



MBG*3060 Quantitative Genetics

Winter 2020

Section(s): C01

Department of Animal Biosciences

Credit Weight: 0.50

Version 1.00 - January 15, 2020

1 Course Details

1.1 Calendar Description

This course examines the nature of Mendelian inheritance when extended to quantitative traits that are jointly influenced by the environment and the simultaneous segregation of many genes. Prediction of response to natural and artificial selection in populations will also be studied.

Pre-Requisites: MBG*2400, 0.50 credits in statistics

1.2 Course Description

Quantitative Genetics is not a new subject by any means. With the rediscovery of Mendel's work in the early 1900's, geneticists started to try to figure out why they observed similarities and differences between plants and animals both in simple characteristics like coat colour, seed colour etc and complex characteristics like size, growth, drought tolerance, temperament, speed and strength. Since no tools existed to study this, they invented them and many early quantitative geneticists were also very good statisticians. Along the way, as quantitative geneticists figured out alleles, genetic variation and selection response, new fields of genetics were spawned - population genetics and evolutionary genetics. But Quantitative Genetics is the grandparent of them all.

So why the heck are we devoting a whole course to dusty theory that is over 100 years old? Because it isn't dusty! Early quantitative geneticists figured out a lot of stuff without the benefit of all of the molecular genetics tools and techniques we have now. And it turns out they got it right! So now that the molecular geneticists are catching up to us, we have an extensive toolkit of methods to figure out what the molecular labs are puzzling over. So welcome to the new old subject of Quantitative Genetics.

1.3 Timetable

Lectures Monday, Wednesday and Friday 2:30 to 3:20 p.m. in Rozanski Hall (ROZH) Room

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1.4 Final Exam

Final exam Monday April 13, 2020 11:30AM - 1:30PM. The location will be announced much closer to the exam date and you can find it on WebAdvisor as well as on the opening page of the CourseLink site for MBG-3060

2 Instructional Support

2.1 Instructional Support Team

| | |
|----------------------|---|
| Instructor: | Andy Robinson |
| Email: | andy@uoguelph.ca |
| Telephone: | +1-519-824-4120 x53679 |
| Office: | ANNU 122 |
| Office Hours: | Mondays 9:30 - 11:00am and after class until 4:30pm (quizzes are mostly due Monday nights) |

2.2 Teaching Assistants

| | |
|----------------------------|----------------------|
| Teaching Assistant: | Shannon Beard |
| Email: | sbeard@uoguelph.ca |
| Teaching Assistant: | Micheline Crosbie |
| Email: | crosbiem@uoguelph.ca |
| Teaching Assistant: | Alexandra Ficht |
| Email: | ficht@uoguelph.ca |

3 Learning Resources

3.1 Additional Resources

Course Notes (Notes)

There is no textbook officially for this course.

The presentation of the course material generally follows the notation and approach in the landmark textbook "Introduction to Quantitative Genetics" by Douglas Falconer originally published in 1962 and available still from Pearson Publishing with Trudy McKay as co-author on more recent editions (retail price is around \$100 on amazon.ca). Falconer's book was itself based on over 50 years of various folks teaching quantitative genetics with strong ties to Prof. J.L. Lush and others at Iowa State University. Throughout the world, this is the *de facto* standard way of presenting this material and Falconer's book has been translated into many, many languages.

However, to save you buying the book, the primary source of reference material for the

course is the lecture slides posted on CourseLink. Lecture slides will be posted at least a day ahead and often in big chunks since our pace through the material will be governed somewhat by questions and discussion in class. Slides will be posted in PDF format in both colour and black & white versions so you can decide which looks best for your purposes and perhaps your printer cartridge budget if you still print out notes. There are many apps out there that can manipulate these PDFs so you can format them any way you prefer.

Also posted (on CourseLink) you will find additional notes and resources. In the interest of saving forests, you might want to access them electronically to see if you need them before printing them out.

Additional material will be posted on CourseLink throughout the semester. Any hand-written document-camera examples from class will be scanned and posted. Sporadically, links to relevant information from the media or scientific literature to provide background on topics we discuss in class will be posted on CourseLink also.

So, bottom line - you will rely on CourseLink heavily throughout the semester for this course.

4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Analyze how allele frequency can fluctuate within a population over time, describe factors that affect these fluctuations and analyze how these factors affect genetic variation
2. Estimate levels of genetic variation within a population and demonstrate how that variation may be exploited to make genetic change in populations over time
3. Demonstrate how an individual locus can contribute to quantitative genetic variation involving many loci in the same individual or in many individuals in the population
4. Demonstrate how genetic variation can be gained or lost through selection of mates, combining different populations and other mechanisms
5. Demonstrate why the mating of close relatives leads to a loss of genetic variation and how to recover lost genetic variation

4.2 Overall Course Learning Outcome

Genetic variation is the engine that drives natural and artificial selection. Quantitative Genetics focuses on quantifying and measuring characteristics about animals called traits and variation in those traits. By the end of this course, you will be able to think like a quantitative geneticist and analyze and quantify genetic variation, showing how it can be influenced and manipulated, both by natural and artificial means.

5 Teaching and Learning Activities

5.1 Topic Schedule

As noted below in Section 7.2 lectures will be recorded in podcast format and posted on CourseLink for both sections. The list of lecture (and corresponding podcast) topics is shown below.

| Week | Lecture / Podcast 1 | Lecture / Podcast 2 | Lecture / Podcast 3 | Quiz |
|-------------|--|--|---|--|
| Jan. 6 | Introduction | Review: MBG-2400 topics | Review: MBG-2400 Topics, Tri-allelic loci, Linkage Disequilibrium | Review quiz available (not for credit) |
| Jan. 13 | Linkage Disequilibrium | Linkage Disequilibrium | Migration - multiple generations | Quiz 1 starts – Tri-allelic loci, linkage disequilibrium |
| Jan. 20 | Single Locus Selection | Single Locus Selection, Mutation | Population Size | Quiz 1 closes Quiz 2 starts - Migration, Selection, Mutation |
| Jan. 27 | Population Size, Effective Population Size | Individual Inbreeding | Individual Inbreeding, Relationships | Quiz 2 closes Quiz 3 starts - Population Size and Inbreeding |
| Feb. 3 | Relationships | Relationships, Tabular Method | Genetics Models, Re-introducing Heritability | Quiz 3 closes Quiz 4 starts – Inbreeding, Relationships, Tabular Method |
| Feb. 10 | Heritability | Re-introducing and expanding Response to | Response to selection | Quiz 4 closes No quiz starts |

| Week | Lecture / Podcast 1 | Lecture / Podcast 2 | Lecture / Podcast 3 | Quiz |
|-------------|--|--|------------------------------|---|
| | | | | selection |
| | Midterm – online, 3-hour time limit starting any time from 12:01 am Tuesday to 11:59pm Friday | | | |
| Feb. 17 | Reading Week | | | No quiz |
| Feb. 24 | Factors affecting response to selection | Heritability from ANOVA | Heritability from ANOVA | Quiz 5 starts - Heritability and Selection |
| Mar. 2 | Repeatability from ANOVA | Direct and correlated response | Allele effects | Quiz 5 closes Quiz 6 starts - Heritability and ANOVA |
| Mar. 9 | Allele effects, breeding values | QTL Detection | QTL Detection | Quiz 6 closes Quiz 7 starts - Direct response, Allele effects |
| Mar. 16 | QTL Detection | QTL Allele Effects Marker Assisted Selection | Marker panel analyses | Quiz 7 closes Quiz 8 starts - Allele effects, QTL Detection Selection and Makeup quizzes start |
| Mar. 23 | Marker panel analyses | Marker panel analyses | Marker panel analyses | Quiz 8 closes Quiz 9 starts - Marker Panel Analyses |
| Mar. 30 | Wrap Up | Wrap Up | Review Last day of | Quiz 9 closes Selection and |

| Week Lecture / Podcast 1 | Lecture / Podcast 2 | Lecture / Podcast 3 | Quiz |
|-----------------------------|------------------------|------------------------|-------------------------|
| | | classes | Makeup Quizzes close |

6 Assessments

6.1 Assessment Details

Weekly CourseLink Quizzes (36%)

Date: See CourseLink or Course Activities, Online

Learning Outcome: 1, 2, 3, 4, 5

Weekly Quizzes - 10 in total, 4 points each, **lowest grade is dropped. Quizzes generally close Monday night but check CourseLink for the deadlines for all of the quizzes.**

Graded Quizzes

The quizzes are scheduled weekly (consult course activities for the overall schedule and CourseLink for the deadline dates). Each weekly quiz has 15 questions; the first 10 questions follow the practice quizzes (see below) and the final 5 questions explore concepts that integrate the topics covered in the quiz with previous topics and relate quantitative genetic theory to practical applications. There are 9 weekly quizzes throughout the semester and a Makeup Quiz at the end of the semester for a total of 10 quizzes and the **best 9 quiz grades** will be used for your final grade.

Please note that the Selection Quiz is not part of this “best 9” system. Generally, each weekly quiz is **open for 8 days** from **Sunday at 6:00 a.m.** to the following **Monday at 11:59 p.m.** and is due when the quiz module closes at **11:59 p.m.** on the due date. You may have quiz experience from other courses that is probably different from the quizzes in this course – there is no time limit here, just a final deadline. During these 8 days, you can re-open and re-enter the quiz as often as you like until you submit it. With this system, there is **no opportunity for late quiz submission** because the answers are released when the quiz closes. **If you are registered with SAS, since the quizzes are open for 8 days giving you about 180 hours to complete the quiz, your regular quiz and exam accommodations are not needed.**

Also note that the **Selection Quiz** and the **Makeup Quiz** have a **longer availability** and **different deadlines.**

As a safety net, you have 2 attempts for each quiz. You will know the grade on your first attempt but you won't know the answers if you choose to make a second attempt. The extra attempt is there should you wish to retry a quiz and CourseLink will keep the highest of the two grades.

Should it happen that you are unable to complete your quiz on time due to circumstances warranting academic consideration contact me by e-mail to request academic consideration. If you have a bad week, the Makeup Quiz is available at the end of the semester as a safety net to replace one quiz. There is no weekly quiz starting the week of the midterm quiz or due over Reading Week. The Selection Quiz is a special quiz covering the very important topic of selection and is designed to review all the types of selection we cover throughout the semester.

The **Selection Quiz is mandatory** and is not part of the “best 9” option described above and it doesn’t have a practice quiz but since it covers all different aspects of selection you have already had practice questions on all the aspects covered.

Practice Quizzes

Each of the 9 weekly quizzes for credit has a matching practice quiz. You have unlimited attempts for the practice quizzes and the question feedback has been specially designed to assist you in understanding the material covered by each question. The practice quizzes remain open for the rest of the semester so you can use them to review for the midterm and final exams as well. Each practice quiz contains 10 questions and many of the quizzes have randomized elements to provide variety and new learning experiences with each attempt. The quizzes for credit may also draw from questions you might see on a practice quiz. Please note there are **no practice quizzes for the Makeup Quiz and the Selection Quiz** since those quizzes review material covered throughout the semester so you have already been practicing for those quizzes.

Review Quiz

There is an additional practice quiz at the beginning of the semester that you can use to review the material from MBG-2400 since it could be at least a year since you have had any exposure to that material. This quiz is purely for your use to recall / review material that was covered in MBG-2400. You will encounter this material again in greater detail and more advanced levels in MBG-3060 so if it fits your study preferences, the review may help reawaken the brain cells that contain this material from MBG-2400.

Selection Quiz (4%)

Date: See CourseLink or course activities, Online

Learning Outcome: 1, 4, 5

This quiz is separate from the weekly quizzes and cannot be dropped.

Online Midterm Quiz (15%)

Date: Week 6, Online

Learning Outcome: 1, 2, 3, 4

The online midterm quiz is available between 12:01am Tuesday February 11 to 11:59pm on Friday February 14.

The midterm quiz is time-limited, once you open the midterm quiz, you have **3 hours in which to complete the 60 questions**. The midterm quiz is more like a real midterm than the weekly quizzes so unlike the weekly quizzes, you have **just one attempt** at the midterm quiz

and the grade will not be released until after the availability period ends. You have a span of 4 days in which to do the midterm, there is no extended deadline option for the midterm quiz so don't leave it to the last minute. If you are unable to complete the online midterm quiz and wish to request academic consideration, contact the instructor as soon as possible. ***If you are registered with SAS and are given accommodations on exams, you must inform the instructor by email CC'ed to your SAS advisor by 11:59 p.m. on February 4 (one week in advance just like you do to book exams with SAS) in order for your accommodation to be applied to the midterm quiz settings, otherwise you will have the regular 3-hour time limit.***

Final Exam (45%)

Date: Mon, Apr 13, 11:30 AM - 1:30 PM, TBD - check WebAdvisor

Learning Outcome: 1, 2, 3, 4, 5

7 Course Statements

7.1 Technology

The vast majority of students are using their own technology such as smartphones, tablets and computers or various flavours in class and/or for the University of Guelph's online Learning Management System (aka CourseLink). In this course, it is your responsibility to ensure that you can access the course materials and complete online course requirements, such as quizzes on CourseLink, within the time allotted regardless of technological issues you may encounter. There are many places on campus and beyond where computers may be accessed or signed out if your own technology is non-functional. If CourseLink is not accessible for a significant period of time (not including scheduled maintenance) deemed by the instructor to have had an impact on students' abilities to complete quizzes, deadlines will be extended.

If you are present in class, you are welcome to use technology to take notes and interact with the course material. This should be done in a way that respects your fellow students by not creating undue distractions.

Also keep in mind that if your technology uses the University's wireless network to access the Internet, the University's acceptable use policy also comes into play.

http://www.uoguelph.ca/cio/sites/uoguelph.ca.cio/files/CIO-ITSecurity-03.1.3-AUP-Approved_0.pdf

7.2 Podcasts

The instructor will record lectures and post edited video podcasts on CourseLink throughout the semester within a few days after each lecture. The podcast will generally have real-time video of the image shown on the classroom projector overlaid with the audio of the instructor's comments and may include hand-written comments, other media etc. These podcasts will represent the officially sanctioned recorded media for the lecture and are

provided for the convenience of students officially registered in the course and may not be reproduced, or transmitted to others, without the express written consent of the instructor. Note that there may be circumstances in which not all of a lecture is recorded so the podcast is an additional aid and not necessarily a replacement for learning the material on your own and through the quizzes and additional media provided.

7.3 Group Work

The weekly quizzes are designed as an experiential learning tool. I encourage you to collaborate and work together on your quizzes to enhance your learning experience. Each of you must submit individual quizzes and you will find with the randomized elements built in to the quizzes that each of you will be doing a slightly different quiz covering the same concepts. The midterm quiz is expected to be an individual effort. The online midterm quiz has a large, randomized bank of questions behind the scenes so each student will have a different midterm quiz.

7.4 Academic Consideration Request

In order to facilitate the process of requesting academic consideration (based on university policies described elsewhere in this outline) and to ensure that you provide sufficient information in making your request, there is a form posted on CourseLink for that purpose.

Requests for academic consideration must be done using this form.

7.5 Email Contact

Email is used as an important source of updates about this course. All official email from the instructor will be sent to your University email account (ie the one with @uoguelph.ca). It is expected that you are checking this email account on a frequent basis. If you email the course instructor, please keep in mind that with over 350 students in this course, the instructor receives a lot of email in a day. In order to facilitate an answer to your email, please consider the following guidelines:

- correspond with the instructor (andyr@uoguelph.ca) using your official University email (@uoguelph.ca). Emails from other addresses (i.e. @gmail.com or @hotmail.com) will be ignored as there is no guarantee who owns the account. By the university's privacy policy, instructors are not allowed to share your course information with the general public or even family members so we will not reply to non-UofG email addresses since there is no guarantee who the email belongs to
- if the answer to your email query can be found in the course outline or other material posted on the MBG-3060 CourseLink site, you may not receive a reply or you may just get a link to the relevant information at best
- include the course code (**MBG-3060**) in the subject along with a **few relevant key words** indicating what your message is about
- include your full name and student number in the email signature

- if you are requesting academic consideration, include a copy of the Academic Consideration Request form found on the MBG-3060 CourseLink site
- allow 24 to 48 hours for a response to your query, especially if you send your message late at night or over the weekend (in other words sending an urgent email expecting a response in a few minutes is not likely to be successful)

8 University Statements

8.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

8.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

8.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>

Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

8.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

8.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

8.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

8.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

8.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>
