Human Biology – Fundamental Genetics & Its Applications

2 Major Program Modifications (Significant Alterations to Existing Program Component)

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Current Admission Requirements:

New Admission Requirements:

No changes

Current Enrolment Requirements:

This is a Type 1 open enrolment program. Students are permitted to enrol in the major during the program enrolment cycle as soon as they have earned 4.0 FCE. It is recommended students complete their first year life science requirements before entering the program.

New Enrolment Requirements:

No changes

Current Completion Requirements:

Required Courses (8.0 FCE)

First-Year Life Sciences

1. BIO120H1, BIO130H1
2. (CHM135H1, CHM136H1)/(CHM138H1, CHM139H1)/CHM151Y1 (transfer credits will be accepted in lieu of the chemistry requirements only if they carry a direct exclusion to a pre-approved chemistry course)
3. MAT135H1/PHY131H1/PHY151H1

Year 2: Foundations in genetics and its applications

4. HMB201H1
5. BIO230H1/ BIO255H1, BIO220H1
6. HMB265H1/BIO260H1
7. BCH210H1
8. statistics: STA220H1/PSY201H1/HMB325H1

Year 3: Selected topics in genetics with greater depth and self-directed learning

9. 1.5 FCE from selected depth courses in molecular genetics and its applications: HMB301H1/HMB311H1/HMB321H1/HMB342H1/HMB360H1/BCH311H1/CSB349H1/PSL350H1/CSB328H1/CSB331H1/CSB340H1/CSB352H1/CSB351Y1/CSB353H1/BCH340H1/EEB318H1/EEB323H1/EEB325H1/EEB362H1/EHJ352H1/MGY377H1/MGY378H1

Year 4: Advanced topics in genetics with emphasis on primary research and critical analysis:
11. 0.5 FCE from courses with advanced topics in fundamental genetics: HMB421H1/ BCH425H1/ BCH426H1/ BCH440H1/ BCH445H1/ CSB428H1/ CSB429H1

n.b. At least 0.5 FCE must be at the 400-level; students are not permitted to be enrolled in more than one Human Biology major program

New Completion Requirements:

Required Courses (8.0 FCE, including at least 0.5 FCE at the 400-level)

Chemical and Physical Foundations of Biological Systems
1. (CHM135H1, CHM136H1)/ (CHM138H1, CHM139H1)/CHM151Y1

Transfer credits will be accepted in lieu of the chemistry requirements only if they carry a direct exclusion or equivalency to a pre-approved chemistry course

2. MAT135H1/ PHY131H1/ PHY151H1/ CSC120H1/ CSC148H1

3. BCH210H1

Biological Foundations of Living Systems
4. BIO120H1, BIO130H1
5. BIO220H1
6. BIO230H1/ BIO255H1

Courses in Fundamental Genetics
7. HMB265H1/ BIO260H1
8. HMB321H1

9. 0.5 FCE from: HMB360H1/ HMB421H1/ HMB435H1/ HMB437H1/ HMB474H1/ BCH311H1/ BCH425H1/ BCH426H1/ BCH440H1/ BCH445H1/ BCH448H1/ CSB328H1/CSB331H1/ CSB340H1/CSB349H1/ CSB351Y1/ CSB353H1/ CSB428H1/ CSB429H1/ EEB318H1/ EEB323H1/ EEB365H1/EHJ352H1/ MGY314H1/ MGY315H1/ MGY340H1/ MGY428H1/MGY452H1/ MGY470H1/ MGY471H1/ PSL350H1

Courses in Applied Genetics
10. HMB201H1

11. HMB301H1/ ECO369H1

12. 0.5 FCE from: HMB401H1/ HMB431H1/HMB436H1/ HMB441H1/ HMB489H1/ HMB340H1/ HMB350H1/ BCH441H1/ BCH447H1/ CSB352H1/ CSB458H1/ CSB459H1/ CSB472H1/ CSB473H1/ CSB474H1/ EEB325H1/ EEB459H1/ EEB460H1/ NFS487H1/ PHL384H1/ PSL404H1/ PSY390H1

Data Analysis and Research-Based Courses
13. 0.5 FCE in statistics: HMB325H1/ EEB225H1/ STA220H1/ STA288H1

14. 0.5 FCE from a research-based or lab course: HMB311H1/ HMB314H1/ MGY315H1/ HMB342H1/ HMB360H1/ HMB496Y1*/ HMB499Y1*/ HST373H1/ MGY314H1/ MGY377H1/ MGY378H1

* A research project from a different unit may be accepted with prior written approval from Human Biology if the course is not counting toward a different program.

Fundamental Genetics and its Applications Major Notes:

1. Courses can only count toward one requirement, even if listed as options to multiple requisites of the program.

2. Not all courses listed have priority enrolment for Fundamental Genetics and its Applications majors. Students are responsible for checking priority of courses and meeting course prerequisites for courses they wish to take.
managed major program.

**Academic Context:**

While advances in the application of genetics has dramatically benefited human society, there is considerable interest among academics and the public sector in understanding how knowledge of genetics influences its application and whether genetic modifications pose a risk to our health and our environment.

In 2015, the Fundamental Genetics and its Applications major program was revised to emphasize fundamental concepts in genetics and how these concepts influence the application of genetics in society. The field of genetics is multidisciplinary, ranging from genomics and heredity to biodiversity and evolution. The application of genetics is equally diverse, encompassing medical diagnosis and genetic counseling, as well as biotechnology, wild life conservation, and many other areas.

The current proposal is a further revision of the program re-orientation that was initiated in 2015. The proposed program is designed to provide students with a firm foundation in both general and applied genetics through courses in HMB as well as courses offered throughout the Faculty of Arts & Science.

Students graduating with a major in the Fundamental Genetics and its Applications program will be able to communicate effectively on principles of genetic research and its application to society, and will also be equipped to pursue further studies in any focus of genetics.

**Learning Outcomes:**

Students enter the program at the end of their first year after establishing a foundation in organic biology and chemistry as well as physical chemistry. Students will also take a course in calculus, physics, or computer science, any of which offers in mathematics that is crucial to many aspects of the study of genetics and where research in genetics is today.

Students build on this foundation with core courses in both fundamental genetics (HMB265H1/BIO260H1, HMB321H1) and applied genetics (HMB201H1, HMB301H1) as well as continuing to expand their knowledge of biological components to genetics (BIO230H1/BIO255H1, BIO220H1, BCH210H1) as well as gathering quantitative research skills (a statistics course and a lab/research-based course) that will help the students learn relevant context and skills to understand the complex field of genetics and utilize their education to any number of post-graduate programs or professions.

The structure of the program allow students enrolled in the major to focus on both fundamental genetic aspects (HMB265H1/BIO260H1, HMB321H1, HMB360H1), as well as see this fundamental genetics being applied in technology and research (HMB201H1, HMB401H1). By having both sides equally represented, we encourage students in the program to meld their learning in the higher year courses and their lab/research based course.

Specific learning outcomes:

By the end of this program, students will be able to:

1. Demonstrate an understanding of the fundamental concepts in a wide range of genetics topics and how these concepts translate into biotechnological and medical applications.
2. Identify and analyze data from genetic research from the primary literature.
3. Understand appropriate quantitative techniques needed to examine genetics data.
4. Identify and evaluate contemporary ethical perspectives on genetics research and its applications.
5. Write and speak effectively about genetics issues to both scientific and broader audiences.

In addition to the learning outcomes listed in the 2015 proposal, as HMB now has teaching labs (which allow us more autonomy to offer more frequent, and larger lab courses), and greater course capacity in some of our 300-level courses, so we also aims to ensure that all students in the Fundamental Genetics and its Applications major gain research experience in applied genetics through the collection, analysis and interpretation of scientific data.

Our objectives and outcomes remain consistent with the 2015 major program modifications, but now that HMB has its own lab space, increased staff support, and wishes to acknowledge the changing fundamental and applied genetics landscape, the required courses have been adjusted to reflect our desired outcomes and objectives, and to offer a more consistent foundation to all students in the program.

**Depth of Knowledge:**

Introductory courses are designed to expose students to fundamental concepts in genetics (HMB265H1/BIO260H1) and its applications (HMB201H1), in particular in biotechnology, and to provide a core knowledge base in these areas from which students will build. Students are then introduced to more advanced applied genetics topics in a range of courses, including biotechnology (HMB301H1), epidemiology (HMB342H1), and bioinformatics (CSB352H1). This carries students so that can further engage in advanced courses in patents in medicine (HMB401H1), the biotechnological interface between science and industry (HMB431H1), computational genomics and bioinformatics.
fundamental genetics is facilitated through depth courses focusing on the structure-function relationship of genes, such as the regulation of gene expression (CSB349H1, MGY420H1), epigenetics (CSB458H1), and the DNA damage response (PCL477H1), as well as learning a systems perspective of genetics and how it relates to evolution and health, such as molecular evolution and genomics (EEB460H1), population genetics (EEB459H1), functional genomics (MGY428H1), human genetics (MGY470H1) and regenerative medicine (PSL404H1).

Critical and Creative Thinking:

Students engage in critical thinking early on in the program. For example, in HMB265H1 and HMB321H1 there are weekly tutorial assignments and tests that focus on the application of course concepts and information through problem-based or case-based learning, whereas written assignments and oral presentations are based on the synthesis and critical analysis of information and techniques from both primary and review articles. These methods are implemented in the context of student-centered learning using a scaffolding approach. In HMB265H1, students are asked to create a unique pedigree as a way to examine their understanding of the flow of genetic information through generations. As with all life science programs, the integration of primary research findings into all of our courses, but especially in 300- and 400-level courses, is a critical component of the student learning experience. Students are taught how to interpret and critically analyze research as well as develop the skills in synthesizing information from multiple sources.

Information Literacy:

Students learn effective written and oral strategies for communicating their analyses and critiques. For example, seminar courses often require students to be creative and persuasive in developing research grant proposals (HMB421H1) or engaging in team-based learning and peer evaluations, either in class or online, in several different courses (HMB321H1, HMB360H1, HMB441H1). Seminar presentations or poster presentations are common among most advanced courses and this enables students to develop key skills in explaining, discussing, critically analyzing and synthesizing research findings in an oral presentation format. Students also have opportunities to cultivate an ability to interact and debate issues in a group setting with guest speakers that are experts in their fields, preparing them with communication skills that will be useful in a professional workplace.

Quantitative Reasoning:

While many courses will integrate quantitative analysis and reasoning, such as genetic mapping (HMB265H1/BIO260H1), risk assessment and GWAS analysis (HMB321H1, HMB342H1), and estimating allele frequencies, mutation rates and heritability (EEB459H1), the program also requires that students take basic statistics courses (HMB325H1/STA220H1/STA288H1/PSY201H1) that will serve as a foundation for understanding concepts and analyzing research in other courses.

Social and Ethical Responsibility:

Several courses will introduce students to some of the bioethical and health policy issues and controversies surrounding specific topics in genetics, including prenatal diagnosis (HMB360H1), and genetic counseling (HMB321H1). The overall objective is to offer a variety of courses that challenge the way they think about the benefits of modern genetics, the limits of these benefits, and negative repercussions that genetics applications have on society, including medicine and biotechnology.

An Integrative, Inquiry Based Activity:

Seminar courses in 400-level courses provide a major opportunity for students to integrate knowledge from across a spectrum of genetics and other life science courses. Students in the major program are encouraged to complete a full-year research project course or a summer research project course (HMB496Y1/HMB499Y1), although this is not a requirement. Students will typically identify suitable supervisors in hospital research institutes or campus-based laboratories and research groups. Research project course oversight includes a HMB faculty advisor that facilitates the placements, guide workshops on research presentation skills or apply statistical analyses (in collaboration with Department of Statistical Sciences), as well as organize research presentation days (with research faculty to serving as assessors). Students gain invaluable first-hand experience integrating their knowledge of genetics and other related subjects, learn to apply their quantitative reasoning and analytical skills, practice effective communication and team-based learning, and learn about ethical standards in research.

Program Delivery:

Method: In Class
Mode: Full Time; Part Time

Brief Description of the Proposal:

Modification of how Calendar listing is organized, for better clarity of program requirements. Courses allowed for the program at the higher levels has been reviewed and revised to better reflect courses that are directly related to the study of fundamental genetics and applied genetics. The total number of FCE required, 8.0, has remained the same.

Details of Proposed Change:

Courses allowed for the program at the higher levels has been reviewed and revised to better reflect courses that are directly related to the study of fundamental genetics and applied genetics. As follows:

1. Both HMB301H1 (Introduction to Biotechnology) and HMB321H1 (Topics in Genetics) are now required courses instead of options.
2. The 0.5 FCE required in upper-year courses in applied genetics and the 0.5 FCE required in upper year fundamental genetics courses has remained, but now includes 300-level courses to allow more freedom of choice (0.5 FCE at the 400-level is still required as per degree regulations, but students have the opportunity to meet this requirement in three separate requisite lines).
3. 0.5 FCE from a pre-approved higher-year lab course or research-based course with genetics-related content (HMB311H1/ HMB314H1/ MGY315H1/ HMB342H1/ HMB360H1/ HMB496Y1/ HMB499Y1/ HST373H1/ MGY314H1/ MGY377H1/ MGY378H1) is now required.

Rationale:

The Human Biology Program completed a self-study in March 2014 that the program and the Faculty of Arts & Science has been steadily working on the recommendations to enhance the overall quality of the program. Many of the recommendations have already been put into effect: our smallest program (Health Care Ethics major) has been closed for further admissions and a proposal to formally close the program will be put forward in October 2017, we have signed a MOA giving the School of the Environment full ownership of the Environment and Health major and specialist (ASMAJ0365 and ASSPE0365) and have agreed to continue teaching and supporting the capstone requirement course for the specialist program: JEH455H1 (Topics in Environment & Health) and giving Environment and Health students enrolment priority in a number of our courses.

One of the first acts was a revision of the Health & Disease (ASMAJ2013 & ASSPE2013), Neuroscience (ASMAJ1472 and ASSPE1472), and our then- Genes, Genetics, and Biotechnology, now Fundamental Genetics and its Applications program (ASMAJ1050 and ASSPE1050), and Human Biology (ASMAJ2035) programs to better align the programs with the teaching strengths of the unit, the resources of the unit, and the course offerings within the Faculty of Arts & Science. These modifications came into effect in 2015-2016.

This realignment of four of our five programs has benefited the program as a whole and our students greatly, and have allowed us to see more clearly where there are gaps in the program structure and program objectives, as well as allowing us to see how to better align the programs with their objectives, as outlined in 2015.

Since then, we have consulted with the Dalla Lana School of Public Health on pedagogy revisions for our Global Health major and Specialist (ASMAJ25757 and ASSPE2575), and have consulted with our faculty and staff to better assess pedagogy gaps and inconsistencies in program structure and pressure points within our programs in terms of enrollment and student outcomes. Many of the gaps/alignment were due to lack of lab space, staff, support, or lack of faculty to teach core courses.

Even in the 2015 major modification proposal, it was outlined that HMB has been working closely with [the Cell Systems and Biology Department], [the Department of Ecology and Evolutionary Biology] and the [Faculty of Arts & Science] to expand and modernize lab course offerings in the planned renovations of the [Ramsay Wright] teaching labs. However, at the time of the proposal, the labs were not yet constructed. Construction began in spring 2015 and they are currently nearing completion. HMB teaching labs will be ready for full-time use by September 2017. As such, we wish to utilize these labs in our HMB courses to better meet listed course objectives for the benefit of our students.

Since many of the recommendations from the external review have been met, and now that HMB has more staff support including 2 lab technicians, a more clear vision, our own teaching labs (which will allow us to use the space more frequently), and have been approved to hire an appointed faculty member starting in July 2017 (the search is currently ongoing) who will allow us to offer more course sections of some of our courses without overburdening teaching assignments, we would like to make further revisions to better meet objectives outlined in 2014.

The proposed restructuring of all of our programs is the next step in further defining improvements and innovations first initiated in 2015-2016.

Impact that the proposal may have on students or other academic units/divisions:

Impact on other units should be minimal as enrolment is not planned to increase. Currently the enrolment into the
change in enrollment up or down, as there are three genetics programs offered within the Faculty of Arts & Science (Molecular Genetics, Fundamental Genetics and its Applications, and Genomics), and students already appear to be self-selecting which genetics program to enrol in based on their specific interest in the diverse field of genetics.

The majority of the courses required in the program are the same course requirement/requirement options as the current Fundamental Genetics and its Applications major. Impact on our unit should also not increase as we have increased staff support.

**Consultation:**

Director Dr. Melanie Woodin has consulted extensively with Vice-Deans Pamela Klassen and Poppy Lockwood as well as with faculty within the Human Biology program. After consultations with Biochemistry in January 2017, we have eliminated the option to use CHM247H1 in lieu of BCH210H1. The program was reviewed by the Life Science Planning Committee in January 2017, and beyond the feedback offered by Biochemistry, no feedback was offered.

**Diversity:**

The re-design of the human biology major program ensures all students receive a solid foundation in the wide scope of human biology. HMB works closely with Accessibility Services, and accommodations requested are met.

**Resource Implications:**

Current support is adequate.

**Faculty and TA Support:**

Current support is adequate.

**Fundamental Genetics and its Applications Specialist**

**Start Session:**

Summer 2017

**Current Admission Requirements:**

**New Admission Requirements:**

No changes

**Current Enrolment Requirements:**

This is a Type 3 limited enrolment program. Meeting the following minimum criteria does not guarantee admissions to the specialist program:

- BIO120H1 with a minimum mark of 60%
- BIO130H1 with a minimum mark of 60%
- CHM135H1 and CHM136H1 or CHM138H1 and CHM139H1 or CHM151Y1 with a minimum mark of 60%
- MAT135H1 or PHY131H1 or PHY151H1 with a minimum mark of 60%
- and, a composite average of at least 70% on the above 2.5 FCE.

Students may apply for this specialist program only during Round 1 of Type 3 Enrolment. Students applying for admissions to the program utilising transfer credits, or later than the end of their first year, will be considered on a case-by-case basis. For more information about Type 3 enrolment, visit the Faculty of Arts & Science Program Enrolment Instructions website.

**New Enrolment Requirements:**

This specialist is a Type 3 limited enrolment program. Admissions will be based on the following criteria, however
specialist program in any given year.

Applying with less than 8 FCEs:

- Completion of BIO130H1 with a minimum grade of 65
- Completion of CHM135H1 and completion of CHM136H1 with a minimum grade of 55 (or CHM151Y1 with a minimum grade of 55).
  
  Transfer credits will be accepted in lieu of the chemistry requirements only if they carry a direct exclusion or equivalency to a pre-approved chemistry course. Please carefully check your Transfer Credit Assessments.
- Completion of 4.0 FCE

Applying with 8 or more FCEs completed:

- Completion of BIO220H1 with a minimum grade of 65
- Completion of BIO230H1/ BIO255H1 with a minimum grade of 65
- Completion of HMB265H1/ BIO260H1
- Completion of BCH210H1

Students may apply for this major program during Round 1 and Round 2 of Type 3 Enrolment after they have earned 4.0 FCE. Students applying for admissions to the program utilizing transfer credits will be considered on a case-by-case basis. Students entering from CEGEP or from another university should contact hmb.undergrad@utoronto.ca after their transfer credit assessment has been complete for program enrolment assessment. For more information about Type 3 enrolment, visit the Faculty of Arts & Science Subject Program Enrolment Instructions website.

Current Completion Requirements:

**Required Courses (14.0 FCE)**

Prior to entering the specialist program:

1. BIO120H1, BIO130H1
2. (CHM135H1, CHM136H1)/(CHM138H1, CHM139H1)/CHM151Y1 (transfer credits will be accepted in lieu of the chemistry requirements only if they carry a direct exclusion to a pre-approved chemistry course)
3. MAT135H1/PHY131H1/PHY151H1

Year 2: Foundations in genetics and its applications

4. HMB201H1
5. BIO230H1/BIO255H1, BIO220H1
6. HMB265H1/BIO260H1
7. BCH210H1
8. statistics: STA220H1/ PSY201H1/ HMB325H1
9. bioethics: PHL281H1/ HMB306H1

Year 3: Selected topics in genetics

10. 1.5 FCE from selected depth courses on molecular genetics and its applications: HMB301H1, HMB321H1, BCh311H1/ CSB349H1/ PSL350H1

11. 0.5 FCE from a higher-year lab course: HMB311H1/ BCH370H1/ CSB330H1/ CSB350H1/ MGY360H1/ MGY379H1

12. 2.0 FCE from depth courses on fundamental and applied genetics: HMB342H1/ HMB360H1/ CSB328H1/ CSB331H1/ CSB340H1/ CSB352H1/ CSB351Y1/ CSB353H1/ BCH311H1/ BCH340H1/ EEB318H1/ EEB323H1/ EEB325H1/ EEB362H1/ EHJ352H1/ MGY377H1/ MGY378H1

Year 4: Advanced topics in genetics with emphasis on primary research and critical analysis

13. 1.5 FCE from courses with advanced topics in applied genetics: HMB401H1/ HMB431H1/ HMB435H1/ HMB436H1/ HMB437H1/ HMB441H1/ HMB489H1/ BCH441H1/ BCH447H1/ CSB458H1/ CSB459H1/ CSB472H1/ CSB474H1/ EEB459H1/ EEB460H1/ NFS487H1/ PSL401H1
14. 1.5 FCE from courses with advanced topics in fundamental genetics: HMB421H1/ BCH425H1/ BCH426H1/ BCH462H1/ BCH440H1/ BCH445H1/ CSB428H1/ CSB429H1/ CSB430H1/ CSB452H1/ CSB460H1/ EEB445H1/ LMP436H1/ MGY420H1/ MGY425H1/ MGY428H1/ MGY434H1/ MGY440H1/ MGY451H1/ MGY452H1/ MGY470H1/ PCL477H1

15. HMB499Y1

n.b. At least 1.0 FCE must be at the 400-level

**New Completion Requirements:**

**Required Courses (12.0 FCE, including at least 1.0 FCE at the 400 level)**

**Chemical and Physical Foundations of Biological Systems**

1. (CHM135H1, CHM136H1)/(CHM138H1, CHM139H1)/CHM151Y1

   *Transfer credits will be accepted in lieu of the chemistry requirements only if they carry a direct exclusion or equivalency to a pre-approved chemistry course*

2. MAT135H1/ PHY131H1/ PHY151H1/ CSC120H1/ CSC148H1

3. BCH210H1

**Biological Foundations of Living Systems**

4. BIO120H1, BIO130H1

5. BIO220H1

6. BIO230H1/ BIO255H1

**Courses in Fundamental Genetics**

7. HMB265H1/ BIO260H1

8. HMB321H1


**Courses in Applied Genetics**

10. HMB201H1

11. HMB301H1/ ECO369H1

12. 1.5 FCE from: HMB401H1/ HMB431H1/HMB436H1/ HMB441H1/ HMB489H1/ BCH340H1/ BCH441H1/ BCH447H1/ CSB352H1/ CSB458H1/ CSB459H1/ CSB472H1/ CSB473H1/ CSB474H1/ EEB325H1/ EEB459H1/ EEB460H1/ NFS487H1/ PHL384H1/ PSL404H1/ PSY390H1

**Data Analysis and Research-Based Courses**

13. 0.5 FCE in statistics: HMB325H1/ EEB225H1/ STA220H1/ STA288H1

14. 0.5 FCE from bioethics: HMB306H1/ HMB406H1/ PHL281H1

15. 0.5 FCE from upper-year lab course: HMB311H1/ HMB314H1/MGY314H1/ MGY315H1

16. 0.5 FCE from research based courses: HMB342H1/HMB360H1/ HST373H1/ MGY377H1/ MGY378H1

17. 1.0 FCE from research project course: HMB496Y1*/ HMB499Y1*

* A research project from a different unit may be accepted with prior written approval from Human Biology if the course is not counting toward a different program.

**Fundamental Genetics and its Applications Specialists Notes:**

1. Courses can only count toward one requirement, even if listed as options to multiple requisites of the program.

2. Not all courses listed have priority enrolment for Fundamental Genetics and its Applications specialists. Students are responsible for checking priority of courses and meeting course prerequisites for courses they wish to take.
Academic Context:

While advances in the application of genetics has dramatically benefited human society, there is considerable interest among academics and the public sector in understanding how knowledge of genetics influences its application and whether genetic modifications pose a risk to our health and our environment.

In 2015, the Fundamental Genetics and its Applications major and specialist programs were revised to emphasize fundamental concepts in genetics and how these concepts influence the application of genetics in society. The field of genetics is multidisciplinary, ranging from genomics and heredity to biodiversity and evolution. The application of genetics is equally diverse, encompassing medical diagnosis and genetic counseling, as well as biotechnology, wildlife conservation, and many other areas.

The current proposal is a further revision of the program re-orientation that was initiated in 2015. The proposed program is designed to provide students with a firm foundation in both general and applied genetics through courses in HMB as well as courses offered throughout the Faculty of Arts & Science.

Students graduating with a major in the Fundamental Genetics and its Applications program will be able to communicate effectively on principles of genetic research and its application to society, and will also be equipped to pursue further studies in any focus of genetics.

Learning Outcomes:

Students enter the program at the end of their first year after establishing a foundation in organic biology and chemistry as well as physical chemistry. Students will also take a course in calculus, physics, or computer science, any of which offers in mathematics that is crucial to many aspects of the study of genetics and where research in genetics is today.

Students build on this foundation with core courses in both fundamental genetics (HMB265H1/BIO260H1, HMB321H1) and applied genetics (HMB201H1, HMB301H1) as well as continuing to expand their knowledge of biological components to genetics (BIO230H1/BIO255H1, BIO220H1, BCH210H1) as well as gathering quantitative research skills (a statistics course and a lab/research-based course) that will help the students learn relevant context and skills to understand the complex field of genetics and utilize their education to any number of post-graduate programs or professions.

The structure of the program allow students enrolled in the specialist to focus on both fundamental genetic aspects (HMB265H1/BIO260H1, HMB321H1, HMB360H1), as well as see this fundamental genetics being applied in technology and research (HMB201H1, HMB401H1). By having both sides equally represented, we encourage students in the program to meld their learning in the higher year courses and their lab/research based course.

Specific learning outcomes:

By the end of this program, students will be able to:

1. Demonstrate an understanding of the fundamental concepts in a wide range of genetics topics and how these concepts translate into biotechnological and medical applications.
2. Identify, analyze, and critically evaluate data from genetic research from the primary literature.
3. Gain research experience in applied genetics through the collection, analysis and interpretation of scientific data.
4. Understand and apply appropriate quantitative techniques needed to examine genetics data.
5. Gain lab experience and relevant skills in genetics related labs
6. Identify and critically evaluate contemporary ethical perspectives on genetics research and its applications.
7. Write and speak effectively about genetics issues to both scientific and broader audiences.

These learning objectives are subtly revised from the Winter 2015 proposed learning outcomes. This is due to revisions in the clarifying process that was initiated in December 2015 that lead to the current program modification proposals. For example "Acquire basic laboratory skills in the life sciences" was revised to "Gain lab experience and relevant skills in genetics related labs." The core pedagogical foundation of the learning objective remains the same, however, we have clarified it, to better explain why the lab courses listed in the relevant requisite line are the approved lab courses for this line.

Depth of Knowledge:

Introductory courses are designed to expose students to fundamental concepts in genetics (HMB265H1/BIO260H1) and its applications (HMB201H1), in particular in biotechnology, and to provide a core knowledge base in these areas from which students will build. Students are then introduced to more advanced applied genetics topics in a range of courses, including biotechnology (HMB301H1), epidemiology (HMB342H1), and bioinformatics (CSB352H1). This carries students so that can further engage in advanced courses in patents in medicine (HMB401H1), the biotechnological interface between science and industry (HMB431H1), computational genomics and bioinformatics (CSB472H1), and nutrigenomics and personalized nutrition (NFS487H1). Specialized knowledge in many areas of fundamental genetics is facilitated through depth courses focusing on the structure-function relationship of genes, such as the regulation of gene expression (CSB349H1, MGY420H1), epigenetics (CSB458H1), as well as learning a
Critical and Creative Thinking:

Students engage in critical thinking early on in the program. For example, in HMB265H1 and HMB321H1 there are weekly tutorial assignments and tests that focus on the application of course concepts and information through problem-based or case-based learning, whereas written assignments and oral presentations are based on the synthesis and critical analysis of information and techniques from both primary and review articles. These methods are implemented in the context of student-centered learning using a scaffolding approach. In HMB265H1, students are asked to create a unique pedigree as a way to examine their understanding of the flow of genetic information through generations. As with all life science programs, the integration of primary research findings into all of our courses, but especially in 300- and 400-level courses, is a critical component of the student learning experience. Students are taught how to interpret and critically analyze research as well as develop the skills in synthesizing information from multiple sources.

Information Literacy:

Students learn effective written and oral strategies for communicating their analyses and critiques. For example, seminar courses often require students to be creative and persuasive in developing research grant proposals (HMB421H1) or engaging in team-based learning and peer evaluations, either in class or online, in several different courses (HMB321H1, HMB360H1, HMB441H1). Seminar presentations or poster presentations are common among most advanced courses and this enables students to develop key skills in explaining, discussing, critically analyzing and synthesizing research findings in an oral presentation format. Students also have opportunities to cultivate an ability to interact and debate issues in a group setting with guest speakers that are experts in their fields, preparing them with communication skills that will be useful in a professional workplace.

In order to complete written and oral assignments, students are required to learn to use Internet based search engines (e.g. PubMed, Google Scholar, Ensembl, etc.) to acquire relevant information from the primary literature and genome databases. Students are typically evaluated on their effective gathering and use of this information through enhanced citations, and the ability to use PowerPoint, Keynote, blogs and other presentation formats.

Quantitative Reasoning:

While many courses will integrate quantitative analysis and reasoning, such as genetic mapping (HMB265H1/BIO260H1), risk assessment and GWAS analysis (HMB321H1, HMB342H1), and estimating allele frequencies, mutation rates and heritability (EEB459H1), the program also requires that students take basic statistics courses (HMB325H1/STA220H1/STA288H1/PSY201H1) that will serve as a foundation for understanding concepts and analyzing research in other courses.

Social and Ethical Responsibility:

Several courses will introduce students to some of the bioethical and health policy issues and controversies surrounding specific topics in genetics, including prenatal diagnosis (HMB360H1), and genetic counseling (HMB321H1, HMB452H1). The overall objective is to offer a variety of courses that challenge the way they think about the benefits of modern genetics, the limits of these benefits, and negative repercussions that genetics applications have on society, including medicine and biotechnology.

An Integrative, Inquiry Based Activity:

Seminar courses in 400-level courses provide a major opportunity for students to integrate knowledge from across a spectrum of genetics and other life science courses. Students in the specialist program are required to complete a full-year research project course or a summer research project course (HMB496Y1/HMB499Y1). Students will typically identify suitable supervisors in hospital research institutes or campus-based laboratories and research groups. Research project course oversight includes a HMB faculty advisor that facilitates the placements, guide workshops on research presentation skills or apply statistical analyses (in collaboration with Department of Statistical Sciences), as well as organize research presentation days (with research faculty to serving as assessors). Students gain invaluable first-hand experience integrating their knowledge of genetics and other related subjects, learn to apply their quantitative reasoning and analytical skills, practice effective communication and team-based learning, and learn about ethical standards in research.

Program Delivery:

Method: In Class
Mode: Full Time; Part Time

Brief Description of the Proposal:
Modification of how Calendar listing is organized, for better clarity of program requirement. The total number of FCE required has been reduced to 12.0 FCE from 14.0 FCE.

Details of Proposed Change:
The total number of FCE required has been reduced to 12.0 FCE from 14.0 FCE to make the program more manageable in four years to students enrolled in the program, and to promote students enrolled in the program to undertake at least one minor program to enhance their trans-disciplinary education.
Courses allowed for the program at the higher levels has been reviewed and revised to better reflect courses that are directly related to the study of fundamental genetics and applied genetics, but the language of the requirement lines did not change here.
0.5 FCE from pre-approved research-based courses now required (HMB342H1/HMB360H1/ HST373H1/ MGY377H1/ MGY378H1)
Update of specialist enrolment criteria (i.e. admissions to the program) to better demonstrate and offer more transparency on criteria already being used for specialist enrolment, and to acknowledge many students enter the program after second year, and we do not assess their 100-level courses for admissions if they are not a first year student.

Rationale:
The Human Biology Program completed a self-study in March 2014 that the program and the Faculty of Arts & Science has been steadily working on the recommendations to enhance the overall quality of the program. Many of the recommendations have already been put into effect: our smallest program (Health Care Ethics major) has been closed for further admissions and a proposal to formally close the program will be put forward in October 2017, we have signed a MOA giving the School of the Environment full ownership of the Environment and Health major and specialist (ASMAJ0365 and ASSPE0365) and have agreed to continue teaching and supporting the capstone requirement course for the specialist program: JEH455H1 (Topics in Environment & Health) and giving Environment and Health students enrolment priority in a number of our courses.
One of the first acts was a revision of the Health & Disease (ASMAJ2013 & ASSPE2013), Neuroscience (ASMAJ1472 and ASSPE1472), and our then- Genes, Genetics, and Biotechnology, now Fundamental Genetics and its Applications program (ASMAJ1050 and ASSPE1050), and Human Biology (ASMAJ2035) programs to better align the programs with the teaching strengths of the unit, the resources of the unit, and the course offerings within the Faculty of Arts & Science. These modifications came into effect in 2015-2016.
This realignment of four of our five programs has benefited the program as a whole and our students greatly, and have allowed us to see more clearly where there are gaps in the program structure and program objectives, as well as allowing us to see how to better align the programs with their objectives, as outlined in 2015.
Since then, we have consulted with the Dalla Lana School of Public Health on pedagogy revisions for our Global Health major and Specialist (ASMAJ25757 and ASSPE2575), and have consulted with our faculty and staff to better assess pedagogy gaps and inconsistencies in program structure and pressure points within our programs in terms of enrollment and student outcomes. Many of the gaps/misalignment were due to lack of lab space, staff, support, or lack of faculty to teach core courses.
Even in the 2015 major modification proposal, it was outlined that HMB has been working closely with [the Cell Systems and Biology Department], [the Department of Ecology and Evolutionary Biology] and the [Faculty of Arts & Science] to expand and modernize lab course offerings in the planned renovations of the [Ramsay Wright] teaching labs. However, at the time of the proposal, the labs were not yet constructed. Construction began in spring 2015 and they are currently nearing completion. HMB teaching labs will be ready for full-time use by September 2017. As such, we wish to utilize these labs in our HMB courses to better meet listed course objectives for the benefit of our students.
Since many of the recommendations from the external review have been met, and now that HMB has more staff support including 2 lab technicians, a more clear vision, our own teaching labs (which will allow us to use the space more frequently), and have been approved to hire an appointed faculty member starting in July 2017 (the search is currently ongoing) who will allow us to offer more course sections of some of our courses without overburdening teaching assignments, we would like to make further revisions to better meet objectives outlined in 2014.
The proposed restructuring of all of our programs is the next step in further defining improvements and innovations first initiated in 2015-2016.

Impact that the proposal may have on students or other academic units/divisions:
Currently this program is a Type 3 program restricted to 44 students per cohort year, with 29 students total currently...
Impact on other units should be minimal as enrolment is not planned to increase. The majority of the courses required in the program are the same course requirement/requirement options as the current neuroscience major. Impact on our unit should also not increase as we have increased staff support.

**Consultation:**

Director Dr. Melanie Woodin has consulted extensively with Vice-Deans Pamela Klassen and Poppy Lockwood as well as with faculty within the Human Biology program. It should be noted that the Provost has inquired on what consultation has been done with units whose courses are listed in the current proposal. The proposal was reviewed at the Life Science Planning Committee in November 2016, and no feedback was received.

**Diversity:**

The re-design of the human biology major program ensures all students receive a solid foundation in the wide scope of human biology. HMB works closely with Accessibility Services, and accommodations requested are met. This will not change. Further, many of our faculty work to offer a variety of assignments that better provide to a variety of learners in their courses.

**Resource Implications:**

Current support is adequate.

**Faculty and TA Support:**

Current support is adequate.