accreditation Review](#) was held over March 28-29, 2017. The external reviewer was Dr. Rob Whyte, Assistant Dean, MD Program, McMaster. Approximately 80 faculty members (including Chairs, decanal representatives and education leaders), 60 students and 12 administrative staff participated in the site visit. The Interim Accreditation Review is a formative, internal review, which will culminate in a report outlining areas that may represent impediments to achievement of full compliance with accreditation standards during the MD Program's next full survey visit, currently scheduled for 2019-20.

10. Health Advocate and Leadership Curriculum Review

The MD Program is planning to establish a Working Group in the late spring 2017 to review its Health Advocate and Leadership curriculum. The Working Group will be chaired by the Vice Dean, MD Program, and will include education leaders from the MD Program, PGME and student representatives, 'at large' faculty members, and externally recognized experts in leadership education. The overarching purpose of the review is to ensure that graduating students have successfully mastered the MD Program's Health Advocate and Leadership competencies. The curriculum will be reviewed in the context of the MD Program's competency framework, relevant Medical Council of Canada (MCC) objectives, AFMC Entrustable Professional Activities for the Transition from Medical School to Residency, Health Advocate and Leadership curriculum at other national and international medical schools, and student and stakeholder reports. The Working Group will report through its Chair to the MD Program Curriculum Committee, with the deliverable being recommendations regarding the program's Health Advocate and Leadership curriculum.

11. Governance and Leadership

- Dr. Sarah McClennan was appointed as Mississauga Academy of Medicine (MAM) Academy Director effective February 6, 2017 for a five-year term.
- Dr. Tony D'Urzo was appointed as Associate Director, Health Science Research (HSR) effective November 15, 2016 for a one-year term.
- Dr. Ashna Bowry was appointed as Associate Course Director, Concepts, Patients and Communities 1 effective December 1, 2016 for a one-year term.

C. Post MD Education (PGME & CPD)

12. Post MD Appreciation Reception

PostMD Education held its annual Appreciation Reception on March 1st, 2017 to honour and recognize the exceptional work and dedication to postgraduate medical education and continuing professional development this past year. The event also recognized the contributions of Program and Site Directors who have completed their terms.

13. Renovations of the Post MD Area

Renovations of the PostMD area are underway. A new PostMD Reception area will greet visitors, new boardrooms and office space are in development with an anticipated completion time of early May.

Postgraduate Medical Education

14. Director of Resident Wellness

Dr. Julie Maggi is the new Director of Resident Wellness at the University of Toronto. Julie started April 1, 2017 to allow for successful transition and formally take over as Director July 1, 2017. Dr. Susan Edwards, the first Director of Resident Wellness, will be leaving the position on June 30, 2017.

15. Physician Health Symposium

The first Faculty of Medicine Physician Health Symposium, “Building Resilient Medical Communities: Current Innovations, Future Possibilities” will be held on Tuesday May 30, 2017. Dr. Jane Lemaire, Vice Chair of Physician Wellness, Department of Medicine, University of Calgary will deliver the plenary. This half-day symposium will serve as an opportunity to showcase completed research and in-action innovations in physician health and well-being initiatives with University of Toronto colleagues.

16. The Best Practices in Evaluation and Assessment (BPEA) Working Group

The Best Practices in Evaluation and Assessment (BPEA) Working Group for Competency-Based Medical Education (CBME) was established just over a year ago to identify evidence-based best practices for the implementation of CBME, and the implications of CBME for Program Evaluation (e.g. accreditation, internal reviews) and Learner Assessments (e.g. information systems, number/type of assessments, remediation). The Draft BPEA Summary Report was released in February 2017 and can be viewed online http://pg.postmd.utoronto.ca/wp-content/uploads/2017/02/BPEA-Report_penultimate_17feb13_WEB.pdf

17. Guidelines for the Evaluation of Postgraduate Trainees

The *Guidelines for the Evaluation of Postgraduate Trainees of the Faculty of Medicine at the University of Toronto* were revised to accommodate the national change in residency education to a competency-based model, and the anticipated new accreditation standards set out by the Royal College of Physicians and Surgeons of Canada (Royal College) and the College of Family Physicians of Canada (CFPC).

18. U of T Teaching & Learning Platform

New U of T Teaching & Learning Platform - Entrada: PGME at the University of Toronto has joined the Entrada consortium. PGME is working with the Faculty of Medicine information systems leaders at Discovery Commons to pilot the basic functionality of Entrada with the Orthopedic Surgery residency competency based residency program. In parallel, PGME is also working with Discovery Commons and Entrada to develop the assessment and evaluation features and functions to support CBME and CBD at U of T. It is expected that the Entrada CBME application for U of T will be ready to support CBD cohorts for the July 2018 academic year. <http://cbme.postmd.utoronto.ca/>

19. CBD (Competency by Design)

CBD (Competency by Design) is a multi-year initiative that will transform specialty education from a time-based system to a hybrid competency-based education and assessment system, across the lifelong learning continuum. Effective July 1, 2017, the residents for the following two disciplines will enter a residency training program that will be based on their competency-based specialty standard documents:

- Anesthesiology
- Otolaryngology – Head and Neck Surgery (OHNS)

A “**Perspectives on CBME**” event was held March 7, 2017 to discuss various program and school CBME implementation journeys. Dr. Eric Holmboe, Senior VP, Milestone Development & Evaluation, ACGME presented on “*Lessons Learned about Implementing CBME for ACGME: When Theory Meets the Reality of Practice*”.

20. CaRMS Match

PGME at U of T had a successful 2017 CaRMS PGY1 match. All 407 PGY1 positions filled in the first iteration. For the fifth year in a row, the University of Toronto is the only medical school in Canada to fill all of its positions in the first round. Of the 407 filled positions, 337 were filled by Canadian Medical Graduates and 70 were filled by International Medical Graduates. The breakdown of our filled positions is below:

U of T – 2017 1st Iteration PGY1 CaRMS Match Results

Discipline	CMG Positions	IMG Positions	Total
Anesthesia	14	4	18
Dermatology	4	1	5
Diagnostic Radiology	7	1	8
Emergency Medicine	7	3	10
Family Medicine - GTA	114	20	134
Family Medicine - Barrie/Newmarket	14	4	18
Family Medicine - Rural	8		8
General Surgery	11	3	14
Internal Medicine	51	10	61
Lab Medicine – Anatomical Pathology	4	2	6
Lab Medicine – Hematological Pathology		2	2
Lab Medicine - Neuropathology	1		1
Medical Genetics	1	1	2
Neurology	5	3	8
Neurology - Pediatric	1	1	2
Neurosurgery	4	1	5

Obstetrics & Gynecology	10	2	12
Ophthalmology	3	1	4
Orthopedic Surgery	7	2	9
Otolaryngology	4		4
Pediatrics	17	4	21
Physical Med & Rehab	3		3
Plastic Surgery	4		4
Psychiatry	31	4	35
Public Health and Preventive Medicine	3		3
Radiation Oncology	4		4
Urology	3	1	4
Vascular Surgery	2		2
Subtotal	337	70	407

The 337 U of T PGME positions for LCME Graduates were filled by:

- 119 U of T graduates
- 126 from other Ontario medical schools
- 84 from other Canadian medical schools
- 8 from U.S. LCME accredited schools

21. Transitions Think Tank Symposium

A “Transitions Think Tank Symposium” is occurring on April 7, 2017 looking at transitions from the perspectives of undergraduate medicine, postgraduate medicine and continuing professional development. Medical learners face many challenges in their transition from medical school to residency to post-residency and/or practice. Program Directors and selection committees also face challenges in assessing and selecting the best candidates for their programs. Several groups/committees have been struck to examine the issue at a national level. This Symposium will launch the conversation locally.

22. The Fellowship Education Advisory Committee (FEAC)

The Fellowship Education Advisory Committee (FEAC) published *Answering the Challenge 2009 – 2016*, a retrospective account of the work of FEAC since its inception in October 2009. The report can be accessed at http://pg.postmd.utoronto.ca/wp-content/uploads/2016/11/FEAC_Report_v3_14-Nov-16_web.pdf

Continuing Professional Development

23. Governance, Staffing

Alison Lind was promoted to the position of Associate Director, CPD on December 1, 2016. Alison joined the CPD Office (then CME) in 1992 and has served in a variety of roles, most recently as Business Development Coordinator. As Associate Director, CPD, Alison will provide leadership to the CPD events team, and will be streamlining event management processes, improving client communications, and enhancing customer relations.

Colin Fleming assumed the position of Senior Financial Officer on February 1, 2017. Colin will play a key role on the CPD leadership team, and will be responsible for providing expert advice and counsel with respect to business modelling, short and long term financial planning, strategic alignment and resource allocation, and evaluating new program and business opportunities. In addition to his work at CPD, Colin continues to oversee financial management of the Standardized Patient Program (SPP) and the Integrated Medical Education Office (IME).

24. CPD Academic

Continuing Professional Development has continued to provide excellence in academic programming. The number of accredited programs continues to grow annually with 400 accredited programs last year. While the majority were live events, increasingly innovative methods of learning are being incorporated into CPD programs and conferences, including web-based and simulation-based learning. CPD continues to be at the forefront of innovation in program development. The CPD annual report (annualreport.postmd.ca/cpd-2016/) highlights just a few of these innovations including [ImageSim \(imagesim.com\)](http://imagesim.com), an on-line education system that teaches health care professionals the interpretation of visually diagnosed medical tests using the concepts of deliberate practice and simulation. Another example is creation of the Canadian Transanal Total Mesorectal Excision (TaTME) Proctorship Network to improve training in this innovative technique.

The CPD Office has continued to be active in the development of programs and conferences. The Medical Record Keeping and Safe Opioid Prescribing Programs continue to attract a wide audience with both programs being offered multiple times per year. Dr. Abhimanyu Sud, Academic Program Director for the Safe Opioid Program was acknowledged by the Department of Family and Community Medicine Education with the Award of Excellence in Development and Use of Innovative Instructional Methods, for the creative and scholarly approach to the program's development. With the looming opioid crisis, CPD was also successful in obtaining funding from the CPSO to update the Safe Opioid Prescribing Program with the release of new national prescribing guidelines. The second annual International Foundations CPD Certificate Program was launched to a growing audience and a new customized blended program was developed for the University of Alberta, Office of Lifelong Learning. CPD was invited to Barcelona, Spain to run the 4th Annual Essential Skills in CPD program for the Association of Medical Education (AMEE) conference attracting participants from across the globe. CPD, with the leadership of Jane Tipping, was also instrumental in development of a CPD Special Interest Group for AMEE which has now been approved as full CPD Committee. CPD will be involved in development of a CPD symposium for AMEE 2017.

The CPD Provincial Collaborative with the 6 Ontario Universities won the Royal College Accredited Providers award for the IDEAS Quality Improvement introductory program. A new 3-year contract for the IDEAS provincial program was approved. The program was rebranded to the IDEAS Foundation Quality Improvement Program with the creation of a blended learning format consisting of a 4-hour online component and a 1-day live session. CPD recently partnered with the Ontario Renal Network to offer the program to 85 interprofessional regional health providers focusing on improving access to renal transplantation.

CPD has been sharing its accreditation expertise through a new mentorship program with the newly created University of Alberta CPD Office. Partnering with the Office of Lifelong Learning at U of A, CPD assisted this new office in developing processes for accreditation of its continuing medical education

programs. As part of this mentorship, CPD entered into a “buddy” peer review relationship with U of A for joint accreditation of its CPD programs. This will allow the U of A Office of Life Long Learning to fulfill requirements to become an accredited provider as defined by the Committee of Accreditation for Continuing Medical Education (CACME).

CPD embarked on development of strategic plan for 2016-2021. The process involved a 5-year review (<http://documents.cpdtoronto.ca/wp-content/uploads/2017/04/CPD-Final-5-Year-Report.pdf>) of CPD activities, creation of a strategic planning committee and engagement of our stakeholders through a needs assessment survey to identify key trends, strength, opportunities and challenges that might influence the future of CPD. A Strategic Planning retreat was held on November 25, 2016 with a theme of evolving CPD across the continuum. Dr. Craig Campbell, Director of CPD for the Royal College of Physicians and Surgeons of Canada presented the keynote address on competency-based CPD, implications and future opportunities. Key stakeholders were engaged to review our strategic priorities and working groups have been engaged to map out goals, objectives and action plans for each priority. The 2015-2016 CPD Award winners were announced as follows:

- Colin Woolf Award for Longterm Contribution to CPD – Ms. Lisa DiProspero and Ms. Kieng Ta
- Colin Woolf Award for Excellence in Course Co-ordination - Dr. Cindy Grief and Ms. Lisa Sokoloff for the Geriatric Mental Health Education Network program
- Colin Woolf Award for Teaching Excellence – Dr. Jonathan Pirie
- CPD Interprofessional Health Care Team Award – Dr. Judith Peranson and team for the SMH New Faculty Program
- Ivan Silver Innovation Award – Dr. Wahid Farhat for the Paediatric Urology Laparoscopy program
- Dave Davis Research Award – Dr. Sanjeev Sockalingam and Dr. David Wiljer
- David Fear Fellowship - Dr. Andrea Waddell and Dr. Karen Devon

Our faculty members continue to have a strong focus on research and scholarship in CPD <https://annualreport.postmd.ca/cpd-2016/awards/>. Dr. Sanjeev Sockalingam was the 2016 Fox Award Recipient for his outstanding presentation of his study examining the relationship between academic motivation and lifelong learning at the 2016 World Congress of Continuing Professional Development in San Diego, California. This study was also selected as one of the Future of Medical Education in Canada CPD (FMED-CPD) projects. More examples of the outstanding work of our faculty can be found on the annual report.

Dr. Schneeweiss completed her term as CPD Educator and member of the nominating committee for the Royal College of Physicians and Surgeons of Canada. She will join the Royal College Regional Advisory Committee as the CPD Dean representative for RAC3. She has also been elected to the Academic Board of the Governing Council for the University of Toronto and will begin her term in July 2017.

25. CPD Enrolment & Accreditation

The number of accredited course offerings continues to grow. An enrolment report for 2016-2017 will be provided in the next Council report.

26. Indigenous and Refugee Health

We are making plans for the North American Refugee Health Conference, which is the largest conference on refugee health globally. In keeping with current world events, our theme will be the

Syrian Refugee crisis. It will take place at the Toronto Sheraton Hotel June 12-14, 2017. We have speakers from the International Organization on Migration in Geneva, CDC Atlanta, Amnesty International, CBC journalist Susan Ormiston, as well as refugee experts across North America. We are expecting 600-700 participants. This year we will have a tropical disease update course in collaboration with the American Society of Tropical Medicine and Hygiene.

27. Standardized Patient Program (SPP)

The Standardized Patient Program is being transferred to the portfolio of the Vice Dean MD Program. The MD Program is the largest client of the program. The administrative restructuring of the Program which began in Spring 2016, is complete and the program is now financial sustainable. The program continues to support teaching and assessment across the medical education continuum, as well as running a number of large licensure exams. The program is taking on new clients and projects, and welcomes requests from all members of the Faculty of Medicine. Please direct inquiries to Jo O'Reilly, Manager of Client Relations and Business Systems (jo.oreilly@utoronto.ca).

D. Graduate and Life Sciences Education (GLSE)

Undergraduate Life Sciences Education

28. GLSE Recruitment Student Group Shadowing Program

The success of our first annual shadowing program during reading week will continue throughout summer school in July for our undergraduate students to be matched up with a graduate student who has volunteered their time.

29. Undergraduate Faculty Teaching Awards

Five awards were adjudicated in four categories.

Excellence in Undergraduate Teaching in Life Sciences

Dr. Paul Yip, Laboratory Medicine and Pathobiology

Excellence in Undergraduate Laboratory Teaching in Life Sciences

Dr. Julie Brill, Molecular Genetics

Excellence in Linking Undergraduate Teaching to Research in Life Sciences

Dr. William Navarre, Molecular Genetics

Sustained Excellence and Innovation in Life Sciences Education

Dr. Christopher Perumalla, Physiology/Division of Teaching Laboratories

Dr. Stavroula Andreopoulos, Biochemistry

30. University of Toronto Excellence Awards (NSERC & SSHRC)

University of Toronto Excellence Award (UTEA) program is funded by the Vice-President Research. The

UTEA program provides eligible undergraduate students with opportunities to conduct summer research projects under the supervision of eligible U of T faculty members. The research term required is 14 weeks.

NSERC (3)

Biochemistry (2)

Physiology (1)

SSHRC (2)

Speech-Language Pathology (1)

Occupational Science and Occupational Therapy (1)

31. GLSE Undergraduate Summer Research Project Studentships

GLSE awarded 7 annual summer research project studentships per summer to support third or fourth year specialist and/or major students in our Basic Science departments and in Laboratory Medicine and Pathobiology. This is a 12 full week summer program, normally between May 1 and August 31, 2017. The award carries a value of \$4,800 each.

32. GLSE Undergraduate Leadership Award

Graduate and Life Sciences Education, Faculty of Medicine will award up to three annual Undergraduate Student Leadership Awards in Life Sciences. The purpose of these awards is to provide opportunities for our undergraduate students in the Faculty of Medicine, Arts and Science Programs to be recognized for their leadership and scholarship. The award carries a value of \$500 each with certificate. The winners will be announced in April.

33. GLSE Undergraduate Ambassadors

As part of our recruitment strategy, we highlight current students (Third year) who have generously volunteered their time to help answer questions for first year students transitioning into their undergraduate studies. It is an important tool for student recruitment into graduate school.

34. GLSE Talks: One Minute Video Competition

GLSE video competition is for all undergraduate and graduate students undertaking a research project. The competition invites students to showcase their ongoing (or potential) research project in a brief and creative one-minute video presentation. The competition will start in June.

35. GLSE Poster Competition

GLSE Poster Competition will promote student talent for the Sixth Annual Undergraduate Research Information Fair Considering Graduate Studies on November 9, 2017. The competition will start in June.

Graduate Education

36. Graduate Awards

a) Graduate Faculty Teaching Awards

Six faculty members were awarded in the following three categories:

- Early Career Excellence in Graduate Teaching & Mentorship Award
 - 2016-2017 – Ana Andrezza - Pharmacology and Toxicology
 - 2016-2017 – Julie Claycomb - Molecular Genetics
- Mid-Career Excellence in Graduate Teaching & Mentorship Award
 - 2016-2017 – Anthony Gramolini - Physiology
 - 2016-2017 – Krista Lanctot - Pharmacology and Toxicology
- Sustained Excellence in Graduate Teaching & Mentorship Award
 - 2016-2017 – Howard Mount - Institute of Medical Science
 - 2016-2017 – Rachel Tyndale - Pharmacology and Toxicology

Each awardee will receive a framed certificate at the Education Achievement Celebration on May 15, 2017 and \$1,000 cash prize.

b) Queen Elizabeth II Graduate Scholarships in Science and Technology (QEII-GSST)

The 2017-18 QEII-GSST competition deadline for student applications were due on March 31, 2017. There are 68 QEII-GSST awards at up to \$15,000 per award available for doctoral-stream Master's and PhD students and clinician/surgical-scientist trainees. QEII-GSST awards are included as part of the graduate student's total stipend funding package.

c) Faculty of Medicine GSEF Merit Scholarships for International Students

The 2017-18 competition deadline for graduate units nominations is May 1, 2017. The GSEF offers merit-based scholarships valued at \$5,000 each to international graduate students who have demonstrated the highest degree of academic excellence. Up to 20 scholarships will be funded by the Office of Graduate and Life Sciences Education. Each GSEF will be approved by the Awards Committee chaired by the Vice Dean, Graduate and Academic Affairs, and will be included as part of the student's total stipend funding package. The GSEF is designed to retain international students by alleviating the cost to the department.

d) Graduate & Life Sciences Education: OSOTF and Other Endowed Awards Competition

The 2017-18 OSOTF and Other Endowed awards competition deadline for graduate student applications is May 12, 2017. There is approximately \$756,000 available for scholarships for graduate students (primarily M.Sc. and Ph.D.) through this GLSE competition. On average, approximately 110 students are awarded and award value is up to \$25,000. OSOTF and Other Endowed awards over \$2,000 are included as part of the student's total stipend funding package.

e) JJ Berry Smith PhD Supervision Award

The JJ Berry Smith Doctoral Supervision Award recognizes outstanding performance in the multiple roles associated with doctoral (PhD) supervision. Two awards are offered annually: one in the Humanities and Social Sciences and one in the Physical and Life Sciences. The awards are presented at the Governor General's Medal reception ceremony in the spring. Recipients receive a JJ Berry Smith Doctoral Supervision Award certificate, an SGS Travel or Conference Award to grant a current doctoral student to support conference participation or research travel, and have their name inscribed on a plaque housed

at the School of Graduate Studies. The Faculty of Medicine nominations to the School of Graduate Studies were due on April 1, 2017.

f) Weston Brain Institute International Fellowships in Neuroscience

The 2017-18 Weston Brain Institute International Fellowships in Neuroscience Call for Applications closed on March 1, 2017. This is an award that provides \$60,000 for each selected student, for up to 3 Canadian graduate students from the University of Toronto conducting translational research in neurodegenerative diseases of aging. Unfortunately, none of the applications received this year were within the scope of the fellowship, which is limited to translational research on neurodegenerative diseases of aging.

37. External Reviews

External reviews for the Department of Immunology and the Department of Radiation Oncology were held on February 1 and 2 and March 30 and 31, respectively. Feedback from both reviews will be available in early summer 2017.

38. Annual Graduate Education Retreat

GLSE will be hosting its second annual Graduate Education Retreat on June 14, 2017 at the Rotman School of Management. This year's focus will be the outcomes of our graduate programs – where our graduates find employment. Using data collected in the School of Graduate Studies' study "10,000 PhDs and Counting" we will look at the career paths of graduate students from Medicine and use this as an anchor to explore work trends and the skills needed to ensure their career success.

39. Curricular Changes

The following is a summary of the curricular changes that have occurred in the Faculty of Medicine for 2016/17:

New Courses	2
Changes to Program Requirements	4
Changes to Admission Requirements	2

The new Professional Masters program in Medical Genomics continues to move through the governance process in a timely manner. The anticipated start date is September 2018.

40. Course Evaluations

Under the direction of the Susan McCahan, Vice-Provost, Innovations in Undergraduate Education, all FOM graduate departments will be participating in the university's endeavour to develop and implement online course evaluations. U of T's Course Evaluation Framework applies a cascaded assessment structure that acknowledges the need for both broad-based and granular assessment across the various levels of the institution.

41. SGS Innovation Fund - Updates

a. Graduate Professional Development Workshops for Faculty

GLSE in collaboration with SGS has implemented a centralized faculty development program that specifically addresses the role of supervisors and Program Advisory Committees in reducing time to completion. It will provide a series of workshops (8) throughout the academic year for faculty, exploring the best practices towards this goal. These workshops will focus on the skills necessary to establish personalized roadmaps to graduation. Faculty are taught best practices for managing scope, establishing clear milestones and setting realistic goals with the early establishment of an Individual Development Plan.

b. Stipendiary Support for Leave of Absence

The Office of Graduate and Life Sciences Education (GLSE), in partnership with the School of Graduate Studies and with support from the SGS Dean's Innovation Fund, advertised the first Leave of Absence Stipendiary (LOA) Fund for research-stream graduate students. The LOA is available for a one-term leave of absence due to health issues (physical and/or mental health challenges). Funding is available up to \$5,000 per student for one term on a one-time only basis. To apply for the LOA Stipendiary Fund, graduate students were asked to submit an information package to the GLSE Office. The deadline for the first call of applications is April 15, 2017.

E. Physician Assistant Program

42. HR Changes

The BScPA Program welcomed Dr. Peter Tzakas into the inaugural role of Program Director, September 2016. This addition allows for the distribution of responsibilities with the Medical Director, Dr. Maureen Gottesman. The Medical Director continues with oversight of the Program and is primarily responsible for fiscal operations; the Program's relationship with clinical sites (liaison and large site recruitment, faculty/site development); policy compliance; recruitment of Course Directors; support of Course Directors in education scholarship; and representation on various internal and external groups and committees. The Program Director is responsible for oversight of the didactic curriculum and liaising with students.

43. Evaluation: Accreditation and Quality Assurance

The BScPA program is currently undergoing accreditation by the Canadian Medical Association (CMA) Conjoint Accreditation Services. Phase I (Self study) was submitted April 3, 2017. Phase II (site visit) is scheduled for October 1-4, 2017.

Maintaining an uninterrupted, national accreditation standard is an essential component of ensuring future viability and success of the PA profession in Canada. Certified PAs must be graduates of an accredited education program. In January 2016, the [CMA announced](#) that they will be divesting from accrediting health professional education programs as of February 2018. CAPA (Canadian Association of Physician Assistants) is the national advocacy and professional body that is responsible for recommending a body to accredit the education programs.

CAPA (the Canadian Association of Physician Assistants) supports PACCC, the Physician Assistant Certification Council of Canada, which independently administers the Canadian National Certification exam. We have been collaborating with various stakeholders since early 2016 to explore the options to secure a replacement organization to be responsible for the external accreditation of PA programs in Canada moving forwards after 2018.

While the CMA Conjoint Accreditation Services will no longer be in operation after January 2018, we are committed to the ongoing compliance of the standards, and know that we have documented the policies and processes well. Regardless of the future of the external accreditation of PA education programs in Canada, the BScPA Program is responsible to meet the continuous quality improvement standards of the University, and will undergo UTQAP in 2017 and at subsequent regular intervals. Quarterly reports are provided to the Faculty Council, University of Toronto and an annual comprehensive report is provided to the Education Committee, Faculty of Medicine and to the MOHLTC (regarding clinical placements).



UNIVERSITY OF TORONTO
FACULTY OF MEDICINE

FOR APPROVAL

TO: Faculty Council

SPONSOR: Allan Kaplan, Vice-Dean, Graduate and Academic Affairs

CONTACT INFO: Rachel Zulla, Graduate Affairs Officer; 416-946-0412;
rachel.zulla@utoronto.ca

DATE: April 24, 2017

AGENDA ITEM: 6.1

ITEM OF BUSINESS: New Program, MHS in Medical Genomics

JURISDICTIONAL INFORMATION:

The University of Toronto Quality Assurance Process dictates that a new program constitutes a major modification and requires the approval of divisional governance. The By-laws of the Faculty of Medicine Faculty Council dictate that major modifications are to be approved by the Education Committee and Faculty Council.

GOVERNANCE PATH:

1. Education Committee – March 9, 2017
2. Faculty Council – April 24, 2017
3. Committee on Academic Policy and Programs
4. Academic Board
5. Executive Committee of Governing Council

CONSULTATIVE PATH:

The proposal has been seen and approved by the following committees at the Faculty of Medicine

- GLSE Graduate Curriculum Committee, February 15, 2017

HIGHLIGHTS:

The MHS in Medical Genomics is a professional Masters degree focused on providing directly actionable skills and knowledge to enable graduates of our program to extend their professional practice. This new program complements the existing graduate programs within the Department of Molecular Genetics, and significantly extends our educational mission by reaching a previously untargeted student cohort.

PROPOSED MOTION

“THAT the proposal to establish a Master of Health Science in Medical Genomics be approved as submitted.”



University of Toronto New Graduate Program Proposal

This template is for all proposals for new graduate programs. It will help to ensure that all evaluation criteria established by the Quality Council are addressed in bringing forward a proposal for a new program. Separate templates have been developed for other types of proposals.

Full Name of Proposed Program:	Master of Health Science in Medical Genomics
Degree Name and Short Form:	Master of Health Science (M.H.Sc.)
Program Name:	Medical Genomics
Professional Program (yes/no)	Yes
Unit (if applicable) offering the program:	Department of Molecular Genetics
Faculty / Division:	Faculty of Medicine
Dean's Office Contact:	Allan Kaplan, Vice Dean, Graduate and Life Sciences Education
Proponent:	Lean Cowen, PhD, Chair, Dept. of Molecular Genetics
Version Date: <i>(please change as you edit proposal)</i>	2016/07/22 019

New Graduate Program Proposal

MHSc in Medical Genomics

Department of Molecular Genetics

Faculty of Medicine

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1 Summary

Genomics, the ability to read and interpret information contained within DNA, is a rapidly growing area with broad reaching implications from bench to bedside. Technological advances are being pushed to the clinic, and the ability to generate and interpret genomic information will drive a new era of healthcare and patient management. With this progress, there is a growing knowledge gap between clinical practice and the discoveries stemming from genome-scale research in human genetics. Advances in systems biology, including genomics, proteomics, and metabolomics, are outpacing the ability of undergraduate medical and scientific teaching to prepare medical and technical staff. Many practicing clinicians and laboratory personnel were trained before the development of modern genomic technologies, yet are faced with the need to generate, integrate, and interpret genetic and genomic data. To address this acute educational need, the Department of Molecular Genetics within the Faculty of Medicine, proposes a new program and associated degree, a professional Masters in Health Sciences (MHSc) in Medical Genomics. This new degree will provide medical trainees, research scientists, and laboratory professionals with the theory and practical knowledge necessary to incorporate genomics data into medical practice.

The MHSc in Medical Genomics is a professional Masters degree that is focused on providing directly actionable skills and knowledge to enable graduates of our program to extend their professional practice. This new program complements the existing graduate programs within the Department of Molecular Genetics, and significantly extends our educational mission by reaching a previously untargeted student cohort. In contrast to the department's existing MSc/PhD graduate program, which is research and thesis-focused, the MHSc in Medical Genomics is a lecture and project-based curriculum. Although similar in title, the department's existing MSc in Genetic Counselling serves a much smaller student cohort with a programmatic focus on clinical genetic counselling and inborn genetic disorders. This MHSc in Medical Genomics is being developed for a new era of research and clinical science, providing professional and practical skills for a world where genetic and genomic data are routinely collected and analyzed across a wide range of patient populations and medical indications.

As a professional Masters degree, the MHSc in Medical Genomics is focused on teaching theory and practice, rather than the creation of new knowledge as is integral to research graduate degrees. This MHSc program's specific focus, orthogonal to existing curricula in the department, University, and across the province, will provide a means by which to provide professionally useful skills in Medical Genomics to students interested in immediate practical implementation.

The MHSc in Medical Genomics consists of a core set of lecture, discussion, and project based courses across a two year program duration. Lecture courses will be delivered by experts in the field comprising of faculty from the Molecular Genetics department and cross-appointed clinical faculty in conjunction with the Faculty of Law and Faculty of Public Health. In addition to lecture-based learning, students will participate in a capstone practicum during the final academic term of the program. For the practicum, students will be split into clinical (for

undergraduate or post-graduate M.D.) and laboratory professional (for post-bachelor's) streams, with unique course work focused on patient interaction and laboratory data generation, respectively.

This professional Masters degree will be the first of its kind in Canada, and will join several elite institutions leading the charge in the United States. This program developed organically from consultation with various stakeholders in Toronto, including clinical training programs, hospital affiliated laboratories, academic research departments, and other University Faculties of Public Health and Law.

The Department of Molecular Genetics, leveraging existing partnerships with the McLaughlin Centre and the Centre for Genetic Medicine at SickKids, is uniquely suited to serve the growing need for graduate-level training in Medical Genomics. This MHSc will leverage the academic strengths of the Department of Molecular Genetics, with direct teaching contributions to this program by more than 25 departmental faculty. Although few comparable programs currently exist in North America, the competitive landscape is expected to change rapidly over the next several years. We are proposing to start this program in Fall 2018, targeting an entering class of 20 students and steady-state of 20 entrants per year.

2 Effective Date

Start date of Fall 2018.

3 Program Rationale

The Department of Molecular Genetics has observed a growing, unmet need for practical training in genetic and genomic methods. Rapid progress in approaches to generate and analyze genetic data has outpaced the ability to cover these cutting-edge approaches in undergraduate (BSc) and undergraduate medical curricula. In response to an observed demand for advanced training in directly actionable medical genomics, the Department of Molecular Genetics began to examine the possibility of building a new course-based graduate program to teach theory and practical skills to students interested in genomic health. During this period of consultation, clinical faculty affiliated with the Department expressed parallel interest in developing a new residency program in clinical genomics for a subset of medical trainees. Following discussion among various faculty and University stakeholders, the Department of Molecular Genetics is proposing a new two-year (five session) MHSc degree targeted to both laboratory and clinically-focused students that provides a unique training and learning environment to teach practical and theoretical aspects of modern genetics and genomics with a strong focus on clinical application.

Professional Master's in Medical Genomics

This program is a course-based professional Masters targeted at students interested in building

academic expertise in actionable professional skills. Students will pursue coursework including genetics, genomic methods, and medical ethics that will enable graduates to generate and interpret genomic data. This degree is relevant whether students will be working as physicians or as laboratory professionals. The program will recruit students who are active clinicians, clinicians-in-training, and those holding Bachelor degrees working in or planning to work in clinical or research laboratory settings. These seemingly diverse student cohorts are each in need of training in medical genomics and, together, will provide orthogonal perspectives and a strong basis for dialogue. For clinicians and clinicians-in-training, the growing availability and visibility of direct-to-consumer genetic testing means that physicians are now at the front lines of assisting patients in interpreting genetic data. For laboratory professionals, genetic tests are a growing component of the data being generated to guide clinical treatment and research discovery.

This diverse student cohort will represent both the clinical and laboratory points of view in a single, shared training environment, allowing students to better appreciate the role of genetic testing on both medical practice and laboratory work. The intensive, full-time five-session program has been designed to provide students with graduate training of fixed duration and enable rapid return to full-time work.

We will draw on the diverse faculty already appointed to Molecular Genetics with strengths ranging from research in mechanisms of disease to oncology to clinical genetics. Courses will be built specifically for this program to provide a focused curriculum of interwoven modules. By including clinicians and clinicians-in-training as part of our student cohort, we will integrate clinical perspective and enable experience-based discussion. Courses delivered by research scientists will be built in consultation with clinical faculty. In addition to lecture-based learning, students will extensively participate in small-group and problem-based learning approaches and participate in interactive case studies. The integrated design of this program will enable delivery of concepts step-wise in a complementary “just in time” fashion; concepts and skills gained in one course will be expected and applied in subsequent modules.

Distinctiveness: Practically focused curriculum taught by leading researchers in medical genomics to train the next generation of genomics professionals

The Department of Molecular Genetics, leveraging existing partnerships with the McLaughlin Centre and the Centre for Genetic Medicine at SickKids, is uniquely suited to capitalize on the growing need for graduate-level training in Medical Genomics. The proposed faculty members include world leaders in clinical and research science genomics. This program will put the University of Toronto in a market leading position, and position the University of Toronto as the first in Canada to offer this degree. Although few competing programs exist worldwide, the competitive landscape is expected to change rapidly over the next several years. For instance, the US National Institutes of Health and National Human Genome Research Initiative has recently funded several pilot and scale-up training programs for Genomic Medicine¹. The

¹ US National Institutes of Health / NHGRI RFA-HG-13-004: “Genomic Medicine Pilot Demonstration Projects”

proposed program presents the opportunity for the Department of Molecular Genetics to capitalize on its position as a leading hub for fundamental and clinical genomics research by translating this research expertise to this new program for training of laboratory and medical practitioners.

Medical Genomics: A program that will Promote Healthy People

By training professionals in genetics and genomics, students graduating from the program will be able to understand and use genomic information in their work. The growing availability and visibility of direct-to-consumer genetic testing means that physicians are now at the front lines of assisting patients in interpreting genetic data. In research and clinical laboratories, genetic tests are a growing component of the data used to guide clinical treatment and research discovery. These tests are rapidly progressing from single genes to panels of multiple genes and now to whole-genome data, with concomitant increases in the complexity of understanding and communicating results.

It is anticipated that the students will drive adoption and implementation of genomic healthcare in Toronto and across Canada, and that the largest demand by post-BSc students will be from those seeking, or currently working in, advanced clinical and research laboratories, where genetic and genomic techniques are a growth sector. This MHSc degree is a value-add for medical trainees and professionals as well: comprehension of genomic data and the ability to interpret and communicate genetic results will place our graduates at the forefront of practicing healthcare providers, and can be expected to provide wide-ranging benefits to clinical practice in Ontario.

Upon completion of this program, medical students and trainees will begin or return to clinical practice with the ability to implement and interpret genomic data. The clinical graduates will be at the forefront of “genomic medicine”. The post-BSc students will be ideally suited for employment in clinical and research science labs implementing the tools of genomic medicine. They will also be highly attractive to publicly funded enterprises or private companies that are producing and interpreting genomic data for the health professions as well as for direct-to-consumer testing laboratories. This degree will distinguish graduates, enhance existing professional practice, enable new career paths, and help enable Ontario to lead the future of Genomic medicine.

This program is fundamentally different from our existing MSc in Genetic Counseling and we anticipate no internal competition between programs. Compared to our Masters in Genetic Counseling, this program targets a different student cohort with non-overlapping career prospects and trajectories. Our target of 20 students per year is 500% the size of our current genetic counseling program; from conception, we have designed this new MHSc to reach a larger and more diverse student population. This program will provide a distinguishing credential for students, and the training it provides is distinct from the clinical approach taught

in the Master of Science in Genetic Counseling program.

In addition to serving a presently unmet academic need for practical training in medical genetics and genomics, the proposed MHSc program is well aligned with the University of Toronto's strategic mandate to further academic excellence through practical graduate training. The Ontario Ministry of Training, Colleges, and Universities' Strategic Mandate Agreement (MTCU SMA, 2014) notes that the University of Toronto is "in a unique position to leverage our research strength into creating and delivering world-class, research-informed professional Masters programs." This proposed MHSc program is particularly aligned with the SMA's suggestion of an expansion of graduate enrolment and noted focus on growth of professional masters programs in biomedicine and health-related fields. This MHSc in Medical Genomics will further the Strategic Research Plan of the University of Toronto² to promote healthy people by translating research achievements from the University of Toronto and beyond into practical professional tools.

4 Fields/Concentrations

n/a

5 Need and Demand

The ideas of genetics are now part of common parlance. Companies tell us that features like quality, reliability, or good design are "in their DNA"; people joke with one another about whether they "have the gene" for a good hockey slap shot. Genetic analyses have moved beyond science fiction to everyday life. Paternity testing is advertised on billboards, and people discover forgotten ancestors using DNA testing with results served by online genealogy portals. *Post Baccalaureate education has lagged behind the emergence of genetics in our culture.*

A demonstrated need for additional genetics training:

Current undergraduate scientific and medical training does not provide competency in advanced genetics required to effectively order and interpret the growing range of genomic clinical data. During expansion of the Department of Molecular Genetics' undergraduate curriculum and informal surveys of alumni, an opportunity to provide masters-level coursework and practical training in genomics was identified. Faculty at the University of Toronto surveying practicing Ontario physicians have found a need for greater training in genetics, and have begun to identify actionable interventions for practicing medical professionals. Discussions with clinicians working metabolic genetics identified an opportunity for an MHSc degree to complement or replace a genomics residency that had been planned. The Professional Masters in Medical Genomics will train laboratory and medical professionals to understand and effectively communicate in the language of genetics and genomics, placing our graduates at the

² <http://www.research.utoronto.ca/wp-content/uploads/2012/10/SRP-2012-web.pdf>

vanguard of genomic medicine.

The proposed professional master's in Medical Genomics will be unique in Canada. We will capitalize on the leading role that the research and clinical community in Toronto plays worldwide in genomics through lecturing by world-leading clinical and data-analysis scientists and practical training in alliance with industry-leading clinical research facilities. Despite the absence of competition in Canada, the United States National Institutes of Health is actively funding pilot-scale "Genomics in Practice" initiatives³ to bridge research and clinical practice. This MHS program will place the University of Toronto at the forefront of this trend in biomedical practice.

Patient knowledge is outpacing that of practicing physicians. The cost of genetic testing is tumbling, and a flurry of medical research is demonstrating the use of whole genome sequences to guide clinical practice. In addition to clinical use, direct-to-consumer marketing of genetic tests is growing rapidly. In addition to large players like 23 and me, a diverse range of startups is appearing, including Geneyouin and Medsavant, two local companies started by department alumni and faculty members. We expect student demand to grow in parallel with increased clinical and direct-to-consumer deployment of genomic tools.

This MHS will capitalize on a unique mixture of skills and previous experience provided by a combined program teaching both research- and clinically-focused trainees. The curriculum will include concomitant training of clinicians and laboratory professionals, paralleling the professional interaction between physicians and clinical laboratory personnel. The initial cohorts will include medical trainees (e.g., residents and fellows) and post-BSc professional students. As this program grows, we will refine elective courses with an aim of further specializing medical and technically focused sub-curricula to best engage our students.

6 Enrolment

Table 1: Graduate Enrolment Projections

Year of study	2017/18	2018/19	2019/20	2020/2021	2021/2022
Year 1	20	20	20	20	20
Year 2	0	20	20	20	20
Total	20	40	40	40	40

This is a new degree that does not supersede any existing offering from the Faculty of Medicine or other University of Toronto departments. As one of the first programs of its kind in the

³ Implementing Genomics in Practice (IGNITE) <http://www.genome.gov/27554264>

world, we expect significant interest from both domestic and international students. Many facets of this curriculum incorporate legal and ethical aspects of medical genomics that will be implicitly and explicitly focused on Canadian practice. Following consultation with the office of the Faculty of Medicine Vice Dean of Graduate and Academic Affairs, we will initially focus our enrolment on domestic students (e.g., 90% domestic, 10% foreign) with the potential to expand to accommodate additional students, both domestic and foreign, as listed below. Students enrolled in this professional Master's program are responsible for their own tuition; foreign enrollees can be expected to pay a higher tuition (BIU offset).

Genomic medicine is a rapidly growing field; increased enrolment beyond our projected steady state is possible if required to serve a growth in demand. Requested administrative and space resources reflect our target of 40 students enrolled in the program at any given time; increased student number would require commensurate growth in support.

7 Admission Requirements

The professional Master of Health Science in Medical Genomics program is a content-dense degree program designed for highly capable students. We anticipate admitting students from diverse academic backgrounds and will prioritize potential for success in this program over any single axis of academic achievement.

Students are admitted under the General Regulations of the School of Graduate Studies.

Applicants must also satisfy the Department of Molecular Genetics additional admission requirements stated below.

- Successful completion of either:
 - an appropriate four year bachelor of science (BSc) degree with a B+ average from a relevant discipline, including, but not limited to: biology, biochemistry, genetics, molecular biology, laboratory medicine, analytical chemistry, or:
 - an appropriate undergraduate medical degree from an accredited university with a B+ average.

- Applicants will complete an application package including all previous university transcripts, full CV/resume, and a one to two page statement of interest describing how this degree program will have an impact on their career path.

- Applicants will be considered based on a combination of previous academic performance and preparation, three letters of reference, professional or research experience (if any), and the potential to immediately implement knowledge gained from

this master's program.

Prior to starting in the program, applicants will have obtained an appropriate BSc, or its equivalent, normally with at least a B+ average. Applicants will be evaluated in a holistic manner to build a well-balanced cohort combining exceptional academic abilities, professional perspective, and career prospects to enrich the out-of-class learning exercises and significant classroom discussion of this program. Applicants with relevant research and/or clinical experience, and those who will make immediate and substantive use of this new degree in professional practice are strongly encouraged to apply.

Students who are non-native English speakers and have received their most recent degree from a non-English speaking institution will be required to demonstrate mastery of written and spoken English prior to application. TOEFL (Test of English as a Foreign Language) and TWE (Test of Written English) scores must be submitted at time of application. Exams must have been written less than 12 months prior to application. Minimum scores for consideration are as follows and align with the School of Graduate Studies minimum:

TOEFL:

- Paper based test and TWE: Overall score 580, TWE 5
- Internet based test IBT: Overall score 93, writing/speaking 22

Applicants whose credentials warrant further consideration will be interviewed in person (for local applicants) or via phone or video interview (e.g., Skype) by no fewer than two program faculty. These interviews will be short (< 30 minutes each) and will be used to gauge the applicant's ability to engage in discourse consistent with this fast-paced program and to confirm student excellence as represented in other application materials.

Explanation

We anticipate that students admitted to this program will significantly exceed these minimum requirements. The desired student cohort will include applicants from diverse career and training backgrounds; no single evaluation metric is sufficient to assess student potential for this program. A fundamental challenge in the admissions process will be the identification of the *most* excellent students who have the potential to both benefit from and contribute to this educational experience. This will be facilitated by holding recruitment events for prospective students to enable faculty to interact with potential students, which has been a resounding success in the research masters and PhD programs in the Department of Molecular Genetics.

Although much of the coursework in this MHS program is factual and technical in nature, successful students may come from a range of academic backgrounds. Typical candidates will have completed an undergraduate degree in biology with a working knowledge of genetics and molecular biology. A range of academic topics are covered in this program; prospective students are encouraged to examine the Graduate Calendar entry to determine if they feel sufficiently prepared to engage in fast-paced learning of the topics listed.

A key determinant of success in this program will be the ability of students to operate in a content-dense learning environment. Letters of reference and one-on-one interviews will be particularly important to identify self-motivated students who are equally able to work independently and in small-group environments. As a professional Masters degree, a major goal of this program is to provide immediately relevant knowledge and career-enabling experience. Students with a demonstrated interest and strong existing career prospects in genomic science or medical genomics will be given priority for admission.

8 Program Requirements

Students in the Medical Genomics program will be required to complete a total of 9.0 full-course equivalents (FCE) distributed as detailed below.

To build a cohesive student cohort, program content is fixed for the first four sessions. During the fifth and final session of the program, students will be tracked into one of two career-specific practica designed to provide information specific to their profession (physician or laboratory scientist).

Session	Course Code	Course Title	Hours	FCE Weight
<i>Session 1: Fall 1</i>	MMG 0001 Y	Advanced Human Genetics	156 hours	
	MMG 0002 H	Biological Statistics	78 hours	1.0
<i>Session 2: Winter 1</i>	MMG 0001Y (continued)	Advanced Human Genetics	78 hours	2.0
	MMG 0003Y	Genomics Methodologies (classical molecular biology)	156 hours	
<i>Session 3: Summer 1</i>	MMG 0003Y (continued)	Genomics Methodologies (next-generation genomics)		2.0
<i>Session 4: Fall 2</i>	MMG 0004H	Communication of Genetic Information	78 hours	1.0
	MMG 0005H	Ethical and Legal Implications	78 hours	1.0

		of Genomics		
<i>Session 5: Winter 2</i>	MMG 0006H	Future Directions in Medical Genomics	78 hours	1.0
	MMG 0007H*	Practicum in Patient Management and Medical Genomics (Option A)	78 hours	1.0
	MMG 0008H*	Practicum in Modern Genomics (Option B)	78 hours	1.0

*Note: Students take either MMG0007 OR MMG0008H

This degree program consists of five full-time consecutive sessions in duration (Fall 1, Winter 1, Summer 1, Fall 2, Winter 2). Due to the cumulative nature of the program, students will proceed as a cohort and high enrolment retention is anticipated. Students are expected to graduate at the completion of term five. A three-year time limit enables students to complete a missed year under extenuating circumstances.

Explanation of the Proposed Requirements

Students will learn 1) fundamentals of the field, 2) principles underlying modern techniques and technologies, and 3) skills necessary to keep up to date with new advancements and communicate effectively with other knowledge users in the field. We anticipate no fewer than six hours of classroom time per week per course, consistent with the double-credit structure proposed.

We anticipate that students will arrive with range of factual knowledge and practical experience relevant to this program. It is therefore critical to simultaneously bring students to a common knowledge base while providing new material.

The unified structure of the program is designed to foster cohesion among students and to ensure that classes can be taught in a cumulative fashion. Learning objectives and concepts presented in the first courses will be expanded upon in subsequent terms. Tracking students in a common academic path enables the streamlining and integration of the program course material as a whole in a manner will ensure students of diverse backgrounds will benefit from each other and achieve the same learning outcomes.

Depending on student background and career path, the capstone fifth session (Winter 2) will include a required course in either patient management (medical track) or a practical laboratory course (professional track). Bifurcating our program at the final session enables the building of a cohesive student body during the bulk of the program while tailoring one of the courses offered during the final session for the present career needs of our students.

Please see Appendix [A] for a full list of the course numbers, descriptions and titles.

9 Program Description

Program delivery and duration:

Our Professional Masters in Medical Genomics will consist of five terms of study, spanning 20 months. Students will enrol on a full-time basis only.

Students will take two courses each consisting of 6 hours per week (for a total of 12 hours per week) for the fall and winter sessions of the first year. The summer of the first year will include a single course taught 6 hours per week. The fall and winter sessions of the second year will include two courses per session at 6 hours per week each term. Students will participate in the spring convocation following successful completion of all program requirements.

The program will be offered face-to-face, to allow for significant exchange between students. Class time will include lectures as well as hands-on, in-class learning activities. The course in Patient Management and Medical Genomics (elective for medical professionals) will include a structured practical component including patient contact. Our Practicum in Modern Genomics (elective for post-BSc students and practising scientists) includes hands-on laboratory exercises in which students generate and analyze genome-scale sequencing data, and will be delivered in the teaching lab facilities in the Faculty of Medicine Division of Teaching Labs.

We will augment lecture-based course delivery with a series of web-based information portals and extensive out-of-class learning and group projects. Course assignments will require students to use online resources, including research literature and databases, allowing them to build a hands-on fluency of genome analysis and statistical tools. Our blended lecture and student-driven delivery model has been selected to teach students theory and use of relevant techniques and data analysis approaches.

Unified and streamlined program structure:

The program has been designed to provide a maximum of practical and theoretical knowledge of advanced content with minimal repetition. Students will enter the program as a unified cohort each year and will progress through each of the required courses together. A single elective course is scheduled during the final session; students will finish the program with a career-specific practicum (MMG007H or MMG008H) in addition to a forward-looking capstone lecture course, Future Directions in Medical Genomics (MMG006H).

The unified approach enables significant synergy between individual courses, provides a unique opportunity for agglomerative learning within and across academic sessions, and ensures that all students have demonstrated competency in all program curriculum. This approach will also generate a cohesive student dynamic that facilitates group projects and learning outside of the classroom.

Whereas the Province's Quality Assurance Framework requires that students complete a

minimum of 2/3 of courses at the graduate level, the University of Toronto requires graduate students to complete all of their course requirements from amongst graduate level courses. This proposed program complies with this requirement.

10 Degree Level Expectations, Program Learning Outcomes and Program Structure

Table 2: Master's DLEs

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
<p>EXPECTATIONS:</p> <p><i>This MHS in Medical Genomics is awarded to students who have demonstrated:</i></p>		
<p>1. Depth and Breadth of Knowledge</p> <p>A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.</p>	<p>Depth and breadth of knowledge is defined in Medical Genomics as knowledge of a broad range of scientific and medical principles that allow the use of genetic information to assist in the diagnosis and treatment of human disease.</p> <p>This is reflected in students who are able to:</p> <p>Depth</p> <ul style="list-style-type: none"> • Understand the molecular biology principles underlying genetic tests used in the clinic • Differentiate among statistical tests and their appropriate application. • Evaluate new genomic and genetic technologies with a particular focus on application to medical testing and patient care. • Identify research and clinical questions that would benefit from the inclusion of genomic data or analyses. <p>Breadth</p> <ul style="list-style-type: none"> • Explain the causes of genetic variation and recognize which genetic tests are suited to each type of variation. 	<p>The program design and requirements that ensure these student outcomes for depth and breadth of knowledge are:</p> <ul style="list-style-type: none"> • MMG001Y, MMG002H, and MMG003Y will impart the foundational knowledge required for breadth and depth. These courses will build on one another and will contain exercises and projects designed to cumulatively develop and reinforce the fundamental principles of human genetics and the application of genetic testing to medicine. • The specialty-specific practicum courses (MMG007H Patient Management and Medical Genomics for clinicians, and MMG008H Practicum in Modern Genomics for scientists) will provide additional domain-specific depth.

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	<ul style="list-style-type: none"> Critically interpret research and clinical literature in the fields of genomics, personalized medicine, and medical genetics. 	
<p>2. Research and Scholarship</p> <p>A conceptual understanding and methodological competence that i) Enables a working comprehension of how established techniques of research and inquiry are used to create and interpret knowledge in the discipline; ii) Enables a critical evaluation of current research and advanced research and scholarship in the discipline or area of professional competence; and iii) Enables a treatment of complex issues and judgments based on established principles and techniques; and, on the basis of that competence, has shown at least one of the following: i) The development and support of a sustained argument in written form; or ii) Originality in the application of knowledge.</p>	<p>Research and Scholarship is defined in Medical Genomics as the ability to interpret and synthesize genetic information and medical findings to understand the biology of human disease.</p> <p>This is reflected in students who are able to:</p> <ul style="list-style-type: none"> Develop biological hypotheses and propose meta-analyses (analysis of existing data bases) or prospective (data collection) approaches to answering these questions. Review the current research literature on a genetic disease and propose additional research avenues for diagnosis, prognosis, or treatment of that disease. Interpret genetic and genomic test results with an understanding of the inherent biases and limitations of an individual assay. Employ academic databases to determine the novelty of a given genetic finding and determine demonstrated or likely functional / health relevance of test results. 	<p>The program design and requirements that ensure these student outcomes for research and scholarship are:</p> <ul style="list-style-type: none"> As part of MMG001Y, students will write a comprehensive review of a genetic disease. This project will allow students to develop skills of scholarship and to gain practice reading and interpreting data in the genetic literature. The specialty-specific practicum courses (MMG007H Patient Management and Medical Genomics for clinicians, and MMG008H Practicum in Modern Genomics for scientists) will include assignments that require the interpretation of original data and the application of these data to recommend diagnoses or courses of treatment.
<p>3. Application of Knowledge</p> <p>Competence in the research process by applying an existing body of knowledge in the critical analysis of a new question or of a specific problem or issue in a new setting.</p>	<p>Application of Knowledge is defined in Medical Genomics as the use of genetic information and principles to guide diagnosis and treatment decisions.</p> <p>This is reflected in students who are able to:</p> <ul style="list-style-type: none"> Identify and list the causative genes and typical symptoms for 	<p>The program design and requirements that ensure these student outcomes for application of knowledge are:</p> <ul style="list-style-type: none"> The background information for these competencies will be presented in MMG001Y, Advanced Human Genetics, and MMG0002H, Biological

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	<p>major human Mendelian diseases</p> <ul style="list-style-type: none"> • Describe the genetic risk factors for major genetically complex human diseases • Use patient medical reports and family history to prepare a pedigree and describe the likelihood of Mendelian disease presence • Interpret raw data to assess the validity of a test result • Identify the appropriate statistical test for different data types and scenarios to calculate patient disease risk • Recommend and justify the need for follow-up testing based on initial findings and patient history 	<p>Statistics.</p> <ul style="list-style-type: none"> • Assignments in MMG003Y, Genomics Methodologies, will incorporate these activities. • Course assignments in MMG004H, Communication of Genetic Information, including group work and presentations, will further reinforce these concepts.
<p>4. Professional Capacity/Autonomy</p> <p>a. The qualities and transferable skills necessary for employment requiring i) The exercise of initiative and of personal responsibility and accountability; and ii) Decision-making in complex situations; b. The intellectual independence required for continuing professional development; c. The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; and d. The ability to appreciate the broader implications of applying knowledge to particular contexts.</p>	<p>Professional Capacity/Autonomy is defined in Medical Genomics as the ability to apply the appropriate skills required for the interpretation and use of human genomic data in a laboratory and clinical setting.</p> <p>This is reflected in students who are able to:</p> <p>Employment skills</p> <ul style="list-style-type: none"> • Demonstrate the ability to interpret and assess genetic data • Justify a course of follow-up testing and potential treatment, with discussion and appropriate weighting of other available options <p>Continuing professional development</p> <ul style="list-style-type: none"> • Use databases and information portals to identify current information related to genetic variants • Critically read and understand 	<p>The program design and requirements that ensure these student outcomes for professional capacity/autonomy are:</p> <p>Employment skills</p> <p>In most courses, students will be tasked with interpretation of actual (anonymized) genetic testing data. A significant component of group work throughout all courses will develop the collaborative skills of students.</p> <p>Continuing professional development</p> <p>All of the courses will require reading and interpreting research manuscripts and medical literature, imparting students with the skills required to add to their knowledgebase. MMG006H, Future Directions in Medical Genomics, will introduce students to the databases of human genetic data and train students to use these sources to</p>

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	<p>scientific and medical literature</p> <p>Ethical behaviour</p> <ul style="list-style-type: none"> • Understand current ethical standards for genetic testing • Appreciate the guidelines for communication of incidental genetic findings in paediatric and adult populations • Be respectful of patient belief systems that affect the use of genetic information <p>Broader Implications</p> <ul style="list-style-type: none"> • Recognize how the growing availability of genetic information is changing the practice of medicine • Use risk information to assess the impact of new genetic findings 	<p>interpret new genetic findings. MMG001Y, Advanced Human Genetics, and MMG003Y, Genomics Methodologies, will emphasize how the rapid progress in genomic technologies requires the continual assessment of the best current approaches to problem solving.</p> <p>Ethical behaviour</p> <p>All students will complete a MMG005H, Ethical and Legal Implications of Genomic Information, taught by members of the Faculty of Medicine, Faculty of Public Health and Faculty of Law. This course will communicate the current ethical and legal standards for genetic information. Students will learn to sensitively communicate with patient populations from varying belief systems.</p> <p>Broader Implications</p> <p>MNG006H, Future Directions in Medical Genomics, will explicitly address how the growing availability of genetic information is expected to transform clinical practice. This course will also address new technologies on the near-term horizon for adoption into genetic and genomic technologies.</p>
<p>5. Communications Skills</p> <p>The ability to communicate ideas, issues and conclusions clearly.</p>	<p>Communications Skills is defined in Medical Genomics as the ability to communicate genetic information in a clear, easily understood manner tailored to the level of training of the audience.</p> <p>This is reflected in students who are able to:</p> <ul style="list-style-type: none"> • Work closely with other laboratory and medical professionals to interpret 	<p>The program design and requirements that ensure these student outcomes for communication skills are:</p> <ul style="list-style-type: none"> • The diverse student class will create interaction between clinicians and laboratory researchers. In addition to formal collaborative projects in class, dedicated learning space will encourage informal

MASTER'S DEGREE LEVEL EXPECTATIONS (based on the Ontario Council of Academic Vice Presidents (OCAV) DLEs)	MASTER'S PROGRAM LEARNING OBJECTIVES AND OUTCOMES	HOW THE PROGRAM DESIGN AND REQUIREMENTS SUPPORT THE ATTAINMENT OF STUDENT LEARNING OUTCOMES
	genetic testing results and collaboratively develop follow-up and treatment plans <ul style="list-style-type: none"> • Prepare and present clearly understandable and supported written and oral summaries of genetic testing results for both patient and professional audiences, including a statistically supported description of disease risk 	interactions among students. <ul style="list-style-type: none"> • Evaluation of student performance in several courses will include written and oral presentations, performed individually and as teams. This will be a particular focus of MMG0004H, Communication of Genetic Information.

11 Assessment of Learning

Assessment of Learning:

Mechanisms for student evaluation:

Program coursework will include a variety of assessment modalities in which students are required to demonstrate acquired knowledge and apply these concepts to both theoretical and practical problems in medical genomics. The program is designed to be cumulative; successful completion of assignments in later courses will require the application of knowledge and methods learned in earlier courses.

Student performance will be quantified through a variety of mechanisms including written quizzes and examinations, oral presentations, and written projects (e.g. case reports). Students will receive a letter grade for each course in addition to a written mid-term performance evaluation.

	Quizzes and Examinations	Written projects	Oral Presentations
1. Depth and Breadth of Knowledge			
Understand the principles underlying genetic / genomic testing methods	X	X	X
Critically assess statistical methods and justify most appropriate techniques	X	X	X

Describe and explain genetic variation and association with disease risk	X	X	
2. Research and Scholarship			
Develop biologically sound hypotheses and propose approaches to test the same		X	X
Demonstrate mastery of research literature to provide support for diagnosis, prognosis, and treatment planning of genetic variation and disease	X	X	X
3. Application of Knowledge			
Interpret raw genomic / genetic data to assess the validity of a reported result	X	X	
Identify and implement the appropriate statistical methods for diverse genomic tests	X	X	
Recommend and justify follow-up testing based on patient history and existing data		X	X
4. Professional Capacity / Autonomy			
Integrate information from databases and scientific publications to assess genetic test results	X	X	
Critically assess new genomic tools and understand primary and research literature		X	X
Understand and follow current ethical standards for genetic testing and evaluation		X	X
Use risk information to assess the impact of new genetic variants		X	X
5. Communication Skills			
Work with laboratory and medical professionals to interpret genetic testing results and collaboratively develop follow-up and treatment plans		X	X
Generate understandable and supported summaries of genetic / genomic test results for both professional and patient audiences	X	X	X

Evaluation of program effectiveness:

A key component of this program is provision of career-enabling skills. We will actively follow our program graduates using a combination of post-completion surveys at several points post graduation (six months, one year, three years), phone and in-person follow-up interviews. Student feedback will be combined with targeted surveys of employers of our graduates to enable head-to-head comparison of program participants and their peers.

We will establish a program steering committee consisting of lead instructors from each course, the departmental chair, program director, and at least two external knowledge users from local hospitals and clinical laboratories. This committee will meet at least once per year to discuss the effectiveness of course content, foster greater integration between course modules, and identify program strengths and focal areas for improvement. Our course content is intentionally

flexible to enable dynamic response to changes in state-of-the-art technologies and to rapidly respond to feedback from program participants. This structured evaluation and course-planning approach will ensure that students are being provided with effective and relevant content.

Medical genomics exists in a fast-changing regulatory environment. While there are not at present any relevant certifications available for the program, we will monitor and aggressively pursue any certifications and professional accreditations that may arise.

12 Consultation

This proposed program has been developed following discussions both inside the Faculty of Medicine and with local stakeholders and knowledge users, including the Dalla Lana School of Public Health, the McLaughlin Centre for Molecular Medicine, and the Division of Clinical and Metabolic Genetics at SickKids.

Preliminary meetings began in 2013 within the Department of Molecular Genetics (Faculty of Medicine) and the Donnelly Centre, a multidisciplinary, an Extra Departmental Unit A cross-faculty research institute comprised of more than 40 research groups across different faculties (Medicine, Engineering and Applied Sciences, Arts and Sciences, and Pharmacy). The impetus for developing this program has been the desire to translate knowledge and research excellence of these two units into a clinically relevant professional Masters program. Upon extremely positive feedback from stakeholders in both departments, we proceeded to engage the greater faculty and surrounding community.

Discussions within the Faculty of Medicine in early 2014 centred around the viability of a new professional Masters program for medical genomics, through consultation with clinical faculty. Feedback from these meetings was strongly positive, and significantly expanded our target student population to include physicians in training at the undergraduate medical and resident levels. Dennis Daneman (Chair, Department of Paediatrics, U of T & Physician-in-Chief, SickKids) and Ronald Cohn (Chief, Division of Clinical & Metabolic Genetics, SickKids) provided valuable insight from the clinician and clinician-scientist perspectives. *Dr. Cohn, in particular, was excited at the potential to leverage our MHSc program in lieu of a separate clinical genomics fellowship.*

We consulted with Steven Scherer, Director of the McLaughlin Centre for Molecular Medicine, to gauge interest from knowledge users and potential employers of our prospective graduates. Dr. Scherer was strongly positive about the program in general, re-affirmed our assessment that this program will provide a novel and timely contribution to genomics education, and suggested the potential for direct externship possibilities in the McLaughlin Centre for professional-track students. As a leader in genomics, Dr. Scherer underscored the importance of our program in providing genomics education to both clinicians-in-training and post-BSc students likely to join genomics research or commercial enterprises.

Further discussions inside the Faculty of Medicine focused on defining our target student population. In mid-2014, we engaged Norm Rosenblum, Associate Dean in charge of the

physician-scientist training program in the Faculty, who supported our targeting of clinical trainees and recent graduates as part of our student cohort. Echoing previous stakeholders, Dr. Rosenblum was extremely positive about our proposal, and the potential for the University of Toronto to take a leadership position in this field.

In mid-2015, we engaged Barbara Secker and Michael Szego of the Joint Centre for Bioethics, an Extra-Departmental Unit C within the Dalla Lana School of Public Health for collaboration on one of our proposed course modules. The Centre for Bioethics delivers the MHS in Bioethics and the graduate Collaborative Program in Bioethics. Drs. Secker and Szego saw significant strategic fit with their teaching efforts, and offered support for the genetic ethics components of MMG 0005H. Prof. Trudo Lemmens of the Faculty of Law already holds a cross-appointment in the Department of Molecular Genetics to teach in its M.Sc. Program in Genetic Counselling. Drs. Szego and Lemmens will participate in the M.H.Sc. course MMG 0005H on Ethical and Legal Implications of Genomic Information.

In June 2015, a draft version of this proposal was presented in a full faculty meeting of the Department of Molecular Genetics and received uniformly strong support. Members of the Department will be largely responsible for program content, with portions of one course, MMG005H, delivered with assistance from Drs. Szego and Lemmens as described above.

13 Resources:

13.1 Faculty Complement

The Department of Molecular Genetics includes faculty members at the University of Toronto both on campus (~50 faculty members) and in two nearby hospitals (SickKids, Mt. Sinai; ~90 faculty members). The Department's scientists and clinician-scientists recruited to teach in this program are world leaders in the generation, interpretation, and clinical use of genetic and genomics information. Over 25 of our faculty members have been tapped to contribute to the program, allowing students to benefit from expertise in specific areas. These faculty members include several Fellows of the Royal Society of Canada, multiple Canada Research Chairs (both Tier 1 and Tier 2), and include recipients of awards for teaching and research. Their accomplishments are detailed in Appendix A.

As a major medical centre of the province of Ontario, clinicians and medical students enrolled in the program will have the opportunity to interact with patients presenting with a wide range of genetic diseases with clinical data representing the latest in genomic medicine.

Table 3: Faculty Complement (please list alphabetically)

Name	Home Department / Unit (who holds primary budgetary appointment)	University Rank	Graduate Faculty Membership Status (e.g., Associate/ Full privileges)	Commitment to other programs (please list other programs in which the person routinely teaches / supervises)	Nature of contribution to this program Course Instructor (CI)
Tenured					
Andrews, Brenda	Donnelly Centre	Professor	Full	Molecular Genetics	CI
Bader, Gary	Donnelly Centre	Associate Professor	Full	Computer Science, Molecular Genetics	CI
Blencowe, Ben	Donnelly Centre	Professor	Full	Molecular Genetics	CI
Emili, Andrew	Donnelly Centre	Professor	Full	Molecular Genetics	CI
Fraser, Andrew	Donnelly Centre	Professor	Full	Molecular Genetics	CI
Hughes, Tim	Donnelly Centre	Professor	Full	Molecular Genetics	CI
Kim, Philip	Donnelly Centre	Associate Professor	Full	Molecular Genetics, Computer Science	CI
Lemmens, Trudo	Law	Professor	Associate	Molecular Genetics	CI
Moffat, Jason	Donnelly Centre	Associate Professor	Full	Molecular Genetics	CI
Morris, Quaid	Donnelly Centre	Associate Professor	Full	Molecular Genetics Computer Science	CI
Roth, Fritz	Donnelly Centre LTRI	Associate Professor	Full	Computer Science, Molecular Genetics	CI
Zhang, Zhaolei	Donnelly Centre Molecular Genetics	Professor	Full	Computer Science	CI
Tenure-Stream					
Caudy, Amy	Donnelly Centre	Assistant Professor	Full	Molecular Genetics	CI
Non-Tenure Stream (i.e., CLTA)					
Rosebrock, Adam	Donnelly Centre	Assistant Professor		Molecular Genetics, Biochemistry	CI, Director

Name	Home Department / Unit (who holds primary budgetary appointment)	University Rank	Graduate Faculty Membership Status (e.g., Associate/ Full privileges)	Commitment to other programs (please list other programs in which the person routinely teaches / supervises)	Nature of contribution to this program Course Instructor (CI)
Status-Only					
Awadalla, Philip	Molecular Genetics OICR	Professor	Full	Molecular Genetics	CI
Cohn, Ronald	Paediatrics Hospital for Sick Children	Associate Professor	Full	Molecular Genetics Paediatrics	CI
Dirks, Peter	Surgery Hospital for Sick Children	Professor	Full	Molecular Genetics	CI
Gingras, Anne-Claude	Molecular Genetics LTRI	Professor	Full		CI
Hudson, Tom	Molecular Genetics OICR	Professor	Full	Medical Biophysics	CI
Meyn, Steve	Paediatrics Hospital for Sick Children	Professor	Full	Molecular Genetics	CI
Parkinson, John	Biochemistry Hospital for Sick Children	Professor	Full	Molecular Genetics	CI
Pearson, Christopher	Molecular Genetics Hospital for Sick Children	Associate Professor	Full		CI
Rommens, Johanna	Molecular Genetics Hospital for Sick Children	Professor	Full		CI
Scherer, Steve	Molecular Genetics Hospital for Sick Children	Professor	Full	IMS	CI

Name	Home Department / Unit (<i>who holds primary budgetary appointment</i>)	University Rank	Graduate Faculty Membership Status (<i>e.g., Associate/ Full privileges</i>)	Commitment to other programs (<i>please list other programs in which the person routinely teaches / supervises</i>)	Nature of contribution to this program <i>Course Instructor (CI)</i>
Stein, Lincoln	Molecular Genetics OICR	Professor	Full		CI
Szego, Michael	Joint Centre for Bioethics	Adjunct Professor			CI
Wilson, Michael	Molecular Genetics Hospital for Sick Children	Assistant Professor	Full		CI
Wrana, Jeff	Molecular Genetics LTRI	Professor	Full		

13.2 Learning Resources

Please see the following Appendices:

Appendix [D]: Library statement confirming the adequacy of library holdings and support for student learning

Appendix [E]: Standard statement concerning student support services

13.3 Financial Support for Graduate Students

As with all professional Masters programs at the University of Toronto, professional Masters students are not eligible for a graduate funding package. Students will be eligible for scholarships and loans typically available to professional Masters graduate students.

13.4 Space/Infrastructure

We anticipate 40 students enrolled across two academic years at steady state. The Department of Molecular Genetics has access to classrooms of appropriate size and configuration in the Medical Sciences Building. Several of these rooms can be used for both small group discussion and general lecture while others are best suited for a single purpose. Rooms have built-in projection systems, microphones, and blackboards or whiteboards. All rooms have internet

access suitable for the use of online tools for data analysis.

The Faculty of Medicine has agreed to identify and renovate a space within MSB to provide a study area for program participants. Funds for this renovation are in the approved 2017/2018 Departmental budget. This learning area would be furnished with cubicles and a group study areas. The proposed space will foster communication and enable on-campus work on team projects and team study among program participants.

The elective laboratory component of the will use Department of Teaching Laboratories in the Faculty of Medicine, which have appropriate equipment and layout to accommodate the students. Multiple laboratories are available for concurrent use, though a single room will be sufficient for the anticipated program size.

A new Program Assistant (0.5 FTE) will be recruited to administer the degree program. The assistant will be housed in existing office facilities in the Department of Molecular Genetics. The inaugural Program Director will remain in his existing office, located in the Donnelly Centre.

14 Quality and Other Indicators

The Molecular Genetics faculty members participating in the program span a range of disciplines from fundamental to clinically relevant genomics using experimental or computational methods. Students in the program will benefit from interacting with these leaders; several salient highlights follow. Drs. Ronni Cohn and Steve Meyn, Co-Directors of the SickKids' Genome Clinic, a project that is the first of its kind in Canada, are working to implement whole genome sequencing in the routine clinical care of children. Dr. Steve Scherer, director of The Centre for Applied Genomics and the McLaughlin Centre for Molecular Medicine, has been leading multiple genome sequencing efforts for mapping diseases including autism. Dr. Tom Hudson, President and Scientific Director of the Ontario Institute for Cancer Research, chairs the International Cancer Genome Consortium's Executive and Scientific Steering committees. Dr. Lincoln Stein, Director of Informatics and Bio-computing, Ontario Institute for Cancer Research (OICR), is leading the Cancer Genome Collaboratory, a \$7.3 M project to process and make available the data from the International Cancer Genome Consortium. Drs. Gary Bader and Quaid Morris are instructors in Canadian Bioinformatics Workshops and are leaders in the development of the Cytoscape application for viewing high dimensional systems biology data. Appendix F contains the CVs of the more than 25 faculty involved in the program present potential faculty for the program who are each at the frontiers of genome medicine, making discoveries and tools to better connect genetic data with patient outcomes.

15 Governance Process:

	Levels of Approval Required
Consultation with Provost	
Decanal and Provostial Sign-Off	
	Faculty/Divisional Governance
Submission to Provost's Office	
	AP&P
	Academic Board
	Executive Committee of Governing Council
<i>Program may begin advertising as long as any material includes the clear statement that "No offer of admissions will be made to the program pending final approval by the Quality Council and the Ministry of Colleges Training and University (where the latter is required)."</i>	
	Ontario Quality Council
	Submitted to MTCU (in case of new graduate degrees and programs, new diplomas)

Appendix A: Courses

Title	Description	FCEs
MMG0001Y: <i>Advanced Human Genetics</i>	This two-session course will bring all students to a common knowledge base and introduce advanced concepts including quantitative trait genetics and epigenetics. Students will learn human genetics from the perspective of phenotype / clinical presentation toward genotype in addition to a semester-long focus on molecular genetics and underlying mechanisms of human disease. This fundamental course will provide a knowledge framework for the entire program and will introduce key concepts that will be examined in detail in subsequent courses.	2.0
MMG0002H: <i>Biological Statistics</i>	The ability to effectively translate genomic test results into clinical plans and to interpret the literature of genomic medicine requires a strong foundation in advanced statistics. This course will use example-based teaching of frequentist and Bayesian statistics. Students will be taught statistical theory and be required to actively employ modern statistical methods and software in the analysis of genomic data. Students will learn how to identify the appropriate statistical methods for a given data set, apply these methods, and critically interpret these results. This course will focus on practical knowledge, with interspersed discussions of how biological statistics integrates into the larger fields of computer science, applied math, and biology.	1.0
MMG0003Y: <i>Genomics Methodologies</i>	While next-generation techniques are making headlines, many deployed clinical assays are predicated on “last-generation” molecular biology tools. We will teach the theory and practice of molecular biology relevant to genetic and genomic testing. This two-session course will consist of classic methods during the first (spring) term, followed modern and emerging methods during the summer term. The second half of the course will include a strong component of computational techniques in genomic assays, reflecting the lock-step development of new molecular biology and data-analysis techniques. Students will complete this course understanding the scientific principles underlying genomic tests, be able to examine the limitations and applications of current tests, and with the necessary background to understand new assays	2.0
MMG0004H: <i>Communication of Genetic Information</i>	This course will teach students the terminology and jargon relevant to genomic research to enable access of medical and scientific literature. In addition, we will train students to effectively and bi-directionally translate clinical information into patient-accessible language. Lectures will be complemented with group projects in which students will prepare written and oral presentations with the goal of building the skills necessary to communicate genomic information to a variety of audiences.	1.0

<p>MMG0005H: <i>Ethical and Legal Implications of Genomics</i></p>	<p>This course will explore the current social and legal landscape of human genetic analysis, with a focus on the application of genome-science on patient care. Students will explore the manifold legal and ethical implications of genomic science, including the cost and complexity of counselling patients in the face of new clinical data types. We will use a combination of lecture and project-based learning to train students on current requirements for obtaining patient consent, ethical implications and protocols for use of patients in research studies, and emerging issues reporting of incidental findings. Particular focus will be made on communication of genetic findings for patients with religious beliefs or value systems that affect clinical care.</p>	<p>1.0</p>
<p>MMG0006H: <i>Future Directions in Medical Genomics</i></p>	<p>Ongoing learning is essential in this fast-growing field. This course will train students about the available resources in genomic medicine and develop an information portal for students for continued learning. We will deliver a series of complementary lectures highlighting new techniques in allied fields such as proteomics, metabolomics, and gene expression analysis. Students will extend their understanding of genomic medicine with topics including tumour and prenatal diagnostic sequencing, molecular pathology, and learn how new assays are deployed to the clinic.</p>	<p>1.0</p>
<p>MMG007H: <i>Practicum in Patient Management and Medical Genomics</i></p>	<p>Genomic medicine is enabling a range of clinical interventions. This course will explore the current and future tools for genomics-driven patient management. Students will engage in hands-on practical exercises designed to prepare them for clinical practice from patient intake through consultation and post-testing counselling. We will focus on current best practices for patient management in Canada and the US, with units focusing on patient intake, the current and future actionability of genetic information, implications of direct-to-consumer genetic testing, and management and notification of potentially affected kin. Students will prepare and present case studies based on actual primary data from collaborating research institutes.</p>	<p>1.0</p>
<p>MMG0008H: <i>Practicum in Modern Genomics</i></p>	<p>We have developed a hands-on laboratory curriculum for teaching state-of-the-art genomics techniques. This course will be delivered as a hybrid of lecture, hands-on laboratory exercises, and extensive computer-based analysis of genomic samples. Students will be tasked with applying much of the knowledge gained throughout the preceding four terms as they generate, analyze, and follow up genomic testing data. Students will complete this course with the ability to perform a range of classic and next-generation genetic and genomic assays, and be “shovel ready” for employment in clinical or research laboratories.</p>	<p>1.0</p>

Appendix B: Graduate Calendar Copy

Medical Genomics

Master of Health Science

Overview: The professional Master's in Medical Genomics program is a fast-paced, content-dense degree program delivered over five continuous sessions. This program will provide medical trainees, research scientists, and laboratory professionals with the theory and practical knowledge necessary to incorporate theory and practical aspects of generating and analysing genomics data into research and medical practice.

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies.
- Applicants must also satisfy the Department of Molecular Genetics additional admission requirements stated below:
 - An appropriate Bachelor of Science (BSc) degree with high academic standing from a recognized university, with a B+ average or better. Applicants would normally possess an undergraduate degree displaying competence in genetics, molecular biology, or related fields.
 - OR
 - An appropriate MD degree with high academic standing from a recognized university, with a B+ average or better.
- Applicants will complete an application package including:
 - All previous university transcripts
 - Curriculum vitae (CV)
 - Statement of interest (1 to 2 pages maximum), including how this program will have an impact on future career path
 - Three letters of reference from professional, academic, or other qualified referees
- Preferred applicants will have relevant research and/or clinical experience, and who can demonstrate an immediate and substantive use of this degree in professional practice.
- Interview (30 minutes).

Program Requirements

- Within this two-year, five-session program, students must complete a total of 9.0 full-course equivalents (FCEs) as follows:
 - Year 1:
 - MMG 0001Y *Advanced Human Genetics* (2.0 FCE, Fall and Winter)
 - MMG 0002H *Biological Statistics* (1.0 FCE, Fall)

- MMG 0003Y *Genomics Methodologies* (2.0 FCE, Winter and Summer)
- Year 2:
 - MMG 0004H *Communication of Genetic Information* (1.0 FCE, Fall)
 - MMG 0005H *Ethical and Legal Implications of Genomics* (1.0 FCE, Fall)
 - MMG 0006H *Future Directions in Medical Genomics* (1.0 FCE, Winter)
 - MMG 0007H *Practicum in Patient Management and Medical Genomics* [Elective for students and trainees patient-facing medical fields] (1.0 FCE, Winter)
 - OR
 - MMG 0008H *Practicum in Modern Genomics* [Elective for students in laboratory / research science careers] (1.0 FCE, Winter)

Program Length

5 sessions full-time (F/W/S/F/W)

Time Limit

3 years

Course List

Required

MMG 0001Y	Advanced Human Genetics
MMG 0002H	Biological Statistics
MMG 0003Y	Genomics Methodologies
MMG 0004H	Communication of Genetic Information
MMG 0005H	Ethical and Legal Implications of Genomics
MMG 0006H	Future Directions in Medical Genomics

Required Elective (chose one)

MMG 0007H	Practicum in Patient Management and Medical Genomics
MMG 0008H	Practicum in Modern Genomics

Graduate Faculty

Full Members

Andrews, Brenda – PhD
Awadalla, Philip – PhD
Bader, Gary – PhD
Blencowe, Ben – PhD
Caudy, Amy – PhD
Cohn, Ronald – PhD, MD
Dirks, Peter – MD
Emili, Andrew – PhD
Fraser, Andrew – PhD
Gingras, Anne-Claude – PhD
Hudson, Tom – PhD
Hughes, Tim – PhD
Kim, Philip – PhD
Meyn, Steven – MD
Moffat, Jason – PhD
Morris, Quaid – PhD
Parkinson, John – PhD
Pearson, Christopher – PhD
Rommens, Johanna – PhD
Roth, Fritz – PhD
Scherer, Steve – PhD
Stein, Lincoln – PhD
Wilson, Michael – PhD
Wrana, Jeff – PhD
Zhang, Zhaolei – PhD

Associate Members

Lemmens, Trudo – DCL
Rosebrock, Adam – PhD
Szego, Michael - PhD

Appendix C: Library Statement

University of Toronto Libraries Report for Professional Masters in Medical Genomics, Faculty of Medicine, 2015

Context: The University of Toronto Library (UTL) system is the largest academic library in Canada and is currently ranked third among academic research libraries in North America, behind Harvard and Yale.⁴ The research and special collections, together with the campus and college libraries comprise almost 12 million print volumes, nearly 5.5 million microform volumes, more than 17,000 journal subscriptions, in addition to a rich collection of manuscripts, films, and cartographic materials. The system provides access to more than 1.5 million electronic books, journals, and primary source materials and increasingly supports access via personal handheld devices.⁵ There are numerous collection strengths in a wide range of disciplines reflecting the breadth of research and instructional programs at the University. The University of Toronto Library system has an annual acquisition budget of \$28 million. The strong collections, facilities and staff expertise attract unique donations of books and manuscripts from around the world, which in turn draw scholars for research and graduate work.

Major North American Research Libraries ⁶					
	2009-10	2010-11	2011-12	2012-2013	2013-2014
ARL RANK	UNIVERSITY	UNIVERSITY	UNIVERSITY	UNIVERSITY	UNIVERSITY
1	Harvard	Harvard	Harvard	Harvard	Harvard
2	Yale	Yale	Yale	Yale	Yale
3	Toronto (3rd)	Toronto (3rd)	Toronto (3 rd)	Toronto (3 rd)	Toronto (3 rd)
4	Columbia	Michigan	Columbia	Columbia	Columbia
5	Michigan	Columbia	Michigan	Michigan	Michigan

⁴ Chronicle of Higher Education, "Library Investment Index at University Research Libraries, 2013 – 2014." In the Almanac of Higher Education, 2015.

⁵ Figures as of 2013 taken from UTL's [2012-2013](http://oneresearch.library.utoronto.ca/sites/default/files/UTL%20Annual%20Report%202012-2013_FINAL_reduced%20size_0.pdf) Annual Report.
http://oneresearch.library.utoronto.ca/sites/default/files/UTL%20Annual%20Report%202012-2013_FINAL_reduced%20size_0.pdf

⁶ Association of Research Libraries Statistics, 2014

Top 5 Canadian Universities in the ARL Ranking of Major North American Research Libraries				
2009-10	2010-11	2011-12	2012-2013	2013-2014
RANK/ UNIVERSITY	RANK/ UNIVERSITY	RANK/UNIVERSITY	RANK/UNIVERSITY	RANK/UNIVERSITY
3/Toronto	3/Toronto	3/Toronto	3/Toronto	3/Toronto
11/Alberta	11/Alberta	10/British Columbia	18/Alberta	22/British Columbia
24/British Columbia	16/British Columbia	15/Alberta	24/British Columbia	26/Alberta
31/Montreal	32/Montreal	18/McGill	30/McGill	35/McGill
37/McGill	38/McGill	32/Montreal	35/Montreal	36/Montreal

Space and Access Services: The Library system provides a variety of individual and group study spaces for both undergraduates and graduates in the 10 central and 23 divisional libraries on the St. George, Mississauga, Scarborough and Downsview campuses. Study space and computer facilities are available twenty four hours, five days per week at one location, Robarts Library. Web-based services and electronic materials are accessible at all times from campus or remote locations, through the U of T based Scholars Portal and other leading edge digital services.

Instruction & Research Support: The Library plays an important role in the linking of teaching and research in the University. To this end, information literacy instruction is offered to assist in meeting Faculty of Medicine degree level expectations in the ability to gather, evaluate and interpret information. These services are aligned with the Association of College and Research Libraries (ACRL) Information Literacy Competency Standards for Higher Education.⁷

Program Specific Instruction: Instruction occurs at a variety of levels for Faculty of Medicine students and is provided by the faculty liaison librarians for the many departments in the Faculty of Medicine. The Gerstein Science Information Centre facilitates formal instruction integrated into the class schedule and hands-on tutorials related to course assignments. Librarians at Gerstein provide one-to-one consultations in person, by phone, email or Skype with graduate students who are conducting literature, scoping or systematic reviews for their theses. The Library, through its liaison librarians, customizes feeds of library resources. These appear prominently in Portal/Blackboard course pages. For example Undergraduate Medical Education at <http://guides.library.utoronto.ca/UME> or Evidence-Based Medicine at <http://guides.library.utoronto.ca/evidencebasedmedicine>.

⁷ Association of College & Research Libraries. *Information Literacy Standards*. ACRL, 2006.

Collections: All college and campus libraries collect materials in support of programs in the sciences and health sciences; the largest collection of materials is centrally located in the Gerstein Science Information Centre. Collections are purchased in all formats to meet the variety of preferences and styles of our current students and faculty. The University of Toronto Library is committed to collecting both print and electronic materials in support of Medical Genomics at the University of Toronto.

Journals: Journals for the degree program in the department of Medical Genomics are listed in the Journal Citation Reports (JCR)⁸ in the subject areas of Genetics and Heredity, Microbiology, Biotechnology and Applied Microbiology, and Medical Informatics. The table below summarizes what the Library subscribes to of the top 25 journals listed in the JCR and which titles are available electronically to staff and students of the University.

Subject Area	e-Journal subscriptions	Print subscriptions	Open Access
Genetics & heredity	22		3
Microbiology	23		2
Biotechnology and Applied Microbiology	21	1	3
Medical Informatics	20	2	3

Monographs: The University of Toronto Library maintains comprehensive book approval plans with 53 book dealers and vendors worldwide. These plans ensure that the Library receives academic monographs from publishers all over the world in an efficient manner. For Medical Genetics monographs are purchased in electronic form where possible. The Library currently receives all current e-books directly from the following publishers: Springer, Elsevier, Taylor & Francis, Cambridge Books Online, Karger, and Wiley.

Preservation, Digitization, and Open Access: The University of Toronto Library supports open access to scholarly communication through its institutional research repository (known as T-Space), its open journal and open conference services, and subscriptions to open access publications. In addition to acquiring materials in support of Medical Genomics, the Library is also, in cooperation with the Internet Archive, digitizing its monograph holdings published before 1923. These books are available without charge to anyone with access to the Internet through the Scholar's Portal e-Book platform.

Key Databases: The Library subscribes to major databases that support the Medical Genomics programs: Medline and Embase in the health sciences, BIOSIS Citation Index in the life sciences, and Web of Science and Scopus that index all science disciplines and the smaller but specific database Genetics Abstracts.

⁸ 2008 Journal Citation Reports® (Thomson Reuters, 2009)

Special Collection Highlight: To support program commitments in Medical Genomics the Library subscribes to a variety of online methods and protocols. E.g. Springer Protocols with titles like Developing and Evaluating Genomics- or Proteomics-Based Diagnostic Tests and Introduction to Genomics (<http://link.springer.com.myaccess.library.utoronto.ca/search?facet-content-type=Protocol>). Also, to support online and blended learning the Library subscribes to the Biomedical and Life Science collection of Henry Stewart Talks, a series of streaming lectures from world experts. The Genetics category includes 580 talks organized into 31 series like Molecular Genetics of Human Disease and The Genetic Basis of Neurological Disorders (http://hstalks.com.myaccess.library.utoronto.ca/main/index_category.php?c=252).

Prepared by:

Gail Nichol

Selector for Life and Health Sciences

September 3, 2015

Submitted by:

Larry Alford

Chief Librarian, University of Toronto Libraries

Date

Appendix D: Student Support Services

All University of Toronto undergraduate and graduate students have access to student services on all three campuses, Mississauga, St. George (downtown Toronto), and Scarborough, regardless of their 'home campus'. The services and co-curricular educational opportunities provide a complement to the formal curriculum by engaging and challenging students to reach their full potential as learners, leaders and citizens. At the University of Toronto (St. George Campus) these services are organized by Student Life Programs and Services, the academic division registrar offices, and the School of Graduate Studies, and support the success of our students from the time they are admitted through degree completion and beyond.

Students have access to comprehensive **physical and mental health care** on campus including a medical clinic, travel medicine services, immunization, contraception and sexual health education. Counselling and treatment options for psychological and emotional concerns include psychotherapy, group therapy and pharmacotherapy, as well as specialized assault counseling services.

Housing needs, including off-campus housing listings and resources for students living independently, are met through the Student Housing Service.

Coaching and education in the development of key **learning skills** – from time management to overcoming exam anxiety – is provided through the Academic Success Centre. The ASC also partners with faculty to integrate success strategies and support into the curriculum.

Students' career exploration and employment services are provided through a **Career Centre** offering resume and interview coaching, workshops, career resources, on and off-campus employment and volunteer listings, job shadowing, and career counseling.

Specialized services are provided for **international students** (orientation, advising, cross-cultural counselling), students with **disabilities** (academic accommodations, advising), students with **children or other family responsibilities** (advising, resources, subsidized child care), **aboriginal students** (academic support, financial counselling) and **lesbian, gay, bisexual and transgender** students (counselling, referrals, equity outreach and engagement).

Participation in **campus life** and **experiential learning** are facilitated through Hart House (clubs, committees, events), the Centre for Community Partnerships (service learning), the Multifaith Centre (interfaith dialogue, events), and the Office of Student Life (leadership development, orientation, recognition and support for student groups, activities.) **Sport and recreational facilities and programs** are provided to all students through both Hart House and the Faculty of Kinesiology and Physical Education.

Students will have access to on-campus departmental meeting and discussion spaces, including the InteractHome housed in the Department of Molecular Genetics, a space which provides flexible study and meeting space, a kitchenette, and provision for data presentation.

School of Graduate Studies, Student Services

All graduate students at the University of Toronto have access to registrarial services and co-curricular programs at the School of Graduate Studies that assist students in meeting their academic goals.

Administrative staff at the School of Graduate Studies (SGS) provide **registrarial** services to graduate students including but not limited to recruitment, admission, orientation, registration, fees, program progress, awards/financial assistance and graduation.

The **Grad Room** is an accessible space on the St. George campus which provides University of Toronto graduate students with a lounge area and a multi-purpose space for academic, social and professional graduate student programming.

Grad Room is home to the **Graduate Professional Skills Program (GPS)**. GPS is a non-academic program presented by SGS consisting of a variety of offerings that provide doctoral stream students a range of opportunities for professional skills development. The program focuses on skills beyond those conventionally learned within a disciplinary program, skills that may be critical to success in the wide range of careers that graduates enter, both within and outside academe. GPS aims to help students communicate effectively, plan and manage their time, be entrepreneurial, understand and apply ethical practices, and work effectively in teams and as leaders.

The Office of **English Language and Writing Support (ELWS)** provides graduate students with advanced training in academic writing and speaking. By emphasizing professional development rather than remediation, ELWS helps students cultivate the ability to diagnose and address the weaknesses in their oral and written work. ELWS offers four types of instruction designed to target the needs of both native and non-native speakers of English: non-credit courses, single-session workshops, individual writing consultations, and website resources.

Appendix E: Compendium of Curricula Vitae

Appendix F: External Review

EXTERNAL APPRAISAL REPORT | New Program Proposal

The external reviewers are asked to evaluate the standards and quality of the proposed program undergoing external review, commenting on the points below. This interactive form is based on the terms of reference and highlights the critical elements that must be considered. Please make note of any recommendations on any essential and/or desirable modifications.

Proposed Program	MHSc, Medical Genomics, Department of Molecular Genetics
Commissioning Officer	Prof. Trevor Young, Dean
External Reviewers	Prof. David Lohnes – Chair, Dept. of Cellular and Molecular Medicine, University of Ottawa Prof. Douglas Marchuk – Vice Chair, Dept. of Molecular Genetics and Microbiology, Duke University
Date of Appraisal Visit	December 12, 2016

EXTERNAL APPRAISAL SUMMARY *(Please provide a summary of your findings)*

The impact of genomics in medical practice is increasing at an exponential pace, and yet, currently there is a dearth of trained professionals capable of interpreting the vast genomics data available on patients, and then clearly translating this information in layman's terms, whether the recipient is a patient or a non-scientist dealing with administrative or business issues. The MHSc in Medical Genomics program is poised to fill this significant void with professionals that are trained in these very skills. The Molecular Genetics faculty of the University of Toronto is uniquely qualified to lead Canada in this emerging area. The objectives of the program are very clear, and completely consistent with the educational mandate of the University and the Department of Molecular Genetics. The admission requirements are clearly spelled out and it is anticipated that as the program grows in stature, it will compete for the very best students from across Canada. The program is highly structured in order to ensure that every graduate possesses all the varied skills required of a professional in this area. The courses are well aligned with the objectives and plans to modify the content of the courses with input from stakeholders and graduates of the program will allow the curriculum to adapt in response to the rapid evolution of this emerging area of medicine. The mode of delivery is appropriate and the practicum in the final year will provide valuable hands-on experience. The heterogeneous composition of the cohort (e.g. BSc, MD, MSc backgrounds) offers an important value-added learning environment, with interactions between students with such diverse backgrounds anticipated to enhance the educational experience. Resources requested are appropriate and the will benefit from the addition of a common room for the students to conduct group-based work; this common room should also be equipped with an adequate number of workstations. Means for ongoing learning, such as on line portals and self-directed learning, were articulated. These are appropriate means for keeping graduates current in this fast-paced area. A clear strength of the proposal rests in the outstanding quality of the faculty to be engaged in the delivery of the curriculum. Important to the success of this program is the appointment of a Director. Such an individual should, ideally, have the relevant academic background as well as the requisite time to develop, and contribute to, the curriculum. There are a number of qualified individuals currently holding appointments to the Department. Alternatively, this may offer an opportunity to recruit new talent to the Department. Finally, the reviewers were most impressed with the energy and vision of the Department Chair, Dr. Leah Cowen, and the Associate Chair and Graduate Coordinator, Dr. Julie Claycomb. The program will be successful in large part due to their considerable talents and efforts.

1. OBJECTIVES

- ***consistency of the program with the University's mission, and Faculty's and Department's academic plan***
- ***clarity and appropriateness of the program's requirements and associated learning outcomes in addressing the academic division's graduate Degree Level Expectations***
- ***appropriateness of the degree or diploma nomenclature***
- The MHSc in Medical Genomics is completely consistent with the University of Toronto mission to meet the practical training of students in an emerging and critical area of health care.
- As the leading institution in Canada in the field of Molecular Genetics, University of Toronto is uniquely situated to provide this training for the entire nation (and beyond). UT may be the only University in Canada capable of successfully establishing this critical program.
- The Department has made a commitment to increase training in the area of human genetics/genomics, and this professional Masters degree is perfectly aligned with that commitment.
- All requirements are clearly spelled out and are appropriate for the needs of the students.
- Similarly, the learning outcomes are clear and appropriate.
- The engagement with diverse stakeholders, especially leaders in this field who will become the future employers of the students, is a brilliant idea to continue to fine-tune the program requirements and learning outcomes.
- The MHSc is the correct and entirely appropriate degree for this program. As a research degree, the PhD would be focused on the wrong skill set, require too many years of training, and thus would be inappropriate.

EXTERNAL APPRAISAL REPORT | New Program Proposal

2. ADMISSION REQUIREMENTS

- ***appropriateness of the program's admission requirements to the learning outcomes of the program***
- ***appropriateness of any alternative requirements for admission into the program such as minimum grade point average or additional languages or portfolios, along with how the program recognizes prior work or learning experience***
- The requirements at the BSc level are appropriate.
- The pre-requisite course requirements in biology and chemistry disciplines are appropriate and will ensure that classes can be taught at the correct level without the need for remedial courses.
- The computer programming skills of the entering students will necessarily vary (in some cases, widely) from student to student. It would be inappropriate to require in advance such training for admission, as doing so would exclude admission to otherwise highly qualified and motivated students with the BSc degree in the biological sciences. The plan to instead provide computer programming training as part of the program curriculum makes the most sense, as articulated to the reviewers during the site visit.
- The minimal grade point average is entirely appropriate. Indeed, as the program gains in stature, it might become a highly competitive program that will be able to admit only the very best of students.
- The plan for recognizing prior work and learning experiences (such as prior clinical experience) is also appropriate.

3. STRUCTURE

- ***appropriateness of the program's structure and regulations to meet specified program learning outcomes and Degree Level Expectations***
- ***rationale for program length in order to ensure that the program requirements can be reasonably completed within the proposed time period***
- The program is highly structured with the curriculum of each year clearly laid out.
- The number of courses is appropriate for a professional degree.
- The course requirements match the learning outcomes and expectations of the degree. As stated earlier, these requirements may change as the professional needs evolve.
- The length of the program appears sound, especially for those students entering with a BSc. This fits the expectations of such students.
- The plan to include medical students or physicians was thought to be innovative and have the potential to greatly enhance the program by providing a different viewpoint for course projects, etc.
- To reiterate, including students coming from the BSc and the M.D. paths is considered one of the best and most innovative parts of the program.
- This innovation listed above necessarily creates some logical issues- issues that are well worth trying to resolve. The main issue is that it is unclear to the reviewers whether students entering the program while still in medical school, or already having finished and now in residency or advanced training, would prefer an accelerated program (less than 2 years).
- This issue was discussed at length during the site visit and Deans Kaplan and Young thought a half-year to possibly a year could be shaved off of the program for medical students in the MHSc Medical Genomics program while concurrently in Medical School. If possible, we anticipate this program would become very popular.

4. PROGRAM CONTENT

- ***ways in which the curriculum address the current state of the discipline or area of study***
- ***identification of any unique curriculum or program innovations or creative components and their appropriateness***
- ***clarity of the nature and suitability of the major research requirements for degree completion***
- ***evidence that each graduate student in the program is required to take all of the course requirements from among graduate level courses***
- Each of the courses is clearly articulated and represents the state of the art in medical genomics.
- The content of each course can be modified in subsequent years to meet the needs of the students as the field of medical genomics evolves.
- Such evolution of course content is necessary in an emerging and rapidly changing field such as medical genomics. Thus, it is no criticism of the program to point out the need of such evolution. Indeed, a strength of this training plan is that the even before day one, the authors realize the need for this evolution to occur.
- Since the MHSc degree is not (and should not be) a research degree there are no research requirements.
- The practicum in the second year is a critical component of the program and arguable represents the best part of the program training. In this regard, the practicum substitutes for the research requirement.
- The course requirements for the entire program are clearly laid out. The program coursework is (nearly) invariant, providing consistent training for all of the students. For such a professional degree, uniformity of training is appropriate and even absolutely essential for the success its students as they enter the workforce.

EXTERNAL APPRAISAL REPORT | New Program Proposal

5. MODE OF DELIVERY

- ***appropriateness of the proposed mode(s) of delivery—distance learning, compressed part-time, online, mixed-mode or non-standard forms of delivery, flex-time options—to meet the intended program learning outcomes and Degree Level Expectations***
- This course-based curriculum offers an appropriate mode of delivery and a defined time line for completion which is desirable for a Professional degree such as offered thorough this program.
- The application of blended-learning approaches through classroom instruction and student-directed (e.g. web-based portals and other online resources; group projects) is an excellent means of instruction. This is especially true given that online applications are commonly used in genomics/genetics, and this aspect of the curriculum is a judicious means to develop this important skill set.
- The use of ‘just-in-time’ cumulative instruction is an appropriate and logical pathway to objectives of the program. This is especially important given the anticipated diverse background of the learners.
- The heterogeneous composition of the cohort (e.g. BSc, MD, MSc backgrounds) offers an important value-added learning environment, with interactions between students with such diverse backgrounds anticipated to enhance the learning experience.
- Such interactions should be encouraged at every opportunity throughout the program by, for e.g., small group problem-based learning modules, co-presentations and other group-based activities.
- The final practicum offers an excellent modality for learning, entirely appropriate for the degree. Under future iterations of the program, it may be beneficial to expand this to other experiential learning opportunities. In an ideal situation, such experiential learning could occur in collaboration with relevant partners in the community, including potential future employers.
- As the program evolves, it may be beneficial to explore opportunities to offer greater flexibility to the curriculum in order to maximize opportunities to MD-stream students.
- An ongoing learning portal, as well as self-directed learning, was proposed for continuing professional development genetics. These are appropriate means for keeping graduates current in this fast-paced area.

6. ASSESSMENT OF TEACHING AND LEARNING

- ***appropriateness of the proposed methods for the assessment of student achievement of the intended program learning outcomes and Degree Level Expectations***
- ***completeness of plans for documenting and demonstrating the level of performance of students, consistent with the academic division’s statement of its Degree Level Expectations***
- Student achievement will be assessed through examinations and quizzes, written projects and evaluation of oral presentations. This is an appropriate means to monitor student achievement. The incorporation of oral presentations is especially important, as verbal communication skills are an essential part of the requisite skill set in the profession.
- In addition to letter grades for coursework, students will also receive midterm written evaluations. The latter should offer a more in-depth feedback of performance. While not articulated, this could be coupled with individual meetings to discuss progress and to provide additional feedback.
- The plans for documentation and demonstration of student performance are clearly articulated. Each domain (depth and breadth of knowledge; research and scholarship; application of knowledge; professional capacity/autonomy; and communication skills) has clearly laid out areas (and modes) for evaluation. These performance criteria are directly relevant to the degree, and are concordant with Degree Level Expectations for the Department of Molecular Genetics.
- Plans for tracking the success of graduates is noted through surveys of graduates as well as their employers. This is an essential component to ensure that the Program is delivering on expectations for this Profession.
- Curriculum oversight by a Steering Committee, which will include two knowledge users, provides an additional means for adapting to changes in the field. This includes any future needs for certification of graduates.

7. RESOURCES

- ***adequacy of the administrative Department’s planned utilization of existing human, physical and financial resources, and any institutional commitment to supplement those resources to support the program***
- ***participation of a sufficient number and quality of faculty who are competent to teach and/or supervise in the program***
- ***adequacy of resources to sustain the quality of scholarship and research activities of graduate students, including library support, information technology support, and laboratory access***
- ***recent research or professional/clinical expertise of faculty to sustain the program, promote innovation and foster an appropriate intellectual climate***
- ***sufficiency of financial assistance for students to ensure adequate quality and numbers of students***
- ***supervisory load distribution and the qualifications and appointment status of supervisors***
- Adequate space for class-based instruction currently exists. This will be augmented with a projected addition of a common room for the students to conduct group-based work. Assuming a steady-state cohort of 40 students, this common room should also be equipped with an adequate number of workstations.

EXTERNAL APPRAISAL REPORT | New Program Proposal

- Recruitment of a 0.5 full time administrative support staff is noted. Due to the unique nature of the proposed program, and the work required to initiate it, this position will be important, and is clearly justified.
- Equally important to the success of this program is the appointment of a Director. Such an individual should, ideally, have the relevant academic background as well as the requisite time to develop, and contribute to, the curriculum. There are a number of qualified individuals currently holding appointments to the Department. Alternatively, this may offer an opportunity to recruit new talent to the Department.
- The Faculty who have been noted as potential contributors to the program are remarkable both in terms of quantity and especially quality. There is a most impressive breadth of relevant expertise from world-class leaders ranging from bioinformatics and genetics to ethics. As regards the latter, appropriate collaborations have been forged with the Faculty of Law and Faculty of Public Health.
- Adequate support is articulated on other fronts. The University of Toronto boasts a world-class library, and is positioned to provide relevant support for this program, including on-line access to contemporary publications. Access to relevant bioinformatics and other tools will also be provided. Adequate and appropriate laboratory space is currently available.
- As a professional degree, MHSc students are not eligible for grant funding. Support will be available in the form of scholarships and loans appropriate for this degree type.
- As a course-based program, there is no consideration needed for supervisory loads or related matters.

8. QUALITY AND OTHER INDICATORS

- ***quality of the faculty (e.g., qualifications, research, innovation and scholarly record; appropriateness of collective faculty expertise to contribute substantively to the proposed program)***
- ***program structure and faculty research that will ensure the intellectual quality of the student experience***
- As noted above, a clear strength of the proposal rests in the outstanding quality of the faculty to be engaged in the delivery of the program.
- Many of the Faculty are International leaders in their respective field, with appropriate expertise ranging from clinical genetics/genomics to bioinformatics and computation to ethics.
- The collective Faculty members to be engaged in this program ensure an outstanding student experience of the high intellectual quality.

Appendix G: Dean's Response to External Appraisal Report



February 21, 2017

Prof. Sioban Nelson
Vice-Provost, Academic Programs
University of Toronto
Simcoe Hall
27 King's College Circle, Room 225
Toronto, ON M5S 1A1

Dear Professor Nelson,

**Re: External Appraisal Report
New Program Proposal - MHSc Program for Medical Genomics**

On behalf of the Faculty of Medicine, University of Toronto, I would like to thank Professor David Lohnes Chair, Dept. of Cellular and Molecular Medicine, University of Ottawa, and Professor Douglas Marchuk, Vice Chair, Dept. of Molecular Genetics and Microbiology, Duke University, for their thorough expert in- depth analysis of the proposal and for their excellent report. I would also like to thank the administrative staff of the Department of Molecular Genetics and all those who contributed to the preparation of the comprehensive new program proposal. I also extend many thanks to all the faculty members and students who met with the external reviewers. Your input was invaluable for this review.

The Faculty of Medicine and the Vice Dean, Graduate and Academic Affairs fully support the proposal for a new Professional Master's degree in Medical Genomics. We are very pleased to see that the two external appraisers are also highly supportive of this new program. They state in their review: "The impact of genomics in medical practice is increasing at an exponential pace, and yet, currently there is a dearth of trained professionals capable of interpreting the vast genomics data available on patients, and then clearly translating this information in layman's terms, whether the recipient is a patient or a non-scientist dealing with administrative or business issues. The MHSc in Medical Genomics program is poised to fill this significant void with professionals that are trained in these very skills. The Molecular Genetics faculty of the University of Toronto is uniquely qualified to lead Canada in this emerging area."

The following highlights the key findings of the appraisers that represent challenges and opportunities for this new Program.

1. Admission Requirements

In response to the fact that computer programming skills of entering students will vary considerably, the reviewers endorse the plan not to require training in this area for admission. Instead the Program will provide computer programming training as part of the program curriculum. Competency in foundational computer programming skills to enable analysis of genomic data will be provided in part through course work and in part through the practicum. Programming skills will be developed in multiple courses including Biological Statistics, Advanced Human Genetics, and Genomics Methodologies. Students will further develop programming skills through participation in a capstone

practicum during the final academic term of the program, with unique course work focused on patient interaction and laboratory data generation and analysis. The Department of Molecular Genetics has phenomenal strengths in bioinformatics and computer programming with world-class faculty, and multiple related graduate programs. The Quantitative Biology in Molecular Genetics track provides quantitative scientists who have backgrounds in physics, computer science and math, with a foundation in modern biology and mentors them towards leadership in cutting-edge interdisciplinary research. The Computational Biology in Molecular Genetics track provides biologists with an immersive curriculum towards leadership in the new discipline of computational molecular genetics. The expertise and training environment for computer programming in Molecular Genetics is outstanding and will support this new program.

2. Program Structure/ Recruitment and Length of the Program

The reviewers state that including students coming from the BSc and the MD paths is considered one of the best and most innovative parts of the program. This innovation necessarily creates some logistical issues - issues that are well worth trying to resolve. The main issue is that it is unclear to the reviewers whether students entering the program while still in medical school, or already having finished and now in residency or advanced training, would prefer an accelerated program (less than 2 years). The reviewers felt it would be worthwhile to shorten the length of the Program for students enrolled in the undergraduate medical program and that this would make the program extremely popular with medical students. The program has not been designed currently to be completed while students are also in another degree program (i.e. undergraduate medical program). This is currently being presented as a full time program and at this point there are no immediate plans to create different pathways. Plans for alternate pathways may be considered in the future after the core program has been in place for a few years.

3. Program Content

This is a research informed program; however, the reviewers recognize that the MSc is not a research degree. They emphasize that the practicum component in the second year is a critical component of the program.

The Practicum in Modern Genomics includes hands-on laboratory exercises in which students generate and analyze genome-scale sequencing data, and will be delivered in the teaching lab facilities in the Faculty of Medicine Division of Teaching Labs. The Practicum will augment lecture-based course delivery, and will provide rigorous training in research techniques that are foundational to medical genomics. Students will also be exposed to cutting-edge research in the area of medical genomics through their courses. Courses will leverage important research papers and advances to illustrate current technologies and approaches for data analysis.

4. Mode of Delivery

The reviewers recommend expanding the experiential components of the curriculum, including in the community and with future employees. There are exciting opportunities in this area that would add value for the Practicum. Molecular Genetics has strong relationships with hospital partners and with the public and private sector through faculty members and the alumni community. The current Molecular Genetics MSc in Genetic Counselling provides an avenue for developing opportunities for experiential components of the curriculum in the clinical space, and alumni from the diverse Molecular Genetics programs provide key connections to build additional opportunities for experiential components with future employees.

5. Assessment of Teaching and Learning

The reviewers recommend in depth feedback of performance for midterm evaluations, including individual meetings to discuss progress and provide feedback. We will incorporate individual meetings as part of the midterm evaluation. In addition, program coursework will include a variety of assessment modalities in which students are required to demonstrate acquired knowledge and apply these concepts to both theoretical and practical problems in medical genomics. The program is designed to be cumulative; successful completion of assignments in later courses will require the application of knowledge and methods learned in earlier courses. Student performance will be quantified through a variety of mechanisms including written quizzes and examinations, oral presentations, and written projects (e.g. case reports). Students will receive a letter grade for each course in addition to a written mid-term performance evaluation. An individual mid-term meeting with the Program Director associated with the performance evaluation will promote effective learning and maximize the educational experience for students.

6. Resources

The reviewers refer to the projected addition of a common room for students to conduct group-based work. The Faculty of Medicine anticipates that this space would be in the Medical Sciences Building, which is the academic home of Molecular Genetics. A review of space allocation for the Medical Sciences Building is currently underway. Funds are committed in the Molecular Genetics budget to support the renovations. The reviewers refer to the recruitment of a .5 FTE administrator and the appointment of a Director. Necessary approvals are already in place to initiate the search for a Teaching Stream Assistant Professor to serve as Program Director, and this is expected to move forward in March 2017. Recruitment of the .5 FTE administrator is expected to occur during the summer of 2018, prior to the launch of the MHSc program in the fall.

Summary

This external review was highly favorable. The review has been very helpful in identifying and discussing the strengths of the new program proposal and ways to improve it. Several of the reviewers' suggestions have been incorporated into the proposal. The Faculty of Medicine will continue to work with the Department of Molecular Genetics to establish this innovative and important new graduate program.

Sincerely,



Trevor Young

cc. Allan Kaplan, Vice Dean, Graduate & Academic Affairs, Faculty of Medicine
Daniella Mallinick, Director, Academic Programs, Planning and Quality Assurance
Cora McCloy, Acting Coordinator, Academic Planning and Reviews
Anastasia Meletopoulos, Academic Affairs Specialist, Office of the Dean

Appendix H: Vice-Provost Response



February 9, 2017

Trevor Young
Dean, Faculty of Medicine and
Vice Provost, Relations with Health Care Institutions
Faculty of Medicine
University of Toronto

Re: Appraisal Report, Proposed new Master of Health Sciences in Medical Genomics

Dear Trevor,

I am very pleased to receive the appraisal of the proposed Master of Health Sciences in Medical Genomics. Your administrative response provides an excellent summary of the appraisal report and highlights the specific suggestions made by the reviewers.

In response to the report's suggestion that an accelerated path be created for students with a medical degree, you indicate alternative pathways in the program may be considered in the future, after the program has been in place for a few years and there has been adequate time to assess the demand. The report praises the practicum as a critical component of the program and suggests in the future it could expand its experiential opportunities. You agree with the appraisers' suggestion and indicate how pursuing this might be accomplished. The report recommended that the mid-term written evaluations of students include in-depth feedback of performance, and the program organize individual meetings to discuss progress. I note that the program will incorporate this suggestion. In terms of resources, the appraisal report emphasizes that the appointment of a director is critical to the program's success and your response confirms that a search for a program director will likely begin in March 2017.

The reviewers were very impressed with the program proposal and stated the program is positioned to fulfill a significant void in this emerging area. I will be very pleased to recommend this new professional master's program to governance for approval, following approval at the divisional level.

Sincerely,

Sioban Nelson
Vice-Provost, Academic Programs

cc.

Amy Lee, Executive Secretary to the Dean, Faculty of Medicine
Allan Kaplan, Vice Dean, Graduate and Academic Affairs, Faculty of Medicine

Anastasia Meletopoulos, Academic Affairs Specialist, Faculty of Medicine

Rachel Zulla, Graduate Affairs Officer, Faculty of Medicine

Daniella Mallinick, Director, Academic Programs, Planning and Quality Assurance, Office of the Vice-Provost, Academic Programs

Jennifer Francisco, Coordinator, Academic Change, Office of the Vice-Provost, Academic Programs

Locke Rowe, Dean, Graduate Studies and Vice-Provost, Graduate Research and Education, School of Graduate Studies

Elizabeth Smyth, Vice Dean, Programs, School of Graduate Studies



UNIVERSITY OF TORONTO FACULTY OF MEDICINE

FOR APPROVAL

TO: Education Committee

SPONSOR: Allan Kaplan, Vice-Dean, Graduate and Academic Affairs

CONTACT INFO: Rachel Zulla, Graduate Affairs Officer; 416-946-0412; rachel.zulla@utoronto.ca

DATE: April 24, 2017

AGENDA ITEM: 6.1

ITEM OF BUSINESS: Significant Modifications to Existing Graduate Programs

JURISDICTIONAL INFORMATION:

The University of Toronto Quality Assurance Process dictates that significant modifications to existing graduate and undergraduate programs constitutes a major modification and requires the approval of divisional governance. The By-laws of the Faculty of Medicine Faculty Council dictate that major modifications to graduate programs are to be approved by the Education Committee and Faculty Council.

GOVERNANCE PATH:

1. Education Committee [For recommendation to Faculty Council] – March 9, 2017
2. Faculty Council [For approval] – April 24, 2017

CONSULTATIVE PATH:

The proposal has been seen and approved by the following committees at the Faculty of Medicine

- GLSE Graduate Curriculum Committee, February 15, 2017

HIGHLIGHTS:

The Department of Medical Biophysics is proposing to implement a modified curriculum for physics and biology stream students starting in September 2017. The modified curriculum will be structured in terms of modules, based on but also extending the existing courses, that are 0.25 credits each, so that students will have greater flexibility to mix-and-match modules between the streams to meet their training goals.

PROPOSED MOTION:

“THAT the physics and biology streams in the MSc and PhD curriculum in the Department of Medical Biophysics be modified as submitted effective September 2017.”

University of Toronto

Major Modification Proposal: Significant Modifications to Existing Graduate and Undergraduate Programs

This template should be used to bring forward all proposals for major modifications to existing graduate and undergraduate programs for governance approval under the University of Toronto's Quality Assurance Process.

Program being modified: <i>(Please specify exactly what program and which components of that are being modified, E.g., BA ... Specialist, Major, and Minor components.)</i>	MSc in Medical Biophysics; PhD in Medical Biophysics
Proposed Major Modification:	Implementation of modular curriculum; Reduction in credit requirements
Department / Unit (if applicable):	Medical Biophysics
Faculty / Academic Division:	Medicine
Dean's Office contact:	Rachel Zulla
Proponent:	Peter N. Burns (Chair)
Version Date: <i>(please change as you edit proposal)</i>	March 6, 2017

1 Summary

Please provide a brief summary of the change(s) being proposed as it relates to the current structure of the program

The Department of Medical Biophysics is proposing to implement a modified curriculum for physics and biology stream students starting in September 2017. The modified curriculum will be structured in terms of modules, based on but also extending the existing courses, that are 0.25 credits each, so that students will have greater flexibility to mix-and-match modules between the streams to meet their training goals.

The total degree credit requirements will also be reduced for the MSc and PhD and harmonized between the two streams. A total of 6 modules (1.5 FCE) plus the seminar course (1.0 FCE) is required for the MSc (2.5 FCE) and an additional 4 modules (1.0 FCE) are required for the PhD (3.5 FCE). A highlight of the modified curriculum is that the program will begin with two

mandatory modules taken jointly by students in the biology and physics streams, addressing scientific exposition, ethics and statistical methodology.

In practice, a student will take the required seminar course and two required modules plus 4 elective modules for MSc. To have a flavour of how this new curriculum will work, an example of module selections for a hypothetical biology and hypothetical physics stream MSc student follows:

<i>Year</i>	<i>Biology Stream</i>	<i>Physics Stream</i>	<i>type</i>	<i>FCE</i>
<i>all</i>	<i>MBP 1015Y Biophysics Seminar</i>		<i>required</i>	<i>1.0</i>
<i>1</i>	<i>Scientific Exposition & Ethics</i>		<i>required</i>	<i>0.25</i>
<i>1</i>	<i>Biostatistics</i>		<i>required</i>	<i>0.25</i>
<i>1</i>	<i>Cell Biology & Cancer</i>	<i>Overview of Medical Imaging</i>	<i>elective</i>	<i>0.25</i>
<i>1</i>	<i>Cell Signaling & Metabolism</i>	<i>Cell biology for Physicists – Introduction</i>	<i>elective</i>	<i>0.25</i>
<i>2</i>	<i>Development, Stem Cells and Cancer</i>	<i>Ultrasound – Overview</i>	<i>elective</i>	<i>0.25</i>
<i>2</i>	<i>Tumour Micoenvironment</i>	<i>Magnetic resonance imaging – Overview</i>	<i>elective</i>	<i>0.25</i>
				<i>2.5 MSc</i>

A PhD student will take the required seminar course and two required modules plus 8 elective modules (4 of which may have been completed during MSc, if MSc Medical Biophysics student). Here is an example of module selections for a hypothetical biology and hypothetical physics stream PhD student:

<i>Year</i>	<i>Biology Stream</i>	<i>Physics Stream</i>	<i>type</i>	<i>FCE</i>
<i>all</i>	<i>MBP 1015Y Biophysics Seminar</i>		<i>required</i>	<i>1.0</i>
<i>1</i>	<i>Scientific Exposition & Ethics</i>		<i>required</i>	<i>0.25</i>
<i>1</i>	<i>Biostatistics</i>		<i>required</i>	<i>0.25</i>
<i>1</i>	<i>Cell Biology & Cancer</i>	<i>Overview of Medical Imaging</i>	<i>elective</i>	<i>0.25</i>
<i>1</i>	<i>Cell Signaling & Metabolism</i>	<i>Cell biology for Physicists – Introduction</i>	<i>elective</i>	<i>0.25</i>

2	<i>Development, Stem Cells and Cancer</i>	<i>Ultrasound – Overview</i>	<i>elective</i>	<i>0.25</i>
2	<i>Tumour Micoenvironment</i>	<i>Magnetic resonance imaging – Overview</i>	<i>elective</i>	<i>0.25</i>
2	<i>Biological Imaging</i>	<i>Clinical Imaging</i>	<i>elective</i>	<i>0.25</i>
2	<i>Cancer Immunotherapy</i>	<i>Radiation Biology & DNA Repair</i>	<i>elective</i>	<i>0.25</i>
2 or 3	<i>Radiation Biology & DNA Repair</i>	<i>Biophysical interactions of light with tissue</i>	<i>elective</i>	<i>0.25</i>
2 or 3	<i>Predictive Oncology & Therapeutics</i>	<i>Biophysics of focused ultrasound, thermal biophysics</i>	<i>elective</i>	<i>0.25</i>
				<i>3.5 PhD</i>

2 Effective Date

September 2017

3 Academic Rationale

What are the academic reasons for the change proposed and how do they fit with the unit’s and Division’s academic plans

This curriculum renewal responds to specific recommendations made in the 2012 Departmental Review, and is designed to provide greater choice and flexibility of curricular structure in this mutli-disciplinary department. As the breadth of the research enterprise in MBP expands, from cancer biology to neuroscience, and from engineering and materials science to epigenetic and computational biology, so the diversity of our student intake has increased. It has become clear that the somewhat rigid structure of our two-stream curriculum was no longer providing the combination of basic and sub-specialty training required of our faculty. In the proposed modular curriculum, students will have greater flexibility to choose a learning path that supports the educational goals of their degree. At the same time, the overall course credit requirements will be reduced to bring the Department into line with cognate basic science departments in the Faculty of Medicine. We anticipate that this will aid in recruitment, lead to shorter time to completion, and allow students to focus more on the thesis research component on their degree. The plan was presented in our self study for MBP’s 2016 review. The 2016 external reviewers wrote: “Program enhancements associated with this revision include: i) modernization of courses, ii) design of a

modular structure that offers more flexibility for students both within and between the Biology and Physics streams, iii) distribution of the responsibility for course delivery to more faculty, which has also lowered the demands on individual faculty, and iv) harmonization of course weighting with the Molecular Genetics Graduate Program that presents opportunities for educational exchange between programs. While implementation of these changes is ongoing, the changes were viewed very favorably by students, faculty in the program, and by this review committee.”

4 Description of the Proposed Major Modification(s)

- *Please describe in detail what changes are being proposed. Major modifications include changes to the program requirements that will significantly change what students will know and be able to do when they complete the program.*
- *Please be explicit about how the learning outcomes have changed and include either the both previous and proposed learning outcomes or one version of the current LOs with the new LO in track changes. You may wish to use Appendices A and B.*
- *Please provide Calendar copy either in track changes or as two separate documents in appendices C and D as applicable.¹*

Proposed curriculum for the Department of Medical Biophysics at the University of Toronto

Executive Summary

The Department of Medical Biophysics is proposing to implement a new curriculum for physics and biology stream students starting in September 2017. The new curriculum will be structured in terms of modules that are 0.25 FCE each, so that students will have greater flexibility to mix-and-match modules between the streams to meet their training goals.

MBP has two entry streams: ‘Physics’ for students with a background in physical sciences (including engineering, maths, computer science, etc) and ‘Biology’ (including chemistry, biochemistry, life sciences, etc). The total credit requirements will be reduced for the MSc and PhD and harmonized between the two streams. A total of 6 modules (1.5 FCE) plus the seminar course (1 FCE) are needed for the MSc and an addition 4 modules (1 FCE) are needed for the PhD.

As the existing course structure is based on units of 0.5 FCE, students will take groups of two modules for each course half-credit. Thus the proposed course MPB1101H (Modules in Medical Biophysics I) will comprise two elective modules. A highlight of the new curriculum is that the program will begin with two required modules taken jointly by students in the biology and physics streams (Scientific Exposition and Ethics; Biostatistics). While these modules will be offered each year, other advanced modules will only be offered every other year. The calendar of

¹ Other major modifications that may be included are significant changes to admissions requirements, significant changes to faculty engaged in program and; a change to mode of delivery, change to the language of the program and offering the program at another location or institution.

modules offered for the next two years will be published by the department every September.

To summarize, the new curriculum will consist of the required seminar course and two required modules plus 4 elective modules for MSc, and an additional 4 elective modules for PhD. To have a flavour of how this new curriculum will work, an example of module selections is shown below.

Year	Biology Stream	Physics Stream	type	FCE
all	MBP 1015Y Biophysics Seminar		required	1.0
1	Scientific Exposition & Ethics		required	0.25
1	Biostatistics		required	0.25
1	Cell Biology & Cancer Models	Overview of Medical Imaging	elective	0.25
1	Cell Signaling & Metabolism	Cell biology for Physicists – Introduction	elective	0.25
2	Development, Stem Cells and Cancer	<i>Ultrasound – Overview</i>	elective	0.25
2	Tumour Microenvironment	<i>Magnetic resonance imaging – Overview</i>	elective	0.25
2	Biological Imaging	<i>Clinical Imaging for Physical Scientists</i>	elective	0.25 (PhD)
2	Cancer Immunotherapy	<i>Radiation Biology & DNA Repair</i>	elective	0.25 (PhD)
2 or 3	Radiation Biology & DNA Repair	<i>Biophysical interactions of light with tissue</i>	elective	0.25 (PhD)
2 or 3	Predictive Oncology & Therapeutics	<i>Biophysics of focused ultrasound, thermal biophysics</i>	elective	0.25 (PhD)
				2.5 (3.5 PhD)

Background

Current biology stream curriculum

The biology stream curriculum as presently offered is summarized briefly. The following courses are required for the MSc (3.5 credits total):

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)
- MBP 1007Y Fundamentals in Molecular and Cell Biology I and II (two terms taken in first year)
- MBP 1010H Quantitative Biology - Statistical Methods (one term taken in first year)
- MBP 1018Y Oncology (one term taken in second year)

Requirements for the PhD comprise all of the requirements of the MSc plus one more 1.0 credit course selected from (4.5 credits total):

- MBP 1001Y Advanced Cell Biology (two terms taken after enrollment or reclassification in the PhD program)

A graduate level course from another department may be chosen in consultation with the student's advisory committee and approved by the stream coordinator or department chair

Current physics stream curriculum

The physics stream curriculum as presently offered is summarized briefly. The following courses are required for the MSc (3.5 credits total):

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)

- MBP 1022H Cell Biology for Physical Scientists (one term taken in 1st year)
- MBP 1024Y Advanced Medical Imaging (two terms taken in 1st year)
- MBP 1028H Optical, Thermal and Radiation Biophysics (one term taken in 1st year)
- MBP 1026H Clinical Imaging for Physical Scientists (one term taken in 2nd year)

Requirements for the PhD are all of the requirements of the MSc plus one more 0.5 credit course selected from (4.0 credits total):

- MBP 1027H Magnetic Resonance Imaging
- MBP 1023H Clinical Radiation Physics and Dosimetry

A graduate level course from another department may be chosen in consultation with the student's advisory committee and approved by the stream coordinator or department chair

Proposed curriculum

The curriculum will be structured as course modules and full length courses. A course module is 7 weeks in duration and will typically have one 2-hour lecture per week for 6 consecutive weeks. Some modules will also include a written exam (in week 7), seminar presentation, or a lab. For comparison, MBP1024Y Advanced Imaging as presently offered has 23 2-hour lectures, 3 labs and 2 exams.

Students will need to fulfill either the physics stream or biology stream course requirements as described below.

Requirements for new students starting in September 2017

Requirements for MSc starting in September 2017 (biology stream):

MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)

6 modules selected as follows:

- *Biostatistics* is required.
- *Scientific Exposition & Ethics* is required.
- Choose one biology stream course module (see Appendix I)
- Choose the balance from: MBP physics or biology stream course modules; or department approved graduate courses in another department (0.5 FCE = 2 modules).

Requirements for MSc starting in September 2017 (physics stream):

MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)

6 modules selected as follows:

- *Biostatistics* is required.
- *Scientific Exposition & Ethics* is required.
- Choose either *Cell & molecular biology for Physicists – Introduction* (see Appendix II); or one biology stream course module (see Appendix I); or a 0.5 or 1 FCE graduate course chosen in consultation with the department that provides a foundation in biology. One such substitute is *JNR1444Y - Fundamentals of Neuroscience: Cellular and Molecular* (see course alternates section below).
- Choose the balance from: MBP physics or biology stream course modules; or department approved graduate courses in another department (0.5 FCE = 2

modules).

Requirements for PhD starting from MSc or PhD in September 2017 (biology and physics streams):

Requirements for the PhD are all of the requirements of the MSc plus the equivalent of 4 modules selected from the following:

MBP biology or physics stream course modules

Department approved graduate courses in another department (0.5 FCE = 2 modules).

5 Impact of the Change on Students

*Outline the expected impact on continuing students, if any, and how they will be accommodated
Please detail any consultation with students*

Continuing students will be required to complete the course requirements set out in the student handbook in the year in which they entered the program. This will mean that existing students will need to complete the number of credits required for the old curriculum. In cases where a required course is no longer offered, we have identified equivalent sets of modules that can be taken to fulfill the legacy requirements within the new curriculum (see appendix D).

The department has conducted informational meetings with students to discuss the implications of these proposed changes.

6 Consultation

Describe the impact of the major modification on other programs and any consultation undertaken with the Dean and Chair/Director of relevant academic units

The department has consulted with the department of Molecular Genetics, which offers a similarly structured modular curriculum. The parallels between the Molecular Genetics and proposed Medical Biophysics curriculum may facilitate future proposals to share some modules between the two departments. Because the scope of our curriculum will not change, we do not anticipate any adverse impact of this proposal on other academic units.

7 Resources

Describe any resource implications of the change(s) including but not limited to faculty complement, space, libraries, and enrolment/admissions.

Please be specific where this may impact significant enrolment agreements with the Faculty/Provost's Office.

Indicate if the major modification will affect any existing agreements with other institutions, or will require the creation of a new agreement to facilitate the major modification (eg.

Memorandum of Understanding, Memorandum of Agreement, etc). Please consult with the

Provost’s Office (vp.academicprograms@utoronto.ca) regarding any implications to existing or new agreements.

The proposed changes will be made using existing resources allocated to the department. While more modules topics will be taught, the teaching commitment involved in each of them is commensurately less; and the module structure, will provide more flexibility and choice for both students and faculty. Many faculty members have volunteered to create and update lecture content for the new curriculum. The 2016 reviewers noted their higher level of engagement in the curriculum.-

8 UTQAP Process

Steps	Approvals
Development/consultation within Unit	
Consultation with Dean’s Office (& VP, AP)	March 2017
	Unit level approval as appropriate
	Faculty/ Divisional Council
Submission to Provost’s Office	
AP&P – reported annually	
Ontario Quality Council – reported annually	

Appendix A: Current Learning Outcomes, and Degree Level Expectations

Address how the design, structure, requirements and delivery of the program support the program learning outcomes and degree level expectations

Degree Level Expectations	Program Learning Outcomes	How the program design / structure supports the degree level expectations
1. MSc Degree		
<p>1. Depth and Breadth of Knowledge</p> <p>A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.</p>	<p>The objective of the Masters program is for students to acquire written and oral scholarly research skills in Medical Biophysics. Students carry out a research project (which is usually laboratory-based), prepare a research thesis, take graduate level courses and attend and participate in research seminars. In addition to the core course requirements, MSc students participate in the Medical Biophysics Graduate Student Seminar Series at which attendance is mandatory. For their thesis work, students acquire knowledge in design of experiments and in the interpretation and critical analysis of research findings. Students must submit a thesis that reports critically on their research and pass an oral examination based on this work. Reclassification into the PhD program is encouraged and takes place by 21 months after entry</p>	<p>Students have a Supervisory Committee comprising the supervisor and at least two other faculty members that meets every 6 months to review and advise on progress. Students complete “core” courses depending upon the stream, Physics or Biology, as follows:</p> <p>MSc - Physics Stream 3.5 FCEs which must include the following core courses:</p> <p>MBP1015Y Biophysics Seminar Course</p> <p>MBP1022H Cell Biology for Physical Scientists</p> <p>MBP1024Y Advanced Medical Imaging</p> <p>MBP1028H Optical, Thermal and Radiation Biophysics</p> <p>MBP1026H Clinical Imaging for Physical Scientists</p> <p>PhD – Physics stream – above courses plus .5 FCE either MBP 1023H Clinical Radiation Physics and Dosimetry or a half course equivalent is a requirement for PhD candidates</p> <p>MSc – Biology Stream 3.5 FCEs which must include the following core courses:</p> <p>MBP1015Y Biophysics Seminar Course</p> <p>MBP1007Y Fundamentals in Molecular and Cell</p> <p>MBP1010H Quantitative Biology – Statistical Methods</p> <p>MBP1018Y Oncology</p> <p>PhD – Biology Stream</p> <p>MSc course requirements above plus MBP1001Y Advanced Cell Biology</p>

2. PhD Degree		
<p>Depth and Breadth of Knowledge</p> <p>A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.</p>	<p>The objective of the PhD program is to prepare candidates for a career in research. The program is designed to provide both a broad knowledge of Medical Biophysics and advanced training in basic research. Graduates are expected to have acquired the ability to conduct independent theoretical and/or experimental research, prepare publications and give public presentations of their work. These objectives are met through a combination of course work, teaching and research seminars, laboratory research and preparation of manuscripts. In addition to the core course requirements, PhD students participate in the Medical Biophysics Graduate Student Seminar Series, at which attendance is mandatory. For direct entry PhD students, a Qualifying Examination is taken at 15 months. All candidates must submit a thesis and defend it at an oral examination conducted by the School of Graduate Studies.</p>	<p>Students have a Supervisory Committee comprising the supervisor and at least two other faculty members that meets every 12 months in the first 4 years and every 6 months thereafter. Students complete the MSc course requirements listed above. In addition:</p> <ul style="list-style-type: none"> - Physics stream students add .5 FCE; either MBP 1023H Clinical Radiation Physics and Dosimetry or a half course equivalent. - Biology stream students add .5 FCE; either MBP1001Y Advanced Cell Biology or a half course equivalent.

Appendix B: Proposed Learning Outcomes, and Degree Level Expectations

Address how the design, structure, requirements and delivery of the program support the program learning outcomes and degree level expectations

Degree Level Expectations	Program Learning Outcomes	How the program design / structure supports the degree level expectations
<p>1. Depth and Breadth of Knowledge</p> <p>A systematic understanding of knowledge, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the forefront of the academic discipline, field of study, or area of professional practice.</p>	<p>The program learning objectives remain the same as stated above. The implementation of a modular structure provides the opportunity for students to select subspecialty topics more closely related to their own thesis research.</p>	<p>The total credit requirements will be reduced for the MSc and PhD and harmonized between the two streams. A total of 6 modules (1.5 FCEs) plus the seminar course (1.0 FCE) are needed for the MSc and an additional 4 modules (1 FCE) are needed for the PhD.</p> <p>MSc: 2.5 FCEs which must include the following core course and core modules:</p> <p>MBP1015Y Biophysics Seminar Course 1.0 FCE</p> <p>MBP1101H Modules in Medical Biophysics I 0.5 FCE</p> <p style="padding-left: 40px;">This consists of two required modules:</p> <p style="padding-left: 80px;">Scientific Exposition & Ethics (0.25 FCE)</p> <p style="padding-left: 80px;">Biostatistics (0.25 FCE)</p> <p>MBP1102H Modules in Medical Biophysics II 0.5 FCE</p> <p style="padding-left: 40px;">Two modules chosen from the list in appendix D.</p> <p>MBP1103H Modules in Medical Biophysics III 0.5 FCE</p> <p style="padding-left: 40px;">Two modules chosen from the list in appendix D.</p> <p>Three-half course identifiers are proposed so that allocation of modules between years 1 & 2 of study is flexible (e.g. 4 in year 1 plus 2 in year 2 or 6 in year 1).</p> <p>PhD: Above plus 1 FCE:</p> <p>MBP1104H Modules in Medical Biophysics IV 0.5 FCE</p> <p style="padding-left: 40px;">Two modules chosen from the list in appendix D.</p> <p>MBP1105H Modules in Medical Biophysics V 0.5 FCE</p> <p style="padding-left: 40px;">Two modules chosen from the list in appendix D.</p>

Appendix C: Current Calendar Copy with Changes Tracked

Medical Biophysics: Introduction

Faculty Affiliation

Medicine

Degree Programs

Medical Biophysics

MSc

PhD

Combined Degree Program

MD / PhD

Collaborative Programs

The following collaborative programs are available to students in participating degree programs as listed below:

1. **Biomedical Engineering**
 - Medical Biophysics, MSc, PhD
2. **Cardiovascular Sciences**
 - Medical Biophysics, MSc, PhD
3. **Genome Biology and Bioinformatics**
 - Medical Biophysics, PhD
4. **Human Development**
 - Medical Biophysics, PhD
5. **Neuroscience**
 - Medical Biophysics, MSc, PhD

Overview

The Department of Medical Biophysics, ~~is~~ an interdisciplinary graduate department ~~with three fields—dedicated to fundamental and translational research in biomedicine, with a particular focus on cancer. Cellular and Molecular Biology, Medical Physics, and Molecular and Structural Biology—~~is Research is carried out in the extensive facilities provided in ~~located~~

primarily at the Princess Margaret Cancer Centre, the Toronto Medical Discovery Tower, and the Sunnybrook Research Institute and the Hospital for Sick Kids Research Institute, as well as at other hospital locations.

The department accepts students in the biological and life sciences as well as in physics, engineering and the mathematical sciences. It offers opportunities for research in a variety of addressing fundamental problems in medical science; projects which cut across the conventional boundaries of biology, physics, engineering, chemistry, and medicine are encouraged. The department emphasizes focuses on basic and applied research related to cancer, but also addresses neuroscience and cardiovascular medicine. Projects include the following areas: tumour biology, radiobiology, membrane function, proteomics, epigenetics, molecular interactions, gene expression, cell differentiation and growth control, viral and chemical carcinogenesis, cellular and molecular immunology, hematopoiesis, macromolecular structure via x-ray crystallography, NMR spectroscopy and electron microscopy, the physics and engineering of diagnostic imaging and radiation-image-guided therapy, development of imaging and therapy systems using x-rays, ultrasound, nuclear magnetic resonance, light and electron optics. For detailed information, please visit the departmental website.

Contact and Address

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Canada

Medical Biophysics: Medical Biophysics MSc

Master of Science

Program Description

The objective of the Masters program is for students to acquire written and oral scholarly research skills in Medical Biophysics. Students carry out a research project (which is usually laboratory-based), prepare a research thesis, take graduate level courses and attend and participate in research seminars. Students select from a flexible, modular curriculum and participate in department-wide Medical Biophysics Graduate Student Seminar which develop skills in cross-disciplinary communication. All MSc students carry out a thesis project, in a laboratory that they select by means of a rotations program on entry to the department. Through this project they acquire knowledge in the design of experiments and in the interpretation and critical analysis of research findings. Students submit a thesis that reports critically on their

research and pass an oral examination. They are guided by a Supervisory Committee through which they have access to the wide range of expertise in our faculty. Students participate in student symposium, invited lecture series and research seminars throughout their program. Students are encouraged to reclassify into the PhD program through an examination taken about 20 months after entry.

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Department of Medical Biophysics' additional admission requirements stated below.
- Successful applicants with BSc degrees are enrolled in the MSc program; qualified students can reclassify (transfer) into the PhD degree program during Year 2.
- Applicants with diverse [academic](#) backgrounds are encouraged to apply.
- Applicants holding bachelor's degrees from non-Canadian universities are required to provide Graduate Record Examination (GRE) scores (General and Subject) with their application.

Program Requirements

- ~~Students must successfully complete all degree course requirements as outlined in the MBP Graduate Student Handbook. Course requirements depend on the subject chosen for study and on the student's background.~~

Biology Stream

2.5 FCEs credits consisting of:

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)
- 6 modules selected as follows:
 - *Biostatistics (0.25 FCE)* is required.
 - *Scientific Exposition & Ethics (0.25 FCE)* is required.
 - One biology stream course module (*0.25 FCE*) (see Appendix D)
 - Balance of 0.75 FCE chosen from physics or biology stream course modules; or (with departmental approval) graduate courses in another department.

Physics Steam

2.5 FCEs credits consisting of:

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)
- 6 modules selected as follows:

- *Biostatistics (0.25 FCE) is required.*
- *Scientific Exposition & Ethics (0.25 FCE) is required.*
- *Either Cell & Molecular biology for Physicists – Introduction (0.25 FCE) or one biology stream course module (see Appendix D); or a graduate course chosen in consultation with the department that provides a foundation in biology (0.5 or 1 FCE).*
- *Balance chosen from physics or biology stream course modules; or (with departmental approval) graduate courses in another department.*

- Successful completion of an oral examination on of the student's research thesis topic.

Program Length

6 sessions full-time (typical registration sequence: F/W/S/F/W/S)

Time Limit

3 years full-time

Medical Biophysics: Medical Biophysics PhD

Doctor of Philosophy

Program Description

The objective of the PhD program is to prepare candidates for a career in biomedical research. It is designed to provide both a broad knowledge of biomedical science and advanced training in basic research at a subspecialty level. Thesis work may address ~~address~~ fundamental and/or translational problems in the biology, diagnosis and therapy of cancer, as well as areas of neuroscience and cardiovascular medicine. By the end of the program, graduates will have acquired the ability to conduct independent theoretical and/or experimental research which makes an original contribution to the field, prepare publications and give public presentations of their work at national and international venues. These objectives are met through a combination of course work, teaching and research seminars, mentored laboratory research and preparation of manuscripts for publication. Graduates from the Medical Biophysics PhD program are to be found in professorial positions in academic research and teaching institutions, in hospital laboratories and in the medical device, pharmaceutical and biomedical science and information industries, including startup companies which they have founded.

Applicants may enter the PhD program via one of three routes: 1) following completion of an MSc degree; 2) transfer from the University of Toronto MSc program; or 3) direct entry following completion of a BSc degree.

PhD Program

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Department of Medical Biophysics' additional admission requirements stated below.
- Applicants may be admitted following completion of an MSc degree program in biological, physical, chemical, or medical sciences from a recognized Canadian university.
- Admission to the PhD program is highly selective and attainment of minimum admission requirements does not guarantee acceptance ~~into the PhD program.~~

Program Requirements

Biology Stream

3.5 FCEs credits consisting of:

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)
- 10 modules selected as follows:
 - *Biostatistics (0.25 FCE) is required.*
 - *Scientific Exposition & Ethics (0.25 FCE) is required.*
 - *At least one biology stream course module (0.25 FCE) (see Appendix D)*
 - *Balance of 1.75 FCE chosen from physics or biology stream course modules; or (with departmental approval) graduate courses in another department.*

Physics Steam

3.5 FCEs credits consisting of:

- MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)
- 10 modules selected as follows:
 - *Biostatistics (0.25 FCE) is required.*
 - *Scientific Exposition & Ethics (0.25 FCE) is required.*
 - *Either Cell & Molecular biology for Physicists – Introduction (0.25 FCE) or one biology stream course module (see Appendix D); or a graduate course chosen in consultation with the department that provides a foundation in biology (0.5 or 1 FCE).*
 - *Balance chosen from physics or biology stream course modules; or (with*

departmental approval) graduate courses in another department.

Successful completion of an oral examination of the student's research thesis

- ~~Because Considering~~ of the broad range of topics available for thesis research and ~~because of~~ the different backgrounds of students admitted, each student, in consultation with his or her supervisor, will plan a program of study that provides the appropriate background for the area of investigation.
- Students are required to take a PhD Qualifying examination in the second year of their study.
- ~~All students must complete the required four full course credits as outlined in the MBP Graduate Student Handbook by the end of Year 3 of the PhD program.~~
- ~~Students who have completed an MSc degree in Medical Biophysics will receive credit for all courses taken during their MSc program in Medical Biophysics. Students who completed their MSc degree in a department other than Medical Biophysics may request one full course credit for that degree. These students must still complete or be formally exempt from the required courses for the Medical Biophysics MSc degree. Exemption from a required course does not reduce the number of courses required; students must substitute another course equivalent in place of the exempted course.~~
- All PhD students ~~are expected~~ will to participate in MBP 1015Y⁰ *Biophysics Seminar Course* regardless of whether or not they have previously received credit for it ~~or not~~.
- Except by special arrangements, students are required ~~to~~ to be at attend the research institute or ~~on-campus~~ laboratory and ~~participating~~ participate full-time until all program requirements are completed.

Program Length

4 years

Time Limit

6 years

⁰ *Course that may continue over a program. The course is graded when completed.*

PhD Program (Transfer)

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Department of Medical Biophysics' additional admission requirements stated below.
- Applicants may be admitted via reclassification (transfer) from the MSc program. Admission to the PhD program is highly selective and attainment of minimum admission requirements does not guarantee acceptance into the PhD program.

Program Requirements

- Considering the broad range of topics available for thesis research and the different backgrounds of students admitted, each student, in consultation with his or her supervisor, will plan a program of study that provides the appropriate background for the area of investigation.
- ~~Because of the broad range of topics available for thesis research and because of the different backgrounds of students admitted, each student, in consultation with his or her supervisor, will plan a program of study that provides the appropriate background for the area of investigation.~~

~~All students must complete the required four full course credits as outlined in the MBP Graduate Student Handbook by the end of Year 3 of the PhD program.~~

- ~~Students who transfer/reclassify into the doctoral program will receive credit for all courses taken during their MSc program in Medical Biophysics. Requirements for students who transfer from the MSc to the PhD are the same as the requirements in the PhD section above. plus an additional .~~ Students who completed their MSc degree in a department other than Medical Biophysics may request one full course credit for that degree. These students must still complete or be formally exempt from the required courses for the Medical Biophysics MSc degree.
- ~~Exemption from a required course does not reduce the number of courses required; students must substitute another course equivalent in place of the exempted course.~~
- All PhD students will participate in MBP 1015Y⁰ *Biophysics Seminar Course* regardless of whether or not they have previously received credit for it.
- Except by special arrangement, students are required to attend the research institute or campus laboratory and participate full-time until all program requirements are completed.
- ~~All PhD students are expected to participate in MBP 1015Y⁰ *Biophysics Seminar Course* regardless of whether they previously received credit for it or not.~~

Program Length

5 years

Time Limit

7 years

⁰ ~~Course that may continue over a program. The course is graded when completed.~~

PhD Program (Direct-Entry)

Minimum Admission Requirements

- Applicants are admitted under the General Regulations of the School of Graduate Studies. Applicants must also satisfy the Department of Medical Biophysics' additional admission requirements stated below.
- Applicants may be admitted to the PhD program via direct entry following completion of a BSc degree. Admission to the PhD program is highly selective and attainment of minimum admission requirements does not guarantee acceptance into the PhD program.

Program Requirements

- Considering the broad range of topics available for thesis research and the different backgrounds of students admitted, each student, in consultation with his or her supervisor, will plan a program of study that provides the appropriate background for the area of investigation.
- Students entering the PhD direct entry option complete the same requirements listed in the PhD section above.
- ~~• All PhD students will participate in MBP 1015Y⁰ Biophysics Seminar Course regardless of whether or not they have previously received credit for it.~~
- ~~• Except by special arrangement, students are required to attend the research institute or campus laboratory and participate full-time until all program requirements are completed.~~
- ~~• All students must complete the required four full-course credits as outlined in the MBP Graduate Student Handbook by the end of Year 3 of the PhD program.~~
- ~~• Students who transfer/reclassify into the doctoral program or who have completed an MSc degree in Medical Biophysics will receive credit for all courses taken during their MSc program in Medical Biophysics. Students who completed their MSc degree in a department other than Medical Biophysics may request one full-course credit for that degree. These students must still complete or be formally exempt from the required courses for the Medical Biophysics MSc degree. Exemption from a required course does not reduce the number of courses required; students must substitute another course equivalent in place of the exempted course.~~
- All PhD students are expected to participate in MBP 1015Y⁰ *Biophysics Seminar Course* regardless of whether they previously received credit for it or not.
- Except by special arrangements, students are required to be at the research institute or on campus and participating full-time until all program requirements are completed.

Program Length

5 years

Time Limit

7 years

⁰ ~~*Course that may continue over throughout the program. The course is graded when completed.*~~

Medical Biophysics: Medical Biophysics MSc, PhD Courses

MBP 1001Y	Advanced Cell Biology
MBP 1007Y	Fundamentals in Molecular and Cell Biology
MBP 1010H	Quantitative Biology—Statistical Methods
MBP 1011H	Foundations of Bioinformatics
MBP 1015Y ⁰	Biophysics Seminar
MBP 1018Y	Oncology
MBP 1022H	Advanced Cell Biology for Physical Scientists
MBP 1023H	Clinical Radiation Physics
MBP 1024Y	Advanced Medical Imaging
MBP 1026H	Clinical Imaging for Physical Scientists
MBP 1027H	Advanced MRI: Signal, Acquisition, and Reconstruction (prerequisite: MBP 1024Y Advanced Imaging or equivalent)
MBP 1028H	Optical, Thermal, and Radiation Biophysics
<u>MP1101H</u>	<u>Modules in Medical Biophysics I: Scientific Exposition and Ethics; Biostatistics</u>
<u>MSP1102H</u>	<u>Modules in Medical Biophysics II</u>
<u>MBP1102H</u>	<u>Modules in Medical Biophysics III</u>
<u>MBP1103H</u>	<u>Modules in medical Biophysics IV</u>
<u>MBP1105H</u>	<u>Modules in Medical Biophysics V</u>

⁰ *Course that continues throughout the program. The course is graded when completed. ~~Course that may continue over a program. The course is graded when completed.~~*

[MBP 1102H-1105H each comprise two modules selected from a list of more than 30 that are offered in Medical Biophysics. Each September the department publishes a list of specific modules available to students during the following two academic years.](#)

Below are some examples of the modules offered in Medical Biophysics:

Biology	Physics
Cell Biology & Cancer	Overview of Medical Imaging
Cell Signaling & Metabolism	Cell biology for Physicists—Introduction
Development, Stem Cells and Cancer	Ultrasound—Overview
Tumour Microenvironment	Magnetic resonance imaging—Overview

Biological Imaging	Clinical Imaging
Cancer Immunotherapy	Radiation Biology & DNA Repair
Radiation Biology & DNA Repair	Biophysical interactions of light with tissue
Predictive Oncology & Therapeutics	Biophysics of focused ultrasound, thermal biophysics
Topics in Emerging Areas of Medical Biophysics—Biology	Topics in Emerging Areas of Medical Biophysics—Biology

APPENDIX D

Requirements for returning students starting prior to September 2017

Returning students are required to complete the degree requirement set out in the MBP Student Handbook in the year that they started their program. These requirements can be fulfilled within the new modular structure as described in the following sections. With approval from the department, a student may also substitute a required course for another that is more suited to their program of study, for example a neurosciences course instead of oncology.

Requirements for MSc starting prior to September 2017 (biology stream):

MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)

10 or more modules selected as follows:

- o If MBP 1007Y has not already been completed, choose one biology stream course module (see Appendix I).
- o If MBP 1010H has not already been completed, choose *Biostatistics*.
- o If MBP 1018Y has not already been completed, choose *Predictive Oncology & Therapeutics*.
- o Choose the balance from: MBP physics or biology stream course modules; or department approved graduate courses in another department (0.5 credit = 2 modules); or already completed MBP courses (0.5 credit = 2 modules) excluding MBP 1015Y. Recommended modules for completing the MBP 1018Y requirement are: *Cell Biology & Cancer Models*; *Cell Signaling & Metabolism*; *Scientific Exposition & Ethics*.

Requirements for MSc starting prior to September 2017 (physics stream):

MBP 1015Y Biophysics Seminar (this is a continuous course which students must attend until their degree is completed)

10 or more modules selected as follows:

- o If MBP 1024Y has not already been completed, choose *Overview of Medical Imaging and Biostatistics*.
- o If the biology requirement (MBP 1022H or equivalent) has not been completed, choose either *Cell & molecular biology for Physicists – Introduction* (see Appendix II); or one biology stream course module (see Appendix I); or a 0.5 or 1 credit graduate course chosen in consultation with the department that provides a foundation in biology. One such substitute is *JNR1444Y - Fundamentals of Neuroscience: Cellular and Molecular* (see course alternates section below).
- o If MBP1026H has not been completed, choose *Clinical Imaging for Physical Scientists*.
- o Choose the balance from: MBP physics or biology stream course modules; or department approved graduate courses in another department (0.5 credit = 2 modules); or already completed MBP courses (0.5 credit = 2 modules) excluding MBP 1015Y. The *Scientific Exposition & Ethics* module is recommended for

completing the MBP 1026H requirement.

Requirements for PhD starting prior to September 2017 (biology stream):

- o Requirements for the PhD are all of the requirements of the MSc plus the equivalent of 4 modules (i.e. 14 modules total) selected from the following:
- o MBP biology or physics stream course modules
- o Department approved graduate courses in another department (0.5 credit = 2 modules).

Requirements for PhD starting prior to September 2017 (physics streams):

Requirements for the PhD are all of the requirements of the MSc plus the equivalent of 2 modules (i.e. 12 modules total) selected from the following:

- o MBP biology or physics stream course modules
- o department approved graduate courses in another department (0.5 credit = 2 modules).
- o MBP 1023H Clinical Radiation Physics and Dosimetry (0.5 credit = 2 modules)

Choosing modules

Existing students should consult their thesis supervisor when selecting modules. Students must obtain approval from the stream graduate coordinator for the selection of modules. Some examples of module selections are shown in Appendix E.

Module availability

All biology stream modules would be offered every two years. A core set of physics stream modules would be offered every year while more specialized topics will only be offered in alternate years or based on student and faculty interest.

Grading and transcripts

There will be a transition period for the implementation of the new curriculum in which grades and transcripts will be reported using the existing course numbers. For example, a physics stream MSc student starting in September 2017 would complete 6 modules. The grade from the first 4 modules would be averaged and reported as MBP 1024Y (1 credit) while the subsequent 2 modules would be averaged and reported as MBP 2026H (0.5 credit).

I – Biology stream modules

Course modules:

1. *Scientific Exposition & Ethics* (required) Coordinators: D. Malkin, J. Woodgett
2. *Biostatistics* (required) Coordinator: P. Boutros
3. *Quantitative Cancer Genomics* (offered in alternate years) Coordinators: T. Pugh, M. Lupien
4. *Cancer Immunotherapy* (offered in alternate years) Coordinator: P. Ohashi (To be confirmed)

5. *Structural Biology & Proteomics (offered in alternate years)* Coordinators: J. Rubinstein, M. Ikura
6. *Cell Signaling & Metabolism (offered in alternate years)* Coordinators: J. McGlade, V. Stambolic
7. *Predictive Oncology & Therapeutics (offered in alternate years)* Coordinators: M. Tsao and B. Haibe-Kains
8. *Tumour Microenvironment (offered in alternate years)* Coordinators: B Wouters, R. Khokha
9. *Epigenetics (offered in alternate years)* Coordinators: H. He, D. DeCarvalho
10. *Development, Stem Cells and Cancer (offered in alternate years)* Coordinators: G. Keller, N. Iscove
11. *Cell Biology & Cancer Models (offered in alternate years)* Coordinators: E. Zacksenhaus, L. Ailles
12. *Radiation Biology & DNA Repair (offered in alternate years)* Coordinators: R. Hakem, M. Koritzinsky
13. *Imaging for Biologists (offered in alternate years)* Coordinators: R. DaCosta, G. Zheng
14. *Clinical and Experimental Biology I & II* Coordinator: Dr. M. Koritzinsky Note that these two modules are taught as an intensive 1 week course (see appendix D).
15. *Topics in Emerging Areas of Medical Biophysics*

Full length courses:

MBP 1015Y Biophysics Seminar Weekly presentation course held jointly with physics stream students at two locations.

II – Physics stream modules

Course modules:

1. *Scientific Exposition & Ethics (required)* Coordinators: D. Malkin, J. Woodgett
2. *Biostatistics (required)* Coordinator: P. Boutros
3. *Overview of Medical Imaging* This module provides a review of the mathematical preliminaries of medical imaging and introduces concepts of image formation, inverse problems, stochastic processes and instrument performance that are common to many medical imaging modalities. This course is a recommended prerequisite for many of the imaging modules offered in the physics stream. Coordinator: J.G. Sled
4. *Magnetic resonance imaging – Overview* Introduction to magnetic resonance imaging covering basic physics, image formation, excitation principles, relaxation mechanisms, and systems design (5 lectures, a lab, and an exam). *Overview of Medical Imaging* or equivalent preparation is a prerequisite for this module. Coordinator: S. Graham
5. *Ultrasound – Overview* Introduction to ultrasonography imaging covering basic physics, image formation, tissue interaction / safety, motion and flow (5 lectures, a lab, and an exam). *Overview of Medical Imaging* or equivalent preparation is a prerequisite for this module. Coordinator: A. Sadegh-Naini

6. *Advanced Ultrasound – Overview* or equivalent is a prerequisite for this module. Coordinator: D. Goertz
7. *Introduction to biophotonics* Introduction to the theory and applications of light interactions with tissue with an emphasis on understanding the basis of photonics for diagnostic and therapeutic applications. Coordinators: A. Vitkin & L. Lilge
8. *Introduction to Optical microscopy* Introduction to the imaging characteristics, design principles, and applications of optical microscope technology. *Introduction to biophotonics* or equivalent is a prerequisite for this module. Coordinator: B. Wilson
9. *Biophysics of focused ultrasound, thermal biophysics* Coordinators: M. O'Reilly
10. *Nanotechnology for Medicine (offered in alternate years)* Introduction to diagnostic and therapeutic applications of nanotechnology in medicine. G. Zheng
11. *Cell & molecular biology for Physicists – Introduction* This course introduces physical scientists to the basic concepts of cell and molecular biology including structure and function of nucleic acids (DNA & RNA) and proteins, DNA replication, transcription, translation, genetics, regulation of gene expression, cell growth and differentiation. Coordinator: J. Rast
12. *Clinical Imaging for Physical Scientists* An introduction to human anatomy and physiology from the perspective of clinical imaging. Basic normal anatomy and physiology will be presented from a radiological perspective and structured according to the major organ systems. Anatomy labs will be included. Examples of specific disease processes will be considered together with findings from X-ray, computed tomography, ultrasound, radionuclide and nuclear magnetic resonance imaging. Assessment is based on course assignments and a final seminar project. Coordinator: A. Martel
13. *Biological Imaging* An introduction to imaging applications presented from the perspective of the biological researcher using imaging technologies such as optical, MRI, X-ray, ultrasound, and radionuclides to study human populations or animal models. Coordinator: J. Lerch
14. *Multidimensional signal processing, undersampled data, and statistical methods (offered in alternate years)* Image models, filters, transformation, undersampled data methods, and image statistics applied to MRI and other imaging modalities. Coordinator: A. Sadegh-Naini
15. *Advanced Magnetic resonance imaging* A selection of topics on MRI related to relaxation contrast, flow, diffusion, BOLD, susceptibility, contrast agents, hyperpolarization, pulse sequence design, RF coils, coil arrays, and artifacts. Coordinator: C. Cunningham
16. *Medical Device Innovation and Entrepreneurship* This module provides a critical examination of the role of intellectual property, regulatory frameworks, funding and business models in the successful and unsuccessful commercialization of new medical devices and technologies. Coordinators: G. Wright, B. Courtney
17. *Topics in Emerging Areas of Medical Biophysics*

Full length courses:

MBP 1015Y Biophysics Seminar Weekly presentation course held jointly with biology stream students at two locations.

MBP 1023H Clinical Radiation Physics and Dosimetry This course is designed to serve as a

comprehensive introduction to the physics of radiation, their interaction with matter and the calculation/estimation and measurement of absorbed dose. This is usually considered the "bread and butter" for students pursuing a career in Clinical Medical Physics. However, we will also discuss modern applications outside dosimetry, such as in Medical Imaging. This course does not cover biological implications of radiation dose in living matter (radiobiology). Students are evaluated on the basis of a mid-term, final exam and class participation.

Course alternates

Graduate students at the University of Toronto can take graduate courses offered in any department, subject to availability and approval of their home department; the latter is given by the graduate coordinators on a case-by-case basis. Some examples of courses that may be of interest to MBP graduate students are listed below. Courses that fulfill specific requirements of the physics-stream curriculum such as [biology foundation] are noted.

1. *JNR1444Y – Fundamentals of Neuroscience: Cellular and Molecular* [biology foundation]
2. *JEB 1365H – Ultrasound: Theory and Applications in Biology and Medicine*
3. *BME1460H – Quantitative Fluorescence Microscopy: Theory and Application to Live Cell Imaging*
4. *JYG1555H – Advanced Topics: Cellular and Molecular Neurobiology*
5. *PSL1026H – Advanced Topics: Experimental Cell Physiology*
6. *CSC2515H – Introduction to Machine Learning*
7. *PSY5110H – Advanced Topics in Behavioural Neuroscience: Imaging Techniques in Preclinical Research*
8. *MSC1006H - Neuroanatomy – Introduction to Anatomical Organization of the Brain*
9. *PSY4706HS - Human Brain Anatomy*
10. *MSC1087H - Neuroimaging Methods using Magnetic Resonance Imaging*
11. *STA2005H - Applied multivariate analysis*
12. *STA4273H – Large Scale Machine Learning*

III – Proposed 2017-2019 schedule

A typical module consists of six 2-hour lectures plus optionally an exam and / or lab. Allowing 7 weeks for each module, the modules would start and end within the following intervals (individual course may vary):

Starting on or after	Ending on or before
September 12, 2017	October 28, 2017
October 31, 2017	December 20, 2017
January 9, 2017	March 3, 2017
March 6, 2017	April 21, 2017
March 27, 2017	Do not schedule lectures this week*
September 11, 2017	October 27, 2017
October 30, 2017	December 20, 2017

January 15, 2018	March 2, 2018
March 5, 2018	April 20, 2018

*Clinical and Experimental Biology I & II modules are offered everyday during week of March 27

Course Module	Sept. 2017	Nov. 2017	Jan. 2018	Mar. 2018	Sept. 2018	Nov. 2018	Jan. 2019	Mar. 2019
<i>Scientific Exposition & Ethics</i> (Malkin & Woodgett)	Fridays Sept-Oct 2-4 pm (PMH)				Fridays Sept - Oct			
<i>Biostatistics</i> (Boutros)			Monday s Jan – Feb 10-12 am TMDT				Mon Jan-Feb	
<i>MBP 1015Y Biophysics Seminar</i>	Tue. PM/ Wed. PM Wednesdays at PMH 4:00 PM Tuesdays Oct SRI 3:00 PM				Tue. PM/ Wed. PM			
<i>Quantitative Cancer Genomics</i> (Lupien & Pugh)			Thurs Jan–Feb 9-11 am PMH					
<i>Cancer Immunotherapy</i> (P. Ohashi)							Thurs. Jan - Feb	
<i>Structural Biology & Proteomics</i> (Ikura & Rubinstein)				Thurs Mar - Apr 9-11 am PMH				
<i>Cell Signaling & Metabolism</i> (McGlade & Stambolic)	Thurs Sep - Oct 9-11 am PMH							
<i>Predictive Oncology & Therapeutics</i> (Haibe-Kains & Tsao)				Mon. Mar - Apr 10 am - 12 pm PMH				
<i>Tumour Microenvironment</i> (Khokha & Wouters)					Thurs Sept - Oct			
<i>Epigenetics</i> (He & de Carvalho)						Thurs Nov - Dec		

<i>Development, Stem Cells and Cancer</i> (Iscove & Keller)									Thurs Mar - Apr
<i>Cell Biology & Cancer Models</i> (Ailles & Zacksenhaus)			Thurs Nov – Dec 9-11 am PMH 7- 605						Friday Mar – April
<i>Radiation Biology & DNA Repair</i> (Hakem & Koritzinsky)								Thurs TBA	
<i>Imaging for Biologists</i> (Da Costa & Zheng)								Fridays Jan – Mar	
<i>Introduction to Medical Imaging</i> (J. Sled) Sept 21 2-4 pm	Wed. Sept– Oct 12:30- 2:30 pm SRI S615					Wed. Sept 13 – Oct 25			
<i>Cell & molecular biology for Physicists – Introduction</i> (J. Rast)			Wed. Nov – Dec 12:30- 2:30 pm SRI S615				Wed. Nov 1 – Dec 13		
<i>MRI – Overview</i> (S. Graham)					Tues. Mar– Apr 12:30- 2:30 pm SRI			Wed. Jan 17 – Feb 28	
<i>Ultrasound – Overview</i> (A.Sadeghi-Naini)					Wed. Mar - Apr 12:30- 2:30 pm SRI S615				Wed. Mar 7 – Apr 18
<i>Advanced MRI</i> (C. Cunningham)			Wed Nov – Dec 12:30- 2:30 pm M7-607 (TBC)						
<i>Advanced</i>									

<i>ultrasound</i>								
<i>Introduction to Optical microscopy</i> (B. Wilson)			Tuesday s Jan - Feb 9- 11 am PMH, 7- 605				Tues. Jan – Feb	
<i>Introduction to biophotonics</i> (A. Vitkin & L. Lilge)	TBC TMDT					Tues. Sept – Oct		
<i>Biophysics of focused ultrasound, thermal biophysics</i> (M. O'Reilly)		Tues. Nov – Dec 12:30- 2:30 pm SRI				Tues. Nov – Dec 12:30- 2:30 pm SRI		
<i>Nanotechnology for Medicine</i> (G. Zheng)			Wed. Jan - Mar (TBC) downto wn					
<i>Clinical Imaging for Physical Scientists</i> (A. Martel)			Mon Jan– Feb 9:15- 11:15 am SRI				time TBD	
<i>Biological Imaging</i> (J. Lerch)			Mon Mar - Apr 10 am- 12 noon PMH, 7- 605	time TBD				Tues. Mar – Apr
<i>Multidimensional signal processing, undersampled data, and statistical methods</i>								time TBD
<i>Medical Device Innovation and Entrepreneurship</i> (G. Wright)	Sept. Wed or Thurs 5-6 pm SRI					TBD		
<i>MBP 1023H Clinical Radiation</i>	time TBD					time TBD		

<i>Physics & Dosimetry</i>						
<i>Clinical & Experimental Biology I & II (M. Koritzinsky)</i>			Mar all day every day for one week			

Examples of module selection

The following are examples to illustrate combinations of modules and courses that a prospective student could choose.

Sample curriculum for **MSc in the physics** stream:

Year 1:

- *Scientific Exposition & Ethics*
- *Biostatistics*
- *Overview of Medical Imaging*
- *Cell biology for Physicists – Introduction*
- *MBP 1015Y Biophysics Seminar*

Year 2:

- *Ultrasound – Overview*
- *Clinical Imaging for Physical Scientists*
- *MBP 1015Y Biophysics Seminar*

Sample curriculum for **PhD in the physics** stream:

Year 1:

- *Scientific Exposition & Ethics*
- *Biostatistics*
- *Overview of Medical Imaging*
- *Cell biology for Physicists – Introduction*
- *MBP 1015Y Biophysics Seminar*

Year 2:

- *Ultrasound – Overview*
- *Magnetic resonance imaging – Overview*
- *Clinical Imaging for Physical Scientists*
- *Radiation Biology & DNA Repair*
- *MBP 1015Y Biophysics Seminar*

Year 3:

- *Biophysical interactions of light with tissue*
- *Biophysics of focused ultrasound, thermal biophysics*
- *MBP 1015Y Biophysics Seminar*

Sample curriculum for **PhD in the physics** stream (neuroscience focus):

Year 1:

- *Scientific Exposition & Ethics*
- *Biostatistics*
- *Overview of Medical Imaging*
- *Magnetic resonance imaging – Overview*
- *MBP 1015Y Biophysics Seminar*

Year 2:

- *JNR1444Y – Fundamentals of Neuroscience: Cellular and Molecular*
- *MBP 1015Y Biophysics Seminar*

Year 3:

- *Biological Imaging*
- *Biophysical interactions of light with tissue*
- *MBP 1015Y Biophysics Seminar*

Sample curriculum for **MSc in the biology** stream:

Year 1:

- *Scientific Exposition & Ethics*
- *Biostatistics*
- *Quantitative Cancer Genomics*
- *Epigenetics*
- *MBP 1015Y Biophysics Seminar*

Year 2:

- *Introduction to Optical microscopy*
- *Clinical Imaging for Physical Scientists*
- *MBP 1015Y Biophysics Seminar*

Sample curriculum for **PhD in the biology** stream:

Year 1:

- *Scientific Exposition & Ethics*
- *Biostatistics*
- *Cell Biology & Cancer Models*
- *Radiation Biology & DNA Repair*
- *MBP 1015Y Biophysics Seminar*

Year 2:

- *Development, Stem Cells and Cancer*
- *Tumour Micoenvironment*
- *Biological Imaging*
- *Cancer Immunotherapy*
- *MBP 1015Y Biophysics Seminar*

Year 3:

- *Cell Signaling & Metabolism*
- *Predictive Oncology & Therapeutics*
- *MBP 1015Y Biophysics Seminar*



COURSE MODULES 2017-2018

<i>Biology</i>	<i>Physics</i>
<ul style="list-style-type: none">• Scientific Exposition & Ethics (mandatory) (Fri. Sept 15 – Oct 27)• Biostatistics (mandatory) (Mon. Jan 9 – Mar 5)• Cell Signaling & Metabolism (Thurs. Sept 14 – Oct 26)• Cell Biology & Cancer Models (Thurs. Nov 2 – Dec 14)• Quantitative Cancer Genomics (Thurs. Jan 11 – Feb 22)• Predictive Oncology & Therapeutics (Mon. Mar 5 – Mar 19, Apr 5 - Apr 19)• Structural Biology & Proteomics (Thurs. Mar 1 – Mar 29, Apr 5 – 19)• Clinical & Experimental Radiobiology I & II (TBA)	<ul style="list-style-type: none">• Scientific Exposition & Ethics (mandatory) (Fri. Sept 15 – Oct 27)• Biostatistics (mandatory) (Mon. Jan 9 – Mar 5)• Medical Device Innovation and Entrepreneurship (TBA)• Overview of Medical Imaging (Wed. Sept 13 – Oct 25)• Cell & Molecular Biology for Physicists - Introduction (Wed. Nov 1 – Dec 13)• Introduction to Biophotonics (Tues. Nov 7 - Dec 19)• Biophysics of Focused Ultrasound & Thermal Therapy (Tues. Nov 7 – Dec 19)• Advanced Magnetic Resonance Imaging (Wed. Nov 8 – Dec 20)• Introduction to Bio-Microscopies (Tues. Jan 10 – Feb 21)• Clinical Imaging for Physical Scientists (Mon. Jan 16 – Feb 27)• Nanotechnology for Medicine (Wed. Jan 18 – Mar 1)• Biological Imaging (Mon. Mar 6 - 20, Apr 3 – 24)• Magnetic Resonance Imaging – Overview (Tues. Mar 7-21, Apr 4 – 25)• Ultrasound – Overview (Wed. Mar 8 – 22, Apr 5 - 26)

Fall 2017

TOPIC	Scientific Exposition and Ethics - MANDATORY
Coordinators	Drs. David Malkin and Jim Woodgett
Day & Time	Fridays at 2:00 pm – 4:00 pm
Location	Princess Margaret Cancer Centre 610 University Ave, Room 6-604 (6 th floor auditorium)
Course Goals	Scientific exposition, discourse and ethics are fundamental principles to the conduct of responsible basic, translational and clinical research. This course will use a combination of didactic lectures and interactive group discussion to explore key elements of these principles under the broad headings of: 1) Principles of Ethical Conduct and Protection of Research Subjects; 2) Scientific Fraud, Plagiarism and Data Misrepresentation – Flagrant and Unintended; 3) Privacy and Confidentiality in the Genome Era (Data Sharing/Validation/Clinical Translation); 4) The Scientist’s Responsibility to the Global Society – Research Advocacy, Communication and Communities; and 5) Authorship Responsibility in the Spirit of Collaboration and Intellectual Property Protection. The format of each lecture will be both didactic, with the lecturer discussing fundamental issues and principles relevant to the topic, and interactive with opportunity for open discussion of a foundational aspect of the subject being addressed in the lecture.
Evaluation Method	End of course exam with a combination of short- and long- answer questions based on information discussed in the lectures, and supplemented with materials provided by the lecturers, and an end-of-course assignment which will be an essay discussing one aspect of the course – topics provided by the course co-directors. The ‘exam’ will count for 50% of the final mark and the assignment will count for 50%.

Schedule

Date	Instructor	Lecture
Sept. 15	Jim Woodgett	Introduction to research ethics: responsibilities and best practices
Sept. 22	Ivan Topisirovic	Biomedical Research: Ethos, Logos... and Pathos (on research misconduct)
Sept. 29	Beth Stephenson	Principles of Ethical Conduct and Protection of Research Subjects
Oct. 6	Marie-Claude Martin	The Scientist’s Responsibility to the Global Society – Research Advocacy, Communication and Communities
Oct. 13	Steve Scherer	Privacy and Confidentiality in the Genome Era (Data Sharing/Validation/Clinical Translation)
Oct. 20	David Malkin	Authorship Responsibility in the Spirit of Collaboration and Intellectual Property Protection
Oct. 27	exam	

Winter 2018

TOPIC	Biostatistics – MANDATORY for 1 st year students only
Coordinators	Dr. Paul Boutros
Day & Time	Mondays at 10:00 am – 12:00 pm
Location	Toronto Medical Discovery Tower 101 College Street, Room 4-204
Course Goals	This module is a graduate level course in applied introductory biostatistics. It is heavily focused on developing practical skills that can be readily applied to new datasets. Students will be working extensively with the R statistical environment, and are encouraged to bring a laptop to class. We focus on understanding and interpreting common analysis-types: central tendencies, count and proportion data, and simple multivariate data. We conclude by touching on applied machine-learning and data-visualization.
Evaluation Method	Final exam, three problem-sets and class participation.

Schedule

Date	Instructor	Lecture
Jan. 8	P. Boutros	Introduction to statistics
Jan. 15	P. Boutros	Univariate Statistics I (parametric methods)
Jan. 22		No class this week
Jan. 29	P. Boutros	Univariate Statistics II (non-parametric methods)
Feb. 5	P. Boutros	Multivariate Statistics I (modeling, quality-assessment, simple models)
Feb. 12	TBA	Multivariate Statistics II (general linear models)
Feb. 26	P. Boutros Room 4-204	Multiple-Testing, Machine-Learning, Data-visualization
March 5	Exam at 1:30 pm, TMDT, 101 College St. Room 4-204	

Fall 2017

TOPIC	Cell Signaling & Metabolism
Coordinators	Drs. Jane McGlade & Vuk Stambolic
Day & Time	Thursdays at 9:00 am – 11:00 am
Location	Princess Margaret Cancer Centre, 610 University Ave, Room 7-605
Course Goals	This module will cover a spectrum of topics in cell biology and biochemistry, including cell-to-cell communication, sensing of extracellular signals, surface receptors as signaling modalities, second messengers, modular architecture of proteins, post-translational modifications as instructive signals, intracellular signal transduction and signaling pathways, effectors of signaling pathways, protein stability and turnover. The module will also encompass a series of themes in cellular metabolism, including cellular energetics, nutrient transport and utilization, plasticity in metabolic networks, cellular metabolism in disease and the interface between cell signaling and cell metabolism. The use of model systems in the study of signaling and metabolism, as well as methodologies for cell signaling research will be discussed. The students should expect to get an advanced understanding of signaling networks and metabolic pathways and knowledge of means for their interrogation.
Evaluation Method	Written assignment

Schedule

Date	Instructor	Lecture
Sept. 14	J. McGlade	Introduction and module description.
Sept. 21	M. Ikura	Ras/MAPK signaling
Sept. 28	J. Filmus	Wnt and Hedgehog Signaling Pathways.
Oct. 5	L. Penn	Tumor Metabolism and Mevalonate Pathway
Oct. 12	V. Stambolic	Obesity and Cancer Signaling
Oct. 19	R. Rottapel	Receptor Tyrosine Kinases
Oct. 26	D. Andrews	Cell Death Signaling

Fall 2017

TOPIC	Cell Biology & Cancer Models
Coordinators	Laurie Ailles and Eldad Zacksenhaus
Day & Time	Thursdays at 9:00 am – 11:00 am
Location	Princess Margaret Cancer Centre, 610 University Ave, Room 7-605
Course Goals	<p>Neoplastic transformation and metastasis are characterized by acquisition of autonomous self-renewal and uncontrolled cell division, increased motility, epithelial-to-mesenchymal transition (EMT), invasion/dissemination, homing to distal tissues and ultimately formation of macrometastases. Cells resist such oncogenic transformation by inducing programmed cell death (apoptosis), senescence and macro-autophagy. The latter two escape routes also have pro-oncogenic effects in certain contexts. Understanding the biology of these processes is the key to many existing as well as novel/future strategies for cancer therapy.</p> <p>This course will introduce basic concepts in cancerous cell cycle, apoptosis, senescence, autophagy and the metastatic cascade, and review recent publications in these fields. It will then discuss Genetically Engineered Mouse Models (GEMM) and patient derived models, and how such models are used to study oncogenic transformation and dissemination, as well as identifying effective therapies.</p>
Evaluation Method	Short exam with multiple-choice questions

Schedule

Date	Instructor	Lecture
Nov. 2	David Andrews	Apoptosis
Nov. 9	Laurie Ailles	Patient-Derived Models of Cancer
Nov. 16	Eldad Zacksenhaus	Autophagy and Senescence
Nov. 23	Tak Mak	Cell Growth and Metastasis (tentative)
Nov. 30	Razq Hakem	Genetically Engineered Mouse Models of Cancer
Dec. 7	Phil Marsden	Stem Cell Niches and the Vasculature
Dec. 14	exam	

Winter 2018

TOPIC	Quantitative Cancer Genomics
Coordinators	Drs. Mathieu Lupien & Trevor Pugh
Day & Time	Thursdays at 9:00 am – 11:00 am
Location	Princess Margaret Cancer Centre, 610 University Ave, Room 7-605 (TBC)
Course Goals	Each class will consist of a 1-hour student lecture reviewing the day's topic in detail, followed by interactive discussion around a specific paper, case report, or mini-workshop illustrating the application of research findings in a novel way (e.g. clinical application, meta-analysis, new use for old data). The organizing Instructor will provide a list of topics that must be covered by the student in the review portion of the class and moderate discussion during the more open portion.
Evaluation Method	Each student will be responsible for a Lecture Topic Review to be held in the first hour of each class (50% of their grade). Each student is also responsible for contributing to the Interactive Manuscript Discussion to follow in the second hour of each class (50% of their grade). The class accepts a minimum of 7 and maximum of 14 students. Instructors are to provide the lecture topic and can suggest manuscripts to be discussed in the second hour at least one week prior to the start date. On the Monday prior to student's presentation (3 days before), lecturers will be available in person or by email to provide an optional review of the student's proposed presentation and discussion plan. The Instructors are responsible for assigning the student's grade using an evaluation form common across all of the lectures.

Schedule

Date	Instructor	Lecture
Jan. 11	Mathieu Lupien Trevor Pugh	Course overview and setting expectations.
Jan. 18	Benjamin Haibe-Kains	Pharmacogenomics: Identifying opportunities for drug repositioning in cancer through aggregation of public data sets
Jan. 25	Hansen He	Transcriptional targets: A quantitative approach to identify new therapeutic targets within the cancer transcriptional landscape
Feb. 1	Michael Hoffman	Cancer epigenomics
Feb. 8	Daniel De Carvalho	Epigenomic weaknesses and immunotherapy: Improving immunotherapy through the power of epigenetic modulation
Feb. 15	Mathieu Lupien	Merging genomes and epigenomes: delineating the functional consequences of genomic alterations in cancer
Feb. 22	Trevor Pugh	Clinical cancer genomics: Approaches to analysis of cancer genomes to guide patient care

Winter 2018

TOPIC	Predictive Oncology & Therapeutics
Coordinators	Drs. Benjamin Haibe-Kains & Ming Tsao
Day & Time	Mondays 10:00 am – 12:00 pm
Location	Toronto Medical Discovery Tower 101 College Street, Room 4-204 (TBC)
Module Goals	One of the main challenges in precision medicine is the selection of the therapeutic strategy that will benefit the most to each individual patient. With the advent of high-throughput profiling technologies, more and more data can be generated to deeply characterize the molecular state of cancer cells and the phenotypes resulting from drug treatment both in vitro and in vivo. The “Predictive Oncology & Therapeutics” course will be composed of a series of didactic lectures on the key topics related to drug development. Each session will tackle of these topics with at least 30 minutes of questions and debates regarding the content of the lecture and its applications in biomedicine. The goal of this course is to provide students with a translational view of drug development, from basic research to clinical implementation. The students are expected to learn about the biological, computational and clinical aspects of the development of cancer therapeutics and their associated biomarkers (companion tests).
Evaluation Method	Short exam with multiple-choice questions

Schedule

Date	Instructor	Lecture
Mar. 5	Cheryl Arrowsmith, Aaron Schimmer	Drug discovery and development
Mar. 12	David Cescon	Preclinical testing of experimental therapeutics
Mar. 19	Benjamin Haibe-Kains, Scott Bratman	Biomarker discovery in preclinical setting
Mar. 26		Do not schedule—a week-long module offered during this time
Apr. 2	TBA	Pharmacogenetics and pharmacokinetics
Apr. 9	Tracy Stockley; Ming-Sound Tsao	Implementation and application of biomarkers in clinical settings
Apr. 16	Lilian Siu, Philippe Bedard	Design of clinical trials for cancer therapeutics
Apr. 23		Evaluation - short exam with multiple-choice questions

Winter 2018

TOPIC	Structural Biology & Proteomics
Coordinators	Drs. Mitsu Ikura & John Rubinstein
Day & Time	Thursdays at 9:00 am – 11:00 am
Location	Princess Margaret Cancer Centre, 610 University Ave, Room 7-605 (TBC)
Course Goals	This course offers 6 lectures that are focused on the current hot topics in structural biology and proteomics. Three lectures are designated to discuss structural biology, in which you will learn (1) protein structure and dynamics, (2) structures of membrane proteins, and (3) structures of supermolecular assembly. These courses will discuss the recent development in structural elucidation of biological macromolecules. You will learn how various research tools such as X-ray crystallography, NMR spectroscopy, and electron microscopy are used to determine atomic-resolution structures of complicated biological macromolecules (i.e. proteins, nucleic acids, etc) and their complexes. In the other three lectures designated to proteomics research, you will study various applications of mass spectrometry-based proteomics. Mass spectrometry has become an indispensable tool for a variety of biomedical research. The lectures intend to cover (1) large-scale mapping protein-protein interactomes in genomes, (2) global characterization of post-translational modifications (such as protein phosphorylation and ubiquitination) in proteomes, and (3) development of biomarkers for diagnosis. These lectures are designed to help students to grasp the overview of the latest advancement in structural biology and proteomics, the very active research fields in biology.
Evaluation Method	Report or essay (to be confirmed)

Schedule

Date	Instructor	Lecture
Mar. 1	Avi Chakrabarty	Structural Biology
Mar. 8	Avi Chakrabarty	Structural Biology
Mar. 15	Brian Raught/Thomas Kislinger	Proteomics
Mar. 22	John Rubinstein	Structural Biology
Mar. 29		Do not schedule –a week-long module offered during this time
Apr. 5	Brian Raught/Thomas Kislinger	Proteomics
Apr. 12	Brian Raught/Thomas Kislinger	Proteomics
Apr. 19	Evaluation	(Mitsu Ikura/John Rubinstein)

Fall 2017

TOPIC	Overview of Medical Imaging
Coordinators	John G. Sled
Day & Time	Wednesdays 12:30 – 2:30pm
Location	Sunnybrook Health Sciences Centre, S-wing, room S615
Course Goals	This module provides the mathematical preliminaries of medical imaging and introduces concepts of image formation, inverse problems, stochastic processes and instrument performance that are common to many medical imaging modalities. An introduction and historical perspective on the major medical imaging technologies is also presented. This course is a recommended prerequisite for the imaging modules offered in the physics stream.
Evaluation Method	Exam (70%) and lab report (30%)

Schedule

Date	Instructor	Lecture
Sept. 13	Peter N. Burns	Introduction to Medical Imaging: a brief history
Sept. 20	John G. Sled	Linear Systems and Fourier Transform Theory I
Sept. 27	John G. Sled	Linear Systems and Fourier Transform Theory II
Oct. 4	John G. Sled	X-rays, Projection and Tomography
Oct. 11	James Mainprize	X-ray CT lab (may need to be scheduled on multiple days to accommodate the number of lab groups)
Oct. 18	John G. Sled	Image formation and Inverse problems
Oct. 25	Exam	

Fall 2017

TOPIC	Cell and Molecular Biology for Physicists - Introduction
Coordinator	Jonathan Rast
Day & Time	Wednesday, 12:30 – 2:30 pm
Location	Sunnybrook, 2075 Bayview Ave, Rm. S615
Course Goals	This course introduces physical scientists to the basic concepts of cell and molecular biology including structure and function of nucleic acids (DNA and RNA) and proteins, DNA replication, transcription, translation, genetics, regulation of gene expression, cell growth and differentiation, basic developmental biology and immunology. The course will stress breadth rather than depth and is designed to introduce physical scientists whose research impinges on biology to the concepts and methodologies of molecular biology.
Evaluation Method	Exam (85%) and class participation (15%)

Schedule

Nov 1	J. Rast	Overview of molecular biology, molecules of life and genomes
Nov 8	J. Rast	DNA and RNA structure, DNA replication
Nov 15	J. Rast	Proteins
Nov 22	J. Rast	Transcription and Translation
Nov 22	J. Rast	Methods in molecular biology
Nov 29	J. Rast	Regulation of gene expression
Dec 6		Study break.
Dec 13		EXAM

TOPIC	Introduction to Biophotonics
Coordinators	Alex Vitkin and Lothar Lilge
Day & Time	Tuesdays, 9:00 – 11:00 am
Location	Toronto Medical Discovery Tower, 101 College St. Room 15-710
Course Goals	The use of light in medical diagnostics, therapeutics and biomedical research is increasing, driven by the advent of new light sources, inexpensive imaging detectors, advanced fiber-optic delivery systems, better understanding of light-tissue interactions, and proven clinical and research applications. The course will focus mostly on <i>in vivo</i> photonics and initially cover (1) the relevant issues of light propagation in / interaction with turbid media such as tissue. The bulk of the course will focus on (2) particular technical implementations and research / pre-clinical / clinical results in photo-diagnostics (effects of <i>tissue on light</i>) and photo-therapeutics (effects of <i>light on tissue</i>). Advanced topics such as (3) molecular imaging, nanophotonics, optical clearing and theragnostics will also be briefly covered. As such, the course goals include basic competencies in these there [(1)-(3)] areas.
Evaluation Method	Class participation and short oral exit exam

Schedule

Date	Instructor	Lecture
Nov 7	Alex Vitkin	Basic biophotonics – light propagation in tissue (Maxwell's equations, transport / diffusion theory and statistical Monte Carlo methods), light-tissue interactions, tissue optical properties, fundamentals of photodiagnostics and phototherapeutics.
Nov 14	Alex Vitkin	Diagnostic <u>imaging</u> , discussions of resolution, contrast, turbidity, imaging depth issues. High resolution diagnostics including optical coherence imaging, photoacoustics, optical projection tomography, confocal and multi-photon techniques; low(er) resolution approaches including diffuse optical imaging
Nov 21	Lothar Lilge	Diagnostic <u>spectroscopy</u> techniques including hyperspectral imaging, fluorescence and Raman spectroscopy
Nov 28	Lothar Lilge	Photo-therapeutics based on non-thermal interactions (low-level laser therapy, photodynamic therapy).
Dec 5	Lothar Lilge	Photo-therapeutics based on temporally-controlled (rapidly pulsed) laser delivery, including photo-ablation and selective photothermolysis
Dec 12	Alex Vitkin	Selected advanced topics such as nanophotonics, molecular imaging, optical clearing and theragnostics
Dec 19	Oral exit exam	

Fall 2017

TOPIC	Biophysics of focused ultrasound, thermal biophysics
Coordinator	Meaghan O'Reilly
Day & Time	Tuesdays, 12:30 – 2:30 pm
Location	Sunnybrook, 2075 Bayview Ave, Room S615
Course Goals	<p>Focused ultrasound can induce both thermal and non-thermal effects in biological tissues. These biophysical interactions form the basis of a range of therapeutic applications in current medical practice and in leading-edge research. The first half of this course will focus on thermal biophysics, drawing examples from focused ultrasound therapy as well as from other thermal modalities, such as radiofrequency and microwave. The physical and biophysical interaction mechanisms between the energy sources and tissue will be emphasized. Fundamentals of thermal dosimetry will be covered, with reference to the relevant tissue properties, the models of energy propagation within tissues, experimental techniques for dosimetry measurements, and the resulting biological effects. In the second half of this course non-thermal bioeffects of focused ultrasound will be examined. The physical mechanisms behind these mechanical effect will be covered, with an emphasis on cavitation and cavitation-mediated effects. Treatment monitoring considerations for non-thermal therapies will be discussed. The current status of thermal medicine and of focused ultrasound therapies will be reviewed using select clinical and pre-clinical examples.</p>
Evaluation Method	Exam

Schedule

Date	Instructor	Subject
Nov 7	Meaghan O'Reilly	Biology/Rationale/Nomenclature
Nov 14	Meaghan O'Reilly	Blood Flow/Modelling/Energy Delivery
Nov 21	Meaghan O'Reilly	Energy Delivery(Cont'd)/Thermometry/Treatment Monitoring
Nov 28	Meaghan O'Reilly	Non-Thermal Mechanisms of Ultrasound/Bioeffects
Dec 5	Meaghan O'Reilly	Cavitation/Cavitation Nucleating Agents
Dec 12	Meaghan O'Reilly	Treatment Monitoring for Non-Thermal Therapies
Dec 19	Exam	

Fall 2017

TOPIC	Advanced Medical Resonance Imaging
Coordinator	Charles Cunningham
Day & Time	Wednesdays, 12:30 – 2:30 pm
Location	Sunnybrook, 2075 Bayview Ave, M-Wing. Room M7-607
Course Goals	To gain an advanced understanding of how MRI works
Evaluation Method	Assignments only

Schedule

Date	Instructor	Subject
Nov 8	Cunningham	Phase encoding, frequency encoding, hybrids, RF pulses
Nov 15	Macgowan	Effects of motion, ghosting, motion compensation methods (e.g., gradient moment nulling, navigators, fast imaging).
Nov 22	Macgowan	Phase contrast and flow (2D & 4D), non-contrast angio, myocardial tagging, clinical implementation
Nov 29	Santyr	MRI Contrast Mechanisms, endogenous and exogenous
Dec 6	Santyr	paramagnetic, susceptibility-based, CEST contrast, magnetization transfer, hyperpolarized agents
Dec 13	Beatty	Image reconstruction - non-cartesian sampling and gridding
Dec 20	Beatty	Multi-channel signal acquisition and image reconstruction

Winter 2018

TOPIC	Clinical Imaging for Physical Scientists
Coordinators	Anne Martel, Korosh Khalili and Sarah Johnson
Day & Time	Monday at 9:15-11:15
Location	M6-502 Breast Centre Lecture Theatre, Sunnybrook Campus
Course Goals	This course seeks to provide an introduction to human anatomy and physiology for physical scientists with an interest in clinical imaging. Basic normal anatomy and physiology will be presented from a radiological perspective in lectures structured according to the major organ systems. A practical anatomy lab is included, through which students will have an opportunity to experience the three dimensional relationships of the structures they seek to image. In the lectures, examples of specific disease processes will be considered together with findings from X-ray, computed tomography, ultrasound, radionuclide and nuclear magnetic resonance imaging. Course evaluation will be based on participation in weekly sessions, and a written assignment.
Evaluation Method	Written assignment

Schedule

Date	Instructor	Lecture
Jan. 15	Korosh Khalili	Gastro-Intestinal Imaging
Jan. 22	Anne Agur	Anatomy Lab (Medical Sciences Building, 9-12am)
Jan. 29	Narinder Paul	Chest Imaging
Feb. 5	David Salonen*	Musculoskeletal Imaging
Feb. 12		Family day – no lecture
Feb. 19	Eugene Yu*	Neuroimaging
Feb. 19	Howard Leong-Poi*	Cardiac imaging
Feb. 26	Jose Sarrazin*	Genito-Urinary Imaging

*subject to confirmation

Winter 2018

TOPIC	Introduction to Bio-Microscopies
Coordinator	Dr. Brian Wilson
Day & Time	Tuesdays at 9:00 am – 11:00 am
Location	Princess Margaret Cancer Centre 610 University Ave, Room 7-605
Module Goals	<p>Various forms of microscopy are widely used in biomedical research as well as in clinical medicine. Major classes of microscopy include: A) optical microscopy (wide-field, fluorescence, laser-scanning confocal, Raman, bioluminescence, near-field, super-resolution, non-linear, light-sheet, intravital), together with a variety of fluorescent and other probes (dyes, fluorescent proteins, small-molecules); B) electron microscopy, in both transmission and surface-scanning modes and: C) scanning-probe microscopy (atomic force, scanning tunneling, near-field).</p> <p>The goal of this Module is to introduce the basic physical principles of the different forms of microscopy and survey the different techniques, instruments and probes used in studying bio-specimens (cells, tissues, biomaterials), illustrating these with examples of biomedical applications. The role of digital techniques and image processing/analysis will be considered.</p>
Evaluation Method	Multiple-choice examination

Schedule

Date	Instructor	Subject
2018 Jan 9	Brian Wilson	Introduction and Optical Microscopies-I
Jan 16	Brian Wilson	Optical Microscopies-II
Jan 23	Brian Wilson	Optical Microscopies-III
Jan 30	Chris Yip	Scanning-Probe Microscopy
Feb 6	John Rubinstein	Electromagnetic Microscopy
Feb 13	Sergio Grinstein	Biomedical Applications
Feb 20	Evaluation	

Winter 2018

TOPIC	Nanotechnology for Medicine
Coordinator	Gang Zheng
Day & Time	Wednesdays, 12:30 – 2:30 pm
Location	Downtown, room TBA
Course Goals	This course is not a basic survey, but a critical and timely analysis of the current state of the nanomedicine field, how it has become incorporated in to multiple disciplines, and the factors that must be considered for its future progress and successful clinical implementation. The course will begin with an introduction to nanotechnology, the unique physical properties that define nanoscale materials, and the state of art techniques to study the nanobiointerface. The course will focus on the design considerations for nanoparticles will be considered through a discussion of how they interface with biology, which make them advantageous additions to the toolkit of agents for disease diagnosis and therapy. The course will then progress to sophisticated approaches for nanomedicine applications. Finally, the course will conclude by covering challenges and opportunities in translation of nanomedicines to the clinic.
Evaluation Method	Each student will produce a written report of a topic covered in the course but unrelated to their thesis project plus an oral presentation on the March 1 st class. <ul style="list-style-type: none"> ○ Format: journal mini-review style, max. 5 pages (1.5 space, pt 12 font) with one figure plus references. ○ Evaluation criteria will be heavily weighted on quality of analysis. The grade will be a combination of attendance and participation (10%), written report (70%) and oral presentation (20%).

Schedule

Date	Instructor	Subject
Jan 17	Warren Chan	Introduction to Nanotechnology in Medicine
Jan 24	Gilbert Walker	Physical Properties Unique to Nanoscale Materials
Jan 31	Christopher Yip	State of Art Techniques to Study NanoBioInterface
Feb 7	Shirley Wu	Nanoparticles for Drug Delivery: Synergistic Drug Combination
Feb 14	Christine Allen	Nanoparticles for Drug Delivery: Theranostics
Feb 21	Gang Zheng	Clinical Translation of Nanomedicine
Feb 28	Evaluation	

Winter 2018

TOPIC	Biological Imaging
Coordinators	Jason Lerch
Day & Time	Monday, 10-12
Location	Princess Margaret Cancer Centre, 610 University Ave, Room 7-605
Module Goals	Imaging has been used to probe important questions in biology. This module will focus on how imaging can be, and has been, used to address such questions. A series of topics will address (1) the knowledge gaps at the beginning of the project; (2) the methodological developments and advances required to address those gaps; and (3) how imaging advanced our knowledge of the field.
Evaluation Method	Students will be asked to write a short grant proposal on a novel project to answer a question in biology using state of the art imaging. In addition, there will be marks for course participation.

Schedule

Date	Instructor	Lecture
2018 Mar 5	Jason Lerch	Course intro and the study of brain plasticity
Mar 12	Mark Henkelman	Genes and development: embryonic mouse imaging
Mar 19	Brian Nieman	Late effects of brain irradiation
Mar 26	Bojana Stefanovic	Vascular coupling
Apr 2	Jason Lerch	Internal grant reviews: peer reviews of grant proposals
Apr 9	Chris Macgowan	Cardiac development
Apr 16	Final grant proposal due.	

Winter 2018

TOPIC	Magnetic Resonance Imaging - Overview
Coordinator	Simon Graham
Day & Time	Tuesdays, 12:30 – 2:30 pm
Location	Sunnybrook Research Institute, 2075 Bayview Ave. Room TBA
Course Goals	Since development of the first hospital-grade systems in the 1980s, magnetic resonance imaging (MRI) continues to make a profound impact on how physicians evaluate soft tissues within the human body. This course provides students with an overview of MRI technology covering the underlying physical principles of signal generation, signal contrast mechanisms, process of image formation, and basic instrumentation. The course is a prerequisite for students who subsequently wish to take Advanced Topics in MRI.
Evaluation Method	Lab and Exam

Schedule

Date	Instructor	Subject
March 6	J. Chen	Basic physics 1
March 13	J. Chen	Basic physics 2
March 20	B. Nieman	Imaging physics 1
Mar 27	B. Nieman	Imaging physics 2
April 3	M. Pop	Laboratory
April 10	M. Pop	Instrumentation
April 17	S. Graham	Exam

Winter 2018

TOPIC	Ultrasound Overview
Coordinators	Ali Sadeghi-Naini
Day & Time	Wednesdays at 12:30 pm – 2:30 pm
Location	Sunnybrook Health Sciences Centre, 2075 Bayview Avenue, Room S615
Course Goals	<p>Ultrasound is a high-resolution and rapid imaging modality that applies high-frequency acoustic waves to create images based on echoes that are generated by acoustic impedance heterogeneity between different materials in a sample. Ultrasound imaging has many clinical applications from monitoring fetus in pregnancy, to diagnostic imaging of breast, abdomen and vasculature, and guiding interventional tools in minimally-invasive procedures.</p> <p>This course will introduce the principles of ultrasound imaging starting with a general overview of this imaging modality and its applications. It will cover basic physics of ultrasound, transducers and beam forming, interaction of ultrasound waves with tissue, signal processing and image formation, flow detection and imaging, quantitative ultrasound techniques, and ultrasound elastography. The Overview of Medical Imaging or equivalent preparation is a prerequisite for this module.</p>
Evaluation Method	Lab report (35%) and exam (65%)

Schedule

Date	Instructor	Lecture
March 7	Ali Sadeghi-Naini	General overview, basic physics of ultrasound, transducers, beam forming
March 14	Ali Sadeghi-Naini	Interaction of ultrasound waves with tissue, ultrasound signal processing, image formation
March 21	Ali Sadeghi-Naini	Flow detection and imaging
March 28	Ali Sadeghi-Naini	Quantitative ultrasound techniques, ultrasound elastography
April 11	Tutorial with TAs	
April 18	Lab with TAs	
April 25	Exam	

“Integrity is doing the right thing, even when no one is watching.”

-British novelist C.S. Lewis

Faculty of Medicine Task Force Report on Research Integrity

I INTRODUCTION

Acting with integrity begins with a commitment to six fundamental values – honesty, trust, fairness, respect, responsibility and courage – even in the face of adversity.¹ As a national and global leader in education and research, the University of Toronto’s Faculty of Medicine (FoM) must ensure this commitment is put into practice as it carries out its mission to develop leaders, contribute to our communities and improve the health of people and populations through the discovery, application and communication of knowledge. Underlying that mission, the FoM embraces the following values², all of which inform how research is conducted:

- Integrity in all endeavors;
- Commitment to innovation and excellence;
- Life-long learning and critical inquiry;
- Promotion of social justice, equity, diversity, and professionalism;
- Effective partnership with all our stakeholders;
- Multi-professional and interdisciplinary collaboration;
- Supportive and respectful relationships;
- Accountability and transparency;
- Responsiveness to local, national, and international health needs.

For the purposes of this report, research is defined broadly to include all fundamental/basic science research; all clinical research, including clinical trials; education research; health policy research; knowledge translation and dissemination; and quality improvement and patient safety. An expanded definition of research can be found in the University’s *Policy on Research Administration*.³

Research activity at the University is governed by a range of University policies such as the *Policy on Ethical Conduct in Research*,⁴ and informed by FoM and affiliated hospital harmonized guidelines and procedures, including the statement of *Principles and Responsibilities Regarding Conduct of Research*.⁵ For a full list of University and FoM policies, guidelines or procedures governing research integrity and misconduct, see Appendix B: University Resources. In addition, the principles outlined in these policies

¹ International Center for Academic Integrity

² Faculty of Medicine, University of Toronto, Vision/Mission/Values, November, 20, 2014, available online at:

<http://www.medicine.utoronto.ca/about-faculty-medicine/vision-mission-and-values>

³ Research Administration Policy, University Governing Council, available online at:

<http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/p1030res.pdf>

⁴ Policy on Ethical Conduct in Research, March 28, 1991, available online at:

<http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppmar281991i.pdf>

⁵ Principles and Responsibilities Regarding Conduct of Research, October 11, 2002, available online at:

<http://medicine.utoronto.ca/sites/default/files/Conduct%20of%20Research.pdf>

or guidelines are consistent with the Tri-Agency Framework⁶ and other funding agencies' ethical codes with respect to research.

Research misconduct has many causes and can take many forms, including but not limited to: fabrication/misrepresentation of data, plagiarism, "text recycling" or self-plagiarism, image or statistical manipulation and image fraud. It can also be associated with a lack of supervisory rigor and failure to apply due diligence in the operation of a research study, laboratory or program.

Ensuring the highest ethical standards is essential to the academic research mission and to the FoM's standing as a national and global leader. The FoM, including its affiliated teaching hospitals, attracts \$790M in research funding, with \$104M for on-campus research. A breach of research integrity not only damages the credibility of individuals, colleagues and collaborating programs and interferes with future science, but also confers extensive reputational risk to the FoM and University at large. Dissemination of fabricated results also has the potential to cause harm to patients and can negatively impact research conducted by others. The speed and ubiquity of digital media amplify these risks, particularly with the advent of social media savvy organizations such as Retraction Watch.

In 2009, University of Toronto formed the Research Oversight and Compliance Office (ROCO) in response to escalating sponsor and regulatory requirements in research as well as growing financial, legal and reputational risks: "ROCO was the first office of its kind in Canada and signaled important recognition of the need to achieve and sustain a level of distributed oversight and compliance consistent with the University's massive and highly decentralized research enterprise."⁷ Over the last five years, research misconduct involving campus-based researchers across all faculties (as opposed to hospital-based researchers)⁸ has been found in a total of five cases: one in 2011; four in 2012; zero in subsequent years.

It is important to recognize that fewer than 10 per cent of full-time faculty members in the FoM (~225 of more than 2,800) work on-campus at the University. Most work in affiliated teaching hospitals and normally engage in research under the hospital auspices. Accordingly, the FoM cannot systematically track research misconduct across all teaching hospitals. However, recent cases involving hospital-based researchers with FoM appointments have certainly attracted public media attention. Any case of research misconduct is important in its own right and also has the potential to damage institutional reputation and cause harm to individuals; therefore prevention must remain an important focus in all the settings in which our faculty conduct their work. Against this backdrop, the Dean of the FoM commissioned the Task Force on Research Integrity to examine the standards of training and practice with regard to the Responsible Conduct of Research among faculty members.

⁶ Tri-Agency Framework: Responsible Conduct of Research, 2016, available online at: <http://www.rcr.ethics.gc.ca/eng/policy-politique/framework-cadre/>

⁷ <http://www.dlsph.utoronto.ca/2013/10/professor-lori-ferris-accepts-avp-position-for-research-oversight-and-compliance/>

⁸ Under the terms of the Research Misconduct Framework Addendum, University of Toronto's affiliated teaching hospitals have jurisdiction over investigations of alleged misconduct in research conducted at the hospitals.

II TERMS OF REFERENCE

“Responsible Conduct of Research” is a concept which must encompass most of the professional activities that are part of research practice. As defined by the Tri-Council funding agencies, this practice encompasses aspects related to research collaborations, conflicts of interest, data acquisition/sharing, protection of human subjects, lab animal welfare, the responsible mentoring of researchers, publication practices/responsible authorship, and processes to investigate allegations of research misconduct.

The Dean’s Task Force on Research Integrity consulted within the Faculty of Medicine. (see Appendix A). The focus of this Task Force is to examine the current state of the Responsible Conduct of Research in the FoM, with the goal of promoting a culture of ethical research practice among all our faculty members. The following are the specific Terms of Reference for this Task Force:

1. To carry out an internal scan of the FoM to identify the current required and recommended training for faculty members across campus and Toronto Academic Health Science Network hospitals with regard to the Responsible Conduct of Research.
2. To carry out an external scan of relevant training programs within Canada and the U.S. to identify best practices and the highest quality training programs.
3. To clarify reporting processes when questions/concerns related to scientific misconduct are suspected at the University.
4. Based on the information obtained from these scans, to recommend standards of required training for all faculty members who are currently engaged in – or who may in the future engage in – research activities.
5. To recommend actions the FoM should take to help foster a ubiquitous culture of ethical research practice for all faculty members.

The scope of this report focuses on faculty members currently conducting (or in the future, may conduct) research activity across all sectors – basic sciences, clinical, and rehabilitative sciences – associated with the FoM. This report provides the Dean of the FoM with concrete recommendations designed to prevent research misconduct.⁹

III ENVIRONMENTAL SCAN

The FoM currently does not mandate a centralized training program regarding Responsible Conduct of Research for faculty members. This is due to the decentralized nature of the research enterprise, which involves scholarly activities conducted not only on University of Toronto campuses but throughout the fully-affiliated sites and associate member hospitals of the Toronto Academic Health Sciences Network (TAHSN) and their research institutes, as well as at community-affiliated sites. Research conduct is generally governed by the policies and practices of each site.¹⁰ Some research integrity training is

⁹ The scope of this report does not address prevention or training specifically aimed at students or trainees.

¹⁰ Harmonized research guidelines as between the University and TAHSN sites are detailed in Appendix B.

mandated by University Departments and takes place on campus; other activities takes place at TAHSN sites.

TAHSN has a Research Committee (TAHSNr) co-chaired by Dr. Michael Julius (Vice-President, Research, Sunnybrook Research Institute) and Dr. Richard Hegele (Vice Dean, Research and Innovation, FoM). Membership on TAHSNr includes each VP Research (or equivalent) representing each affiliated site within TAHSN and representatives from the University, including from the Vice-President, Research and Innovation's portfolio. In the spring of 2016, Drs. Julius and Hegele asked each fully-affiliated and community-affiliated site representative to answer the following questions:

1. Does your Research Institute offer faculty members who do research specific training sessions, didactic lectures, online modules or other learning approaches provided to promote research integrity?
2. How are these materials/sessions offered and by whom?
3. What is communicated to faculty members about the consequences if research integrity is breached and how is that message conveyed?

Eleven of thirteen member sites within TAHSNr responded. Results indicate there are already considerable efforts in place at the majority of TAHSN sites in training faculty members in research integrity, including web-based training and e-learning, orientation activities, in-class training, symposia, rounds and other forums. One VP Research summarized general aspirations as follows: "The focus of training is intended to promote responsible practice by establishing quality standards."

Although there is variability between sites in the approaches used locally for training faculty members in research integrity, several themes emerged:

- Seven of the affiliated sites alluded to research investigators completing online modules on the Responsible Conduct of Research, of which 12 modules are available via the Collaborative Institutional Training Initiative Canada website (discussed further below). Institutional membership in the Network of Networks (N2) allows these modules to be completed at no cost to the investigator. There is variability between sites as to whether completion of some or all related modules is mandatory, ranging from "strongly recommended" to "Research Ethics Board approval is not given until all applicants have completed the N2 training."
- Other online resources relevant to clinical research include the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) Good Clinical Practice and Tri-Council Policy Statement 2 (TCPS2)—Ethical Conduct of Research. For investigators doing research involving human subjects, completion of TCPS2 is mandated by all sites.
- In those institutions that mandate refresher training, this ranges from every 2-5 years.

- Some institutions have found it useful to separate training for basic science researchers from training for clinical researchers. (See Task Force Recommendation #12, p. 15)
- Institutions make their investigators aware of policies and procedures in place for addressing allegations of research misconduct, with revisions and updates communicated electronically.
- At least one of the affiliated sites stated that research integrity training should not be made a mandatory requirement, as this would unduly burden the many for the actions of a few.

In addition to online modules, there are other approaches to research conduct training across TAHSN, including:

- Offering free access to online plagiarism detection software;
- Research orientation sessions for new personnel and research investigators; and
- Annual research retreats or periodic research integrity forums and other in-house professional development.

At the national level, the federal Secretariat on Responsible Conduct in Research has, since late 2011, had a policy on “consent to disclosure” for any serious research misconduct for all researchers seeking Tri-Council funding.¹¹ This policy requires all researchers applying for CIHR, NSERC or SSHRC grant funding to consent to the Agency disclosing any information relevant to the breach that is in the public interest, including the:

- Name of the individual who committed the breach;
- Nature of the breach;
- Institution where the individual was employed at the time of the breach;
- Institution where the individual is currently employed; and
- Recourse imposed by the Agency against the respondent.

Given this regulatory requirement, it is ever more important that institutions that rely on Tri-Council funding for research – including FoM – proactively work to educate faculty members on the Responsible Conduct of Research and foster a culture that rewards and recognizes integrity in research as a key aspect of faculty member recognition, including promotion and awards.

Looking beyond Canada, the Collaborative Institutional Training Initiative (CITI) is a nonprofit organization based at the University of Miami that offers comprehensive training on the Responsible Conduct of Research. Founded in 2000, CITI materials on the Responsible Conduct of Research constitute the most comprehensive and utilized training in elite institutions in the US. Its mission:

“To promote the public's trust in the research enterprise by providing high quality, peer reviewed, web based, research education materials to enhance the integrity and professionalism of investigators and staff conducting research.”

¹¹ http://www.nserc-crsng.gc.ca/NSERC-CRSNG/governance-gouvernance/consentFAQ-consentementFAQ_eng.asp#10

In 2010, the Network of Networks (N2) in Canada – an alliance of 90+ clinical research entities and institutions including University of Toronto – partnered with CITI to establish a source of high quality, web-based Canadian instruction around safe, responsible, ethical research conduct. Most applicable to the scope of this report are the Responsible Conduct of Research modules (see below under “Recommendations”) offered through N2; written at a general level and suitable to researchers in all disciplines, these modules provide a solid foundation relating to the norms, principles and rules governing responsible research practice in Canada.¹² The N2 member institution may set the number and list of modules required for certification; an administrator receives automated reports of individual training completion and can generate further reports.

The University of Toronto is a N2 member. Anyone with an institutional email account (@utoronto.ca) may sign in and use the CITI modules.

IV Research Misconduct Definitions & Examples

The University of Toronto’s ***Framework to Address Allegations of Research Misconduct*** defines research misconduct as:

“...any research practice that deviates seriously from the commonly accepted ethics/integrity standards or practices of the relevant research community and includes but is not limited to intentional fabrication, falsification, and plagiarism as defined by the University’s Code of Behaviour on Academic Matters.....due regard is given for honest errors, honest differences in methodology, interpretation or judgement, or divergent paradigms in science; what is at issue are genuine breaches of the integrity of the research process.”¹³

Research misconduct most often falls into the following three broad categories:

1. **Fabrication:** Making up data or results and recording or reporting them.
2. **Falsification:** Manipulation of research materials, equipment, or processes, or changing or omitting data or results such that the research is not accurately represented in the research record.
3. **Plagiarism:** The appropriation of another person’s ideas, processes, results, or words without giving appropriate credit. This includes **self-plagiarism:** Recycling or re-using one’s own work without appropriate disclosure and/or citation.

However, other types of research misconduct are also recognized. These include, but are not limited to:

¹² <http://n2canada.ca/the-collaborative-institutional-training-initiative-citi-canada/#more-390>

¹³ <http://www.research.utoronto.ca/wp-content/uploads/documents/2013/09/Research-Misconduct-Framework-Jan-1-2013.pdf>

Impropriety of authorship: Claiming undeserved authorship on one's own behalf, excluding material contributors from co-authorship, including non-contributors as authors, e.g. ghostwriting, or submitting multi-author papers to journals without the consensus of all named authors.

Misappropriation of ideas: Taking the intellectual property of others, perhaps as a result of reviewing someone else's article or manuscript, or grant application and proceeding with the idea as one's own.

Violation of generally accepted research practices: This can include the manipulation of experiments to generate preferred results, deceptive statistical or analytical practices to generate preferred results, or improper reporting of results to present a misleading outcome.

Suppression of publication: Failing to publish significant findings due to the results being adverse to the interests of the researcher or his/her sponsor(s).

Inappropriate behavior in relation to suspected misconduct: Failure to cooperate with any claims of misconduct made against a faculty member, failure to report known or suspected misconduct, destruction of any evidence related to any claim of misconduct, retaliation against any persons involved in a claim of misconduct, knowingly making false claims of misconduct.

V UNIVERSITY REPORTING PROCESSES

Addressing Suspicions of Research Misconduct:

Bringing forward concerns about research misconduct may be a daunting prospect for members of the University community. A variety of mechanisms exist within the University and the FoM to alleviate the stress associated with whistleblowing.

The University's **Framework to Address Allegations of Research Misconduct** (the "Framework") permits allegations to be lodged anonymously in limited circumstances. Anonymous complaints should be submitted with enough information to allow the allegations, including supporting facts and evidence, to be assessed by the University, without requiring additional information from the individual who made the complaint. It should be noted that the University may elect not to proceed with anonymous allegations, particularly where there is insufficient supporting material. If the University elects to proceed with an anonymous complaint, the individual who lodged the complaint is not entitled to participate in the process set out in the Framework.

Assurances regarding confidentiality are also an integral element of the University's Framework, which requires the highest possible degree of confidentiality be maintained regarding the allegations, inquiries and investigations, subject to required disclosures (ex. pursuant to law or policy). The commitment to confidentiality applies both to the individual bringing forward the complaint, as well as the subject of

the complaint, with the Framework identifying the confidentiality obligations of all involved parties at various stages of the process.

Additionally, there are a number of avenues for individuals concerned about suspected research misconduct to obtain support and advice within FoM, including:

- Contacting the applicable Department Chair(s);
- Conferring with relevant FoM senior leaders based in the hospitals or on campus; and
- Speaking to the Clinical Faculty Advocate.

Initiating a Complaint:

As a preliminary matter, the University’s Framework encourages individuals concerned about a potential case of research misconduct to seek an explanation from the suspected individual, if appropriate, to ensure no misunderstanding.

Complaints should be directed to the University’s Vice-President Research and Innovation portfolio (VPRI) at **research.integrity@utoronto.ca**; . The University’s Associate Vice-President, Research Oversight and Compliance handles the complaints on behalf of the VPRI.

Complaints should be made in writing, set out all relevant information and include supporting evidence, if available. Unless brought forward anonymously, the complaint should identify and be signed and dated by the complainant and provide appropriate contact information. Allegations must be made in good faith and declare any conflict of interest.

Reporting and Responding to Research Misconduct:

The Task Force has developed a high level overview of the Framework’s process to assist faculty members in reporting and responding to allegations of research misconduct. **NB: The following overview should not be used without reference to the corresponding Framework.**

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
1	5.1-5.2	File Complaint	Allegations must be in writing, set out relevant information and evidence, and be signed and dated by, and identify	Complaints should be directed to VPRI: research.integrity@utoronto.ca • ¹⁶ •

¹⁴ Review for further details.

¹⁵ Responsible party indicated is from the University, unless otherwise indicated.

¹⁶ Reference to “Dean(s)” in this overview means the Dean of the academic division in which the Respondent holds their primary appointment. If the Respondent holds primary appointments in different divisions (e.g. FoM and School of Graduate Studies), the referral is to both Deans, who will decide which will serve as Dean for purpose of the complaint and will keep the other informed of the complaint’s status.

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
			Complainant.	
2	Framework Addendum 4-5	Determine Jurisdiction	Determine if hospital or University has jurisdiction over complaint of Research Misconduct, in accordance with the Addendum to the University's Framework . If complaint falls within the University jurisdiction, process unfolds as per below. ¹⁷	Associate Vice-President, Research Oversight and Vice-Provost, Relations with Healthcare Institutions; Affiliated Hospital's Vice-President, Research, or delegate.
3	5.3-5.4	Referral to Vice-President, R&I	Complaint forwarded to Office of Vice-President, Research & Innovation ("R&I").	Individual in receipt of Complaint
4	5.5-5.6	Referral by Vice-President, R&I	Vice-President, R&I will notify and provide the subject of the complaint (the "Respondent") with a full copy of complaint and refer complaint to Dean(s) ¹⁸ normally within 7 days ¹⁹ of receipt.	Vice-President, R&I
5	7.1	Administrator Appointed	Dean appoints an Administrator ²⁰ to conduct a preliminary inquiry, normally to begin within 20 days of the Dean's receipt of complaint.	Dean
6	7.2-7.3	Preliminary Inquiry	Administrator gathers information and provides recommendation as to whether complaint should	Administrator appointed by Dean

¹⁷ If complaint falls within hospital's jurisdiction, the hospital may commence its own inquiry, and may report its findings to the University.

¹⁸ Reference to "Dean(s)" in this overview means the Dean of the academic division in which the Respondent holds their primary appointment. If the Respondent holds primary appointments in different divisions (e.g. FoM and School of Graduate Studies), the referral is to both Deans, who will decide which will serve as Dean for purpose of the complaint and will keep the other informed of the complaint's status.

¹⁹ All timelines refer to maximum number of working days allowable.

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
			proceed to an investigation normally within 60 days of Vice-President, R&I's receipt of complaint.	
7	8.2, 8.6	Appointment of Investigation Committee	Dean appoints Investigating Committee normally within 15 days of receipt of Administrator's recommendation that Investigation should be conducted (composition of which is detailed in Framework).	Dean
8	8.2-8.7	Committee Convenes	Investigating Committee convenes normally within 30 days of appointment.	Investigating Committee
9	8.3	Reporting Commencement of Investigation	Dean informs Vice-President, R&I that an investigation of a complaint of research misconduct has commenced.	Dean
10	8.7	Notice of Committee's Appointment	Investigating Committee notifies Respondent and Complainant of the investigation process, including their respective rights and obligations, namely: <ul style="list-style-type: none"> • Complainant may provide written materials to supplement complaint; • Respondent may comment on any supplementary material from Complainant; • Complainant may review the response of Respondent to 	Investigating Committee

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
			supplementary material.	
11	8.7	Other Steps in Investigative Process	Investigating Committee: <ul style="list-style-type: none"> • will set deadline for submission of responses and evidence; • may conduct interviews, which will be summarized and provided to interviewed party; • will provide Respondent with access to documents to enable a fair opportunity to respond to relevant material. 	Investigating Committee
12	8.6	Interim Findings	Committee will provide interim findings to Dean, if it's of the view that such must be reported to fulfil University's obligations to its community or third parties.	Chair of Investigating Committee
13	8.2	Investigation Complete	Investigation to be complete normally within 60 days of Committee's first meeting.	Investigating Committee
14	8.8	Final Report	Committee delivers final report to Complainant, Respondent, Dean and Vice-President, R&I normally within 30 days of completed investigation (content of final report detailed in Framework).	Investigating Committee
15	8.8	Respondent and Complainant Opportunity to Respond to Final Report	Respondent and Complainant have up to 15 days to make submissions to the Dean regarding the findings, in	Respondent / Complainant

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
			advance of any administrative action recommended to be taken by the Dean.	
16	8.9	Report of the Dean	Dean informs Vice-President, R&I of the findings of the investigation and the Dean's decision about administrative action.	Dean
17	9.1	Where no Research Misconduct Found	Dean sends letter confirming finding of no Research Misconduct to Respondent, with copy to Complainant and, at Dean's discretion, to other persons.	Dean
18	9.2	Where Research Misconduct is Found	Dean decides on remedial/disciplinary action, in consultation with Vice-President, R&I and Provost within 15 days of Dean's receipt of submissions from Respondent in response to the Final report. For Research Misconduct involving faculty member, action may include proceedings leading to sanctions under <i>University's Code of Behaviour on Academic Matters</i> or <i>Policy and Procedures on Academic Appointments</i> or other University policies and/or agreements and related procedures.	Dean
19	9.3	Communication about Outcome	Vice-President, R&I may communicate outcome of	Vice-President, R&I

	Framework Reference ¹⁴	Step	Explanation	Responsible University Party ¹⁵
			investigation to other parties within or external to University.	
20	10	Reviews	Respondent may have rights of review, grievance or appeal related to sanction pursuant to University policy or a collective agreement. Where a Respondent has no access to any other process for review of the administration action or sanction, they may seek review by the Vice-President, R&I, which must be sought within 5 days of the decision regarding the administration action or sanction.	Applicable tribunal, adjudicator or Vice-President, R&I

VI TASK FORCE RECOMMENDATIONS

After thorough consultations and a review of best practices, the Task Force has compiled a series of recommendations designed to ensure the FoM reflects its position as a national and international leader through the highest standards of research integrity. Recognizing the complexity of FoM research – across scientific domains, multiple campuses, hospitals and sites – there are some core strategies recommended for immediate implementation under three categories: data management, training initiatives and facilitating a culture of integrity.

DATA MANAGEMENT:

To adhere to best practices, faculty members engaged in research should:

1. Follow national guidelines with respect to digital data management, e.g. Tri-Agency Statement of Principles on Digital Data Management.²¹

²¹ Found online at: <http://www.science.gc.ca/default.asp?lang=En&n=83F7624E-1>.

2. Consult international guidelines on clinical trial protocols, clinical trials registration and reporting of trials, cohort studies, systematic reviews, etc. according to the relevant recommendations, e.g. the Consolidated Standards of Reporting Trials (CONSORT) Statement.²²
3. Outline hypotheses and data analysis plan prior to conducting a research study in order to guide the responsible collection, formatting, preservation and sharing of data throughout the entire lifecycle of a research project and beyond.²³
4. Use electronic data systems wherever possible for data collection and management, e.g., use of computer assisted data entry, such as through use of a data management system like REDCAP²⁴. Funding to cover the costs of a data management system should be incorporated into grant applications.
5. Ensure data collection/data entry is not performed by the investigator (e.g. instead, a research assistant or data entry clerk); funding for this should be incorporated into grant applications.
6. Put into place a formal plan for data quality control (e.g. double data entry, source document comparisons, etc.). Data quality control should not be performed by the investigators. Funding for this should be incorporated into grant applications.
7. In cases where there are no laws, regulations, policies or REB requirements mandating it, still consider, consider using a Data Safety Monitoring Board (DSMB) as an independent review/advisory committee for clinical research where human subjects are being recruited, in trials and even possibly cohort studies.²⁵
8. Ensure the project raw dataset is stored securely as per the data retention requirements (by either the PI or by research institute, as appropriate).
9. Provide the analysis dataset to a statistician responsible for analysis (post coding of variables and quality control using raw data).
10. Provide an opportunity for other members of the research team to review coding, analytic output and/or redo modelling to ensure consistency of findings prior to dissemination and publication.

TRAINING INITIATIVES:

11. The Task Force strongly recommends that for all faculty members engaged in research the N2 modules should be completed every 3 years (see below). For faculty involving human subjects, N2 modules 1-11 should be completed²⁶ every 3 years. For all faculty engaged in animal research, modules 1- 4 and 6-12 should be completed every 3 years.

²² CONSORT Statement and resources are found available online at: <http://www.consort-statement.org/>

²³ See Tri-Agency Statement of Principles on Digital Data Management, *supra* note 22.

²⁴ Found online at: <https://projectredcap.org/>

²⁵ A DSMB complements the role of a Research Ethics Board (REB) and has a much broader scope for oversight of data.

²⁶ Any faculty member can access the N2 modules by registering as a user on the CITI site: <https://www.citiprogram.org/> and click on the "Register" button under "Create an account". As long as the individual has a UTOR email address, s/he should be able to create the account and access the modules.

- 1) Research Misconduct
- 2) Introduction to the Responsible Conduct of Research
- 3) Ethics and the Responsible Researcher
- 4) Conflicts of Interest in Research
- 5) Human Participants Research and Ethics
- 6) Writing with Integrity
- 7) Data Acquisition and Management
- 8) Publication Practices and Responsible Authorship
- 9) Peer Review: Role and Process in Life Sciences Research
- 10) Responsible Mentoring
- 11) Collaborative Research
- 12) Animal Care and Use

12. This training recommendation should be part of the applicable annual faculty member review process (i.e. credentialing, or reappointment or review).

Faculty members who have no expectation of engagement in any aspect of research may be exempt from the recommended training modules. The FoM should aim to collaborate with affiliated sites to review annually the activities of exempted faculty members, and remove exemptions for those who may be engaged in research, as broadly defined previously.

FACILITATING A CULTURE OF INTEGRITY:

13. Institute formal and encourage informal mentoring programs for undergraduate students, trainees and fellows to ensure the next generation of researchers is fully versed in research integrity principles
14. Create educational opportunities to promote integrity values among faculty members through ongoing in-person engagement and communication on these issues, for example:
 - a. Training in appropriate practices for supervisors of research in the FoM;
 - b. Review of principles of data management and training obligations for all faculty;
 - c. Recurring key messages in speaking remarks to appropriate research audiences;
 - d. Annual research integrity forum with external speakers and case discussions;
 - e. Ensuring any faculty members funded through national funding agencies are aware of all policies they are subject to, e.g., Tri-Council-funded faculty members are aware of the Tri-Council Framework, including mandatory consent to disclosure policy for serious RCR breaches.
15. Remain current on national issues related to responsible conduct of research by nominating the FoM Vice Dean, Research and Innovation (or delegate) to attend quarterly teleconference meetings of a national “community of practice” group piloted in 2015 by the Secretariat for Responsible Conduct of Research.

16. Review current research award criteria across FoM Departments and Units to ensure criteria relating to an individual's values, professionalism and citizenship are included in adjudication.
17. Ensure support and protection for those who bring forward suspicions of research misconduct and communicate the FoM's expectation that, consistent with University policy, any retaliation against complainants will be dealt with accordingly.
18. Demonstrate the FoM's commitment to transparency through encouraging the University to publicly report, e.g. posting an annual anonymized update summarizing findings of misconduct and sanctions across the FoM.
19. Seek increased coordination between University and affiliated hospitals and clinical sites with respect to administrative procedures to ensure appropriate and timely communication regarding research misconduct investigations and findings, as permitted by applicable law, policy and agreements.
20. Consider whether Framework may be interpreted to allow early and timely notification of the Dean and Vice-Dean, Research & Innovation, FoM, upon complaint submission.
21. Encourage strengthened communications between the VPR&I, Dean and Department Chairs to ensure Chairs have appropriate information regarding candidates for faculty appointments or promotions with respect to research misconduct.
22. Develop an annual ethics scorecard as an internal tracking tool under the auspices of the FoM's Vice Dean, Research and Innovation.

Although a complex matter, the Responsible Conduct of Research at the institutional level requires an ongoing commitment to facilitate a culture of integrity and provide access to resources that enable best practices in the conduct of research. The Task Force believes that the adoption of the foregoing recommendations will significantly foster the ability of FoM faculty members to conduct research to the highest ethical standard, underscoring the University of Toronto's position as a national and international leadership in education and research. The FoM is committed to collaborating with its faculty members and affiliated institutions in disseminating these recommendations, and providing faculty development and other supports to facilitate their adoption.

APPENDIX A: Task Force membership and stakeholders consulted

Allan S. Kaplan, MSc., MD, FRCPC (Chair)

Vice Dean Academic and Graduate Affairs, Faculty of Medicine; Professor, Department of Psychiatry, University of Toronto

Richard Hegele, MD, FRCPC, PhD

Vice Dean Research and Innovation, Faculty of Medicine; Professor, Department of Laboratory Medicine and Pathobiology, University of Toronto; Chief, Department of Paediatric Laboratory Medicine, SickKids

Lynn Wilson, MD, CCFP, FCFP

Vice Dean, Partnerships, Faculty of Medicine; Associate Vice Provost, Relations with Health Care Institutions; Professor, Department of Family and Community Medicine, University of Toronto

John Bohnen, MD

Senior Advisor to the Dean on Clinical Affairs; Professor, Department of Surgery, University of Toronto

Gillian Hawker, MD, MSc., FRCPC

Sir John and Lady Eaton Professor and Chair, Department of Medicine, University of Toronto

James Rutka, MD, PhD, FRCSC, FACS, FAAP, FAANS

RS McLaughlin Professor and Chair, Department of Surgery, University of Toronto

Sara Gottlieb

Legal Counsel, Faculty of Medicine/Office of the Vice Provost, Relations with Health Care Institutions, University of Toronto

Linda Quattrin

Executive Director, Office of Communications, Faculty of Medicine, University of Toronto

Stakeholders consulted:

Basic Science Chairs Committee

Clinical Chairs Committee

Dean's Executive Committee, Faculty of Medicine

Dean's Advisory Group, Faculty of Medicine

Graduate Chairs Committee

Rehab Science Chairs Committee

TAHSN Research Committee (VPs of hospital-based research institutes and University representatives)

Professor Lori Ferris, Associate Vice-President for Research Oversight and Compliance

Professor Sioban Nelson, Vice Provost Academic Programs

Professor Vivek Goel, Vice President Research and Innovation

Professor Jay Rosenfield, Vice Dean, MD Program (prior to July 1, 2016)

Professor Sal Spadafora, Vice Dean, Post MD Education

Susan Zimmerman, Executive Director, Secretariat on Responsible Conduct of Research
Government of Canada

APPENDIX B: University Resources

<i>Core University Policies and Framework Relating to Research Integrity</i>	
Policy /Framework	Application
Research Administration Policy (University)	Defines “Research” and sets out University’s general principles and procedures for research proposals and agreements and the roles and responsibilities of relevant parties.
Policy on Ethical Conduct in Research (University)	Establishes institutional commitment to “highest standards of ethical conduct in every aspect of research including applications, proposals, the research itself, reports and publication.”
Framework to Address Allegations of Research Misconduct (University)	Sets out process under which University responds to allegations of research misconduct.
Research Misconduct Framework Addendum, Procedures for Determining Jurisdiction in Complaints Involving Certain Non-University Institutions (University)	Clarifies whether University or hospital institution has jurisdiction over a research integrity complaint involving individual with an appointment at, or conducts research in a fully or community affiliated teaching hospital.
Code of Behaviour on Academic Matters (University)	Defines forms of research misconduct, including intentional fabrication, falsification, and plagiarism and reviews and procedures for addressing such, including appeal rights.
Policy on Research Involving Human Subjects (University)	Sets out University’s principles relating to research projects involving human subjects undertaken or under auspices of University, regardless of whether project funded or administered by University.
Publication Policy (University)	Sets out qualifications for publication of research undertaken at the University.
Policy on Conflict of Interest - Academic Staff (University)	Sets out what constitutes a conflict of interest, describes procedures to follow when faculty members engage in professional work for supplementary income, and establishes procedures for other situations which could give rise to an apparent conflict of interest.
Statement on Conflict of Interest and Conflict of Commitment (University)	Provides a number of principles affirming the commitment of the University to the identification and management of real and perceived conflicts of interest and conflicts of commitment.
Policy and Procedures on Academic Appointments (University)	Sets out grounds and procedures for terminating employment of tenured faculty for faculty members charged with academic offences.
Guidelines for Research	Sets out principles to be followed in University research where

Involving Possible External Pressure to Disclose Participant Data (University)	external pressure to disclose is reasonably foreseeable.
Statement of Protection for Intellectual Freedom and Publication Rights (FoM and Affiliated Institutions)	Details the University and hospital commitment to principles of intellectual freedom, including agreement to prohibit practices with sponsors or otherwise that negatively impact integrity of pursuit of academic freedom.
Policy on the Offer and Acceptance Of Finders Fees or Completion Fees In Research Involving Human Subjects (FoM)	Addresses the issue of finders' fees and completion fees in research involving human subjects.
Standards of Professional Behaviour for Medical Clinical Faculty (FoM)	Articulates expectations for the standards of professional behavior and ethical conduct of clinical faculty members in carrying out professional duties, including in research practices.
Statement of Principles and Responsibilities Regarding Conduct of Research (FoM)	Provides Faculty of Medicine's principles, as of 2002, for preventing research misconduct and outlines the responsibilities of faculty members in conducting their research.
Relationships with Industry and the Educational Environment in Undergrad and Postgrad Medical Education (FoM)	Sets out standards of best practices between Faculty of Medicine and industry, including disclosure measures.
Relevant External Policies Relating to Research Integrity	
Policy /Framework	Application
International Committee of Medical Journal Editors Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals	The ICMJE provides recommendations regarding best practice and ethical standards in the conduct and reporting of research and other material published in medical journals, and are intended primarily for use in submissions to ICMJE member journals.
TCPS 2 (2014) – latest edition of Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans	Developed by the three federal granting agencies (CIHR, NSERC and SSHRC), this document sets out the University's obligations to comply with requirements for review, oversight and conduct of research involving human participants and/or personal information.
CONSORT Statement	Comprises a 25-item checklist to report how trial was designed, analysed and interpreted and flow diagram to display progress, to assist reporting of trial findings in a transparent and critical manner.
Tri-Agency Statement of Principles on Digital Data Management	Outlines funding agencies' expectations for research data management and responsibilities of researchers, research communities, institutions and funders in meeting such expectations.
Access to N2 Training Module	
https://www.citiprogram.org/ and click on the "Register" button under "Create an account". Enter UTOR email address to create the account and access the modules.	
Questions Involving Research Integrity	
Type of Question	Contact

General Research Policies / Questions	Vice Dean Research and Innovation, Faculty of Medicine
Application of University Framework to Address Allegations of Research Misconduct	Associate Vice-President, Research Oversight and Compliance
Other Applicable Guidelines, Policies, Frameworks	Office of Research and Innovation Research Office, Faculty of Medicine