



## WELCOME TO GENETICS!

In this course we consider many important areas of genetic study including eukaryotic patterns of inheritance, genetic mapping, mutation and use of genetics for understanding gene function, chromosome organization and mutation, and Recombinant DNA technology and genome analysis.

To take this course you need to have successfully completed [BIOB10H, BIOB11H (or BIOB10Y)] and [PSYB07 or STAB22, or an equivalent statistics course]. Prerequisites are enforced for your benefit and that of the other students in the course.

The knowledge you learn in this course is valuable for the practice of health or veterinary-related science, genetic counseling, genetic diagnostics, the use of genetics and molecular technologies to better understand complex biological processes and systems. It also will help you be a better science-literate citizen in a complex world and will generally help you develop better analytical, problem solving and interpersonal skills. If you keep up with the learning activities of this course it also can be fun!

To do well in this course and avoid unnecessary stress it is vital to keep up with the work on a weekly basis: understanding the key concepts, completing assigned activities to develop skill in using the concepts, and doing weekly lab work on time. To help you make a strong start with this learning pattern there will be weekly online quizzes for the lecture content and unannounced but frequent lab quizzes.

**Please come to the first class and every class having carefully read the posted, Module notes and slides.**

The University of Toronto is dedicated to fostering an academic community in which the learning and scholarship of every member may flourish, with vigilant protection for individual human rights, and a resolute commitment to the principles of equal opportunity, equity and justice. The instructor and Teaching Assistants of BIOC15 fully endorse this policy. Welcome all!

## DELIVERY OF LECTURE COURSE CONTENT AND INTERACTION TIMES

The knowledge content for this course is developed in 10 Learning Modules. So that everyone is ready to succeed in BIOC15 There is also a review learning module for relevant parts of BIOB11 and a bonus quiz on that material. The bonus quiz is not mandatory but I recommend you read the review module and take the bonus quiz.

**Class meetings for this course are Wednesdays 9-11am in SW128.** Class meetings are important for mastering genetics but they are not lectures! The Learning module notes and slides for each learning module are posted in advance of each class and you are expected to have critically read the notes before class, and bring questions to the meetings and be ready to apply the content of module notes to solving real world genetics problems.

There are weekly online module quizzes (through Quercus). Each online Module quiz will open on a Friday and remain open for 10 days, except the bonus quiz, which will be open until the last day of the term. For the online lecture quizzes you can work cooperatively with study partners but you must each complete the quiz by its closing date to receive credit, and you should be a participating thinker in the final solutions (or else you likely will not perform as well as you would like on Test 1 and the final exam!)

Creating a class with effective learning is a two-way exchange; I need your feedback and interactions to understand if I am getting the ideas across, so I need many students attending class ready to ask questions and flex their strengthening genetics muscles! Also remember doing well is not just about having a good set of notes! To convert the information in the Module notes to your own working knowledge of genetics you need to consider the content compared to what you already know, and how you can use the content to solve real world genetic problems. Doing the assigned genetics problems is very important. One good way to assess how well you are doing this is to come to class and to fully engage with the learning activities.

**WHAT MIGHT BE ON THE TEST OR FINAL EXAM?** Test 1 and the Final Exam content, and the level of detail of test and the final exam will be as covered in the Module notes and slides, problems assigned in the Module notes, and definition/terms in the provided genetics dictionary (also found in the module notes).

## Textbook, Solutions' Manual and Lab Manual

The textbook for this course is Genetics from Genes to Genomes, 2<sup>nd</sup> Canadian edition. It is packed as a bundle with the Solutions manual. The textbook/solutions manual bundle may be purchased at the bookstore. You need to have access to the textbook for the assigned problems, to succeed in this course. If you want to purchase the e-book here is the link to access it. <https://connect.mheducation.com/class/c-hasenkampf-click-here-to-enter-course>

The lab manual is posted on Quercus; download your copy and bring the relevant part to each lab.

## PRACTICALS/ LABORATORY INFORMATION

Labs start in the second week of classes in the week of Sept 9<sup>th</sup>. Each of you is assigned to one practical section that you attend on a weekly basis. Attendance in labs is mandatory; unexcused absences will reduce your mark. To encourage students to come to lab prepared for the work, there will be unannounced quizzes in labs. These quizzes will relate to the information provided in the BIOC15 lab manual.

In addition to your lab practical time, additional lab work (called flex time) will need to be done by your lab team from Sept 16-Nov 8<sup>th</sup> (some groups finish a week earlier). During this flex time some members attend the genetics lab at additional posted times to create your genetic crosses and collect data. The success of your genetic crosses requires coordinated teamwork. Please develop a good working relationship and effective communication system with your team members. The ability to work as part of a team is an important life skill; use this course as an opportunity to improve your abilities. The lab work is designed to reinforce the concepts and problems considered in the class meetings. If you fully engage with the lab work it will improve your learning in genetics.

**Labs** There are 9 formal lab meetings, starting in the week of Sept 9<sup>th</sup>; the practicals are held in SW248 or SW250.

They occur as follows

P01 Mon 10am-1pm in SW248

P03 Tue 11am-2pm in SW248

P04 Tue 2-5pm in SW248

P05 Tue 2-5 pm in SW250

P07 Wed 1-4 pm in SW250

You need to regularly attend the practical you are registered in.

## COURSE COMMUNICATION

Course announcements, communications and Module notes and slides will be available on the BIOC15 Quercus course site. Be sure you have a Utorid and know how to access QUERCUS. Check the BIOC15 QUERCUS site regularly for important, time-sensitive announcements.

### Dr. H's office hours are

Mondays 8:30 to 10am in SY246 (except for Sept 24 and Oct 1 when they will be in SW250)

Wednesdays 11:30-12:30 in SY246.

Fridays 3:30-5:00 in SW250 (except for Sept 6 & 13<sup>th</sup> and from Nov 15<sup>th</sup> onward when they will be in SY246).

**During these times** Dr. Hasenkampf is available for all questions about lectures and test content and is also able to provide advice about the fly cross data interpretation, and general program and post-graduation planning.

email questions are welcome (hasenkampf@utsc.utoronto.ca), but allow two working days for response time. (note complex genetics questions cannot be done by email)

Learn the name of your TA and lab team mates and interact with your TA and fellow students with respect. They are your important learning partners! Questions about lab work and assignments, lab quizzes *etc.* should be addressed to your TA.

## LEARNING GOALS AND OUTCOMES FOR BIOC15 GENETICISTS

1. Students will be able to inter-relate chromosome behavior during meiosis with the key rules of inheritance: segregation of alleles, independent assortment, sex linkage, linkage, and maternal inheritance.
2. Students will combine their knowledge of probability theory with the rules of inheritance to be able to do pedigree analysis and accurately predict genetic outcomes. Additionally students will be able to interpret pedigrees and phenotypic ratios to determine if genes likely are autosomal or sex-linked, linked or sorting independently, and genotypes of parents.

3. Students will develop an appreciation of how genes work within organisms and will be able to use this knowledge to understand and predict phenotypic ratios. Also, students will be able to interpret phenotypic ratios to identify the number of genes, allelic relationships, dominance relationships, and types of interaction gene interactions in biological pathways.
4. Students will examine the cellular processes that combat DNA damage and replication errors, and will be able to analyze how mutations can be used to explore biological processes, genome structure and evolution.
5. Students will be able to characterize the types of DNA- and chromosomal mutations and will understand the origins and consequences of these mutations. Students will be able to predict the impact on chromosomal mutations on inheritance and phenotypes conversely determine the type of chromosomal mutation that has occurred based on altered inheritance pattern and phenotypes.
6. Students will be able to describe the key molecular technologies that led to the sequencing of the human genome (and other model organisms) and will understand how entire genome sequencing has led to systems approaches to understanding biochemical and developmental pathways, human diseases and related therapeutic approaches. Students will be able to use this knowledge to interpret molecular phenotypes and relate them to genotypes and organismal phenotypes.
7. Students will do genetic crosses using the model organism *Drosophila melanogaster* to deduce the genotype, mode of inheritance, dominance relationship(s) and recombination frequency map distances and interference of several *Drosophila* genes. These classical genetic techniques will provide students with first hand experience with the rigor and precision needed to perform biological experiments, and with the difficulties, frustrations and errors that can occur.
8. Students will gain experience working collaboratively as part of a team to accomplish the work of a set of experiments. This includes learning to distribute a task's workload equitably and to give each other productive feedback in a professional and constructive manner.
9. Students will evaluate their data and create a group oral and an individually, personally written report of their experiment that effectively communicates complex ideas to colleagues.
10. Students will practice communicating as a professional in all communications for this course: emails to team mates, TAs and instructor, and in the careful organization of lab notebook and accurate and time stamped data collections, and in oral and written assignments.

#### TURNITIN

Normally, students will be required to submit their course essays (in BIOC15 this is the Experiment Summary and Analysis report) to Turnitin.com for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their essays to be included as source documents in the Turnitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site".

Your TA will give you instructions on how to submit your assignment to TurnItIn in advance of the submission deadline.

#### TERM TEST AND FINAL EXAM INFORMATION AND ABSENCE POLICY FOR TERM WORK

There will be one, IN CLASS term test (**Wednesday Oct 9<sup>th</sup>, 9-11 am in class**) and a cumulative final exam. A make up test will be available for those who have provided the requirement documentation of a grave circumstance. The format of the makeup test may be different from the original test. The date of the makeup test will likely be announced during Reading Week and likely will occur in the week of Oct 21-25<sup>th</sup> (exact date/time of makeup will depend on who needs to take it).

If you are prevented from attending Test 1 due to illness you provide the [UTSC Verification of Illness Form](#) within 2 days of the term test (or within 2 days of the end of the documented indisposition) to Jennifer Campbell ([jacampbell@utsc.utoronto.ca](mailto:jacampbell@utsc.utoronto.ca)) Course Coordinator in Biological Sciences. Please ensure your physician has indicated a clear start date, end date and visit date(s) on the form. Notes that are missing dates or have dates that do not correspond to the test missed will not accepted. *Please note that being registered in a class that occurs at the same time as BIOC15 is not an acceptable reason to miss the test.*

Anyone without an acceptable (and appropriately documented) reason for missing a test (or assignment or lab) will receive the grade of zero for the relevant work.

The departmental Policy on Missed Term Tests and missed Term Assignments can also be found at <https://www.utoronto.ca/biosci/missed-term-work-policy>.

#### FINAL EXAM

The final exam in this course, as in the challenges we face in life, is comprehensive in nature. For BIOC15 this means the exam will assess your working knowledge of our topics from throughout the course. The Final exam will be held in the examination period. Anyone absent from the Final exam must petition the registrar's office to take a deferred exam. Details on how to petitions can be found at <https://www.utoronto.ca/registrar/missing-examination>

Remember this course is about learning Genetics. When you are well, work hard and engage! If you are sick, take care of yourself, do what you can from home and get back into the swing of the course once you are well. Feel free to contact me for help strategizing for getting caught up.

Course evaluations for BIOC15 (and all courses are done online; please participate and let your voice be heard).

#### MARKING SCHEME FOR THE COURSE

Test 1 <b>October 9th</b>	20 %	In class 9-11 am
Module quizzes	20 %	online through the course site 2% <u>each quiz</u>
Final exam	36 %	(Comprehensive for all lectures)
Oral lab presentation	3%	
Experiment Summary and Analysis	9%	
Weekly Lab work	12 %	(attendance & participation, ability to work fairly and effectively as a team-member, lab assignments, lab quizzes)
Bonus quiz on the BIOB11 review module	1%	

Very Important Information - This is a lecture and laboratory course. To pass this course you must have an overall passing grade AND pass the laboratory portion of the course (lab engagement and oral and written reports)

#### ACADEMIC INTEGRITY

The University treats cases of cheating and plagiarism very seriously. The University of Toronto's *Code of Behaviour on Academic Matters* (<http://www.governingcouncil.utoronto.ca/policies/behaveac.htm>) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences.

Potential offences in papers and assignments include using someone else's ideas or words without appropriate acknowledgement, submitting your own work in more than one course without the permission of the instructor, making up sources or facts, obtaining or providing unauthorized assistance on any assignment.

On tests and exams cheating includes using or possessing unauthorized aids, looking at someone else's answers during an exam or test, misrepresenting your identity, or falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes.

Please avoid academic dishonesty, have confidence in your own ability to learn and grow academically by doing your own thinking and writing! I know you can learn a lot about genetics and yourself in this course.

#### ACCESSABILITY

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services as soon as possible.

AccessAbility Services staff (located in Rm AA142) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations 416-287-7560 or email [ability@utsc.utoronto.ca](mailto:ability@utsc.utoronto.ca). The sooner you let us know your needs the quicker we can assist you in achieving your learning goals in this course.

Schedule of Module Topics and In Class Test. (Lab Schedule Is In The Lab Manual, Only A Few Highlights Are Given Here)

Sept 4 Module 1

- Module 1.1 Course Organization and Perspective on Learning about Genetics & Yourself
- Module 1.2 Characteristics of the Hereditary Material
- Module 1.3 Designing Experiments Carefully - Mendel Set the Standard for Doing Controlled Matings.
- Module 1.4 Mendel's First Series of Experiments Led to Mendel's First Law: Segregation of Alleles
- Module 1.5 How Genes Work: Relating Mendel's Terms- Alleles, Genotype & Phenotype to DNA, RNA and Protein.
- Module 1.6 Using Mendel's First Law (Probability and Pedigrees)
- Module 1.7 Mendel's Dihybrid Crosses and His Second Law (Independent Assortment) and How It Generates New Gene Combinations.

**There are no BIO15 labs in the first week of class**

Sept 11 Module 2

- Module 2.1 Crosses with Co-Dominant and Incompletely Dominant Alleles – They Do Not Yield the Same Phenotypic Ratios as Dominance/Recessive Ones
- Module 2.2 How Genes Work - Why Are Some Alleles Recessive While Others Are Dominant, Codominant or Incompletely Dominant?
- Module 2.3 Another Complication to Mendel's Type Of Crosses - Multiple Alleles
- Module 2.4 More Complications to Phenotypic Ratios in Mendelian-Style Crosses due to pleiotropy or lethality.
- Module 2.5 How Genes Work – Genes' Functions and Interactions
- Module 2.6 Not All Proteins Function as Enzymes

**BIO15 Labs begin this week**

Sept 18 Module 3

- Module 3.1 Reviewing what we learned from Mendel and Garrod and Beadle and Tatum
- Module 3.2 Gene Interactions that Create Modified Mendelian Ratios for Discrete traits.
- Module 3.3 Dihybrid Crosses Are not Always Enough to Figure Out The Mode Of Inheritance
- Module 3.4 Continuous Traits
- Module 3.5 Summarizing Complex Traits as Seen in Dihybrid Crosses for Autosomal Genes, which Sort Independently and Are Determined by Simple Dominant/Recessive Alleles.
- Module 3.6 How Genes Work - Considering Another Complication Seen in Nature: Penetrance and Expressivity
- Module 3.7 Overview of Chapter 3 The Chromosomal Basis of Inheritance Part I
- Module 3.8 Sex Chromosomes and Sex Linkage
- Module 3.9 Organelle Inheritance
- Module 3.10 Autosomal Genes, Sex Linked Genes and Organelle Genes – A Summary

Sept 25 Module 4

- Module 4.0 Overview of the Chromosomal Basis of Inheritance Part II
- Module 4.1 Chromosome packaging throughout the cell cycle.
- Module 4.2 M Phase the Division Phase for Eukaryotic Cells
- Module 4.3 Mitosis the Type of Nuclear Division that Produces Two Genetically Identical Nuclei
- Module 4.4 Meiosis the Type of Nuclear Division that Produces Four Genetically Different Nuclei (each with a 50% Reduction in Chromosome Number)
- Module 4.5 Key Features of Meiosis and How It Differs from Mitosis
- Module 4.6 The Chromosome Theory of Inheritance
- Module 4.7 Chromosome Behavior During Meiosis Provide the Biological Basis for Mendel's Laws
- Module 4.8 Meiosis and Sexual Reproduction Are Great Sources of Variation!
- Module 4.9 What Are All the Exceptions We Already Know About for Mendel's Laws, and What Is the Next (and last) Major Exception?
- Module 4.10 Development of the Concept of Linkage

Oct. 2 Module 5

- Module 5.1 Recap and Operational Definition of Independent Assortment and the Test for Linkage

Module 5.2 Syntenic Genes Sometimes Show Linkage and Sometimes Show Independent Assortment; Why?  
 Module 5.3 Understanding the Relationship of Crossing-over to Recombination Frequencies.  
 Module 5.4 Mapping Genes on Chromosomes Using Recombination Frequencies - General Principles  
 Module 5.5 Mapping Using Frequencies of Recombinant Types from Controlled Matings of Testcrossed Dihybrids  
 Module 5.6 Mapping Genes Using Testcrossed Trihybrids, 'The Three Point Testcross'  
 Module 5.7 Interference  
 Module 5.8 Mapping Human Genes Using Traditional Mapping Techniques  
 Module 5.9 Calculating Recombination Frequencies from Selfed, Dihybrids (When Males And Females Have Approximately the Same Rates Of Crossing-over.  
 Module 5.10 The Relationship of Genetic Maps (based on frequencies of recombinant type gametes) To Physical Maps of The Chromosome?  
 Module 5.11 Using Map Distances to Predict Cross or Mating Outcomes  
 Module 5.12 Chi-Square in linkage experiments

Oct 9 **Test 1 (in class)**

**Oct 14 Thanksgiving**

**Reading Week Oct 15-18; no class or practicals but don't forget to continue fly matings in flex times**

Oct 23 Module 6

Module 6.1 Creating and Analyzing Karyotypes  
 Module 6.2 Chromosome Rearrangements - An Overview  
 Module 6.3 Deletions  
 Module 6.4 Duplications  
 Module 6.5 Inversions  
 Module 6.6 Reciprocal Translocations  
 Module 6.7 Summary Table for Chromosome Rearrangements  
 Module 6.8 Transposition and Transposable elements  
 Module 6.9 Whole Chromosome Mutations an Introduction to Terms and Symbols  
 Module 6.10 Aneuploidy

Oct 30 Module 7

Module 7.1 Euploid Mutations  
 Module 7.2 DNA Errors, DNA Damage, and Mutation Definitions and Overview  
 Module 7.3 DNA Replication Is a Natural Sources of DNA Errors that Can Lead to Mutation  
 Module 7.4 Cellular Biochemistry & Ionizing Radiation Are Natural Sources of DNA Damage that Can Lead to Mutation  
 Module 7.5 Mutagens and an Assay For Chemical Mutagenicity  
 Module 7.6 DNA Repair Mechanisms (in addition to proofreading and mismatch repair during DNA replication)

Nov 6 Module 8

Module 8.1 Molecular Analysis of DNA as a Tool for Understanding Biological Processes  
 Module 8.2 Tool 1 Nucleic Acid Hybridization  
 Module 8.3 Tool 2 Cutting Chromosomal DNA Into Smaller Pieces by Breaking Phosphodiester Bonds.  
 Module 8.4 Restriction Mapping and Gel Electrophoresis - Separating Segments of DNA from Each Other Based on Size  
 Module 8.5 Restriction Digestion of Entire Genomes - Estimating the Average Size of the Restriction Fragments and How Many Different Pieces are Generated  
 Module 8.6 Molecular Cloning

**Week of Nov 11<sup>th</sup> Oral lab reports done in lab practicals, for details see the lab manual.**

Nov 13 No new Module; Dr Hasenkampf will be in our class room SW128 to answer *Drosophila* questions regarding the upcoming 'Experiment Summary and Analysis' report

Nov 20 Module 9

Module 9.1 Types of Libraries and Their Characteristics

Module 9.2 Screening Libraries to Find the Gene of Interest.

Module 9.3 Blotting techniques that Combine Nucleic Acid Hybridization and Gel Electrophoresis

Module 9.4 Polymerase Chain Reaction

Module 9.5 DNA Sequencing Techniques

Module 9.6 Sequencing Entire Genomes and The Human Genome Sequencing Project

Module 9.7 Matching Up Open Reading Frames (ORFs) Identified in the Human Genome Sequence

with

Functioning Genes

**Nov 20 Experiment Summary & Analysis report is due Wed. Nov 20th, noon. Life happens; there is a grace period until Nov 27<sup>th</sup> noon. The grace period relates to the paper copy and the TurnItIn copy. For details see the lab manual.**

Nov 27 Module 10

Module 10.1 Assigning Function to Open Reading Frames (ORFs) - Overall Approach

Module 10.2 Assigning Function to Open Reading Frames (ORFs) - Knock outs

Module 10.3 Assigning Function to Open Reading Frames (ORFs) - Reporter Gene Studies

Module 10.4 Assigning Function to Open Reading Frames (ORFs) - Microarrays

Module 10.5 Assigning Function to Open Reading Frames (ORFs) - Yeast two hybrid assays

Module 10.6 Using Genome Wide Sequencing to Study and Exploit Natural Variation – Establishing the Ref Seq.

Module 10.7 A Quantitative Look at the Variation Seen from Human to Human.

Module 10.8 DNA Polymorphisms and their Applications

Module 10.9 Personal Genomics – A Case Study



I look forward to exploring the marvels of Genetics with you this term! Welcome to BIOC15!