



# **ANSC\*6240 Topics in Animal Genetics and Genomics**

Winter 2023

Section(s): C01

Department of Animal Biosciences

Credit Weight: 0.50

Version 1.00 - March 08, 2023

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## **1 Course Details**

### **1.1 Calendar Description**

Current literature and classical papers pertaining to quantitative genetics, animal breeding and animal genomics are reviewed in detail through presentation, discussion and critical analysis.

### **1.2 Course Description**

The course is designed to provide a framework to effectively use new - OMICS technologies, combining structural and functional genomic data into systems biology to understand the nature of complex phenotypes in animals. Using systems biology, the students will learn how to integrate the genomic information to develop testable hypothesis in relation to the regulation of gene networks associated with economically important traits in livestock.

### **1.3 Timetable**

Lectures: Mondays 2:30pm - 5:20pm, ANNU room 101 and/or by Zoom depending on COVID-19 situation and considering UofG guidelines.

Theory Lectures

Practical lecture / Computer Labs

## 1.4 Final Exam

No final exam in this course.

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# 2 Instructional Support

## 2.1 Instructional Support Team

<b>Instructor:</b>	Angela Canovas
<b>Email:</b>	acanvas@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x56295
<b>Office:</b>	ANNU 125
<b>Office Hours:</b>	Office hours by appointment / email me always if you need it.

## 2.2 Instructor's Role and Responsibility to Students

The instructor will facilitate discussions, present lecture notes in an interactive fashion, provide feedback to students, help with project direction and oversee/prepare the lab activities.

## 2.3 Course Technology and Technical Support

### CourseLink

This course is being offered using CourseLink (powered by D2L's Brightspace), the University of Guelph's online learning management system (LMS). By using this service, you agree to comply with the University of Guelph's Access and Privacy Guidelines. Please visit the D2L website to review the Brightspace privacy statement and Brightspace Learning Environment web accessibility standards.

<http://www.uoguelph.ca/web/privacy/> <https://www.d2l.com/legal/privacy/>  
<https://www.d2l.com/accessibility/standards/>

### Technical Support

If you need any assistance with the software tools or the CourseLink website, contact CourseLink Support.

Email: [courselink@uoguelph.ca](mailto:courselink@uoguelph.ca)

Tel: 519-824-4120 ext. 56939 Toll-Free (CAN/USA): 1-866-275-1478

**Support Hours (Eastern Time):**

Monday thru Friday: 8:30 am–8:30 pm

Saturday: 10:00 am–4:00 pm

Sunday: 12:00 pm–6:00 pm

**Teams (via Office 365)**

Office 365 Teams is a collaboration service that provides shared conversation spaces to help teams coordinate and communicate information. This course will use Teams for one on one meetings with your Instructor. It is recommended that you use the desktop version of Teams. As a student you are responsible for learning how to use Teams and it's features.

For Teams Support visit the CCS website for more information.

<https://www.uoguelph.ca/ccs/services/office365/teams>

## Zoom

This course will use Zoom for lectures. Check your system requirements to ensure you will be able to participate.

<https://opened.uoguelph.ca/student-resources/system-and-software-requirements>

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## 3 Learning Resources

### 3.1 Required Resources

#### Course Materials (Other)

- Lecture slides and other materials will be posted on CourseLink.
- Manuals of the different software used in the course will be posted on CourseLink.
- R Manual, R codes and/or R packages will be provided and posted on CourseLink.

### 3.2 Recommended Resources

#### Suggested Reading Material (Readings)

Suggested reading material (examples and references used in the course)

Barrett, J. C., Fry, B., Maller, J. D. M. J., & Daly, M. J. Haploview: analysis and visualization of LD and haplotype maps. *Bioinformatics*, 21(2), 263-265. 2004.

SNP discovery in the bovine milk transcriptome using RNA-Seq technology. Cánovas A, Rincon G, Islas-Trejo A, Wickramasinghe S, Medrano JF. *Mamm Genome*. 21(11-12):592-8. doi: 10.1007/s00335-010-9297-z. 2010.

Trapnell, C., Roberts, A., Goff, L., Pertea, G., Kim, D., Kelley, D. R., ... & Pachter, L. Differential gene and transcript expression analysis of RNA-seq experiments with TopHat and Cufflinks. *Nature protocols*, 7(3), 562- 578. 2012.

Franceschini, A. STRINGdb Package Vignette. *Nucleic Acids Res*. 2013.

RNA sequencing to study gene expression and single nucleotide polymorphism variation associated with citrate content in cow milk. Cánovas A, Rincón G, Islas-Trejo A, Jimenez-Flores R, Laubscher A, Medrano JF. *J Dairy Sci.* 96(4):2637-2648. doi: 10.3168/jds.2012-6213. 2013.

Marjoram, P., Zubair, A., & Nuzhdin, S. V. Post-GWAS: where next? More samples, more SNPs or more biology?. *Heredity*, 112(1), 79-88. 2014.

Review: RNA-Seq applications in Livestock. Wickramasinghe, S., Cánovas, A., Rincon, G., & Medrano, J. F. *Livestock Science*, 166, 206-216, doi: 10.1016/j.livsci.2014.06.015. 2014.

Comparison of five different RNA sources to examine the lactating bovine mammary gland transcriptome using RNA-Sequencing. Cánovas A, Rincón G, Bevilacqua C, Islas-Trejo A, Brenaut P, Hovey RC, Boutinaud M, Morgenthaler C, VanKlompberg MK, Martin P, Medrano JF. *Sci Rep.* 4:5297. doi: 10.1038/srep05297. 2014.

Multi-tissue omics analyses reveal molecular regulatory networks for puberty in composite beef cattle. Cánovas A, Reverter A, DeAtley KL, Ashley RL, Colgrave ML, Fortes MR, Islas-Trejo A, Lehnert S, Porto-Neto L, Rincón G, Silver GA, Snelling WM, Medrano JF, Thomas MG. *PLoS One.* 9(7):e102551. doi: 10.1371/journal.pone.0102551. 2014.

Chang, C. C., Chow, C. C., Tellier, L. C., Vattikuti, S., Purcell, S. M., & Lee, J. J. Second-generation PLINK: rising to the challenge of larger and richer datasets. *Gigascience*, 4(1), 7. 2015.

Smedley, D., Haider, S., Durinck, S., Pandini, L., Provero, P., Allen, J., & Bardou, P. The BioMart community portal: an innovative alternative to large, centralized data repositories. *Nucleic acids research*, 43(W1), W589- W598. 2015.

Transcriptome analyses identify five transcription factors differentially expressed in the hypothalamus of postversus prepubertal Brahman heifers. Fortes MR, Nguyen LT, Weller MM, Cánovas A, Islas-Trejo A, Porto-Neto LR, Reverter A, Lehnert SA, Boe-Hansen GB, Thomas MG, Medrano JF, Moore SS. *J Anim Sci.* 94(9):3693-3702. doi: 10.2527/jas.2016-0471. 2016.

Hu, Z. L., Park, C. A., & Reecy, J. M. Developmental progress and current status of the Animal QTLdb. *Nucleic acids research*, 44(D1), D827-D833. 2016.

RNA-seq based detection of differentially expressed genes in the skeletal muscle of Duroc pigs with distinct lipid profiles. Cardoso TF, Cánovas A, Canela-Xandri O, González-Prendes R, Amills M, Quintanilla R. *Sci Rep.* 7:40005. doi: 10.1038/srep40005. 2017.

Joint QTL mapping and gene expression analysis identify positional candidate genes influencing pork quality traits. González-Prendes R, Quintanilla R, Cánovas A, Manunza A, Figueiredo Cardoso T, Jordana J, Noguera JL, Pena RN, Amills M. *Sci Rep.* 7:39830. doi: 10.1038/srep39830. 2017.

Global differential gene expression in the pituitary gland and the ovaries of pre- and

postpubertal Brahman heifers. Nguyen LT, Reverter A, Cánovas A, Venus B, Islas-Trejo A, Porto-Neto LR, Lehnert SA, Medrano JF, Moore SS, Fortes MR. J Anim Sci. 95(2):599-615. doi: 10.2527/jas.2016.0921. 2017.

SNP detection using RNA-sequences of candidate genes associated with puberty in cattle. Dias MM, Cánovas A, Mantilla-Rojas C, Riley DG, Luna-Nevarez P, Coleman SJ, Speidel SE, Enns RM, Islas-Trejo A, Medrano JF, Moore SS, Fortes MR, Nguyen LT, Venus B, Diaz IS, Souza FR, Fonseca LF, Baldi F, Albuquerque LG, Thomas MG, Oliveira HN. Genet Mol Res. 16(1). doi: 10.4238/gmr16019522. 2017.

### 3.3 Additional Resources

#### Library Access (Other)

As a student, you have access to the University of Guelph's library collection, including both physical and electronic materials. For information on checking out or couriering physical library items, accessing electronic journals and returning items to the library, visit the library's website.

If you are studying off campus and would like to access the library's electronic resources, use the Off Campus Login and login using your Single Sign On credentials or using your last name and library barcode.

<https://www.lib.uoguelph.ca/>

<https://www.lib.uoguelph.ca/campus-login>

#### Ares

How to access course reserve materials through the University of Guelph McLaughlin Library. Select **Ares** on the navbar in CourseLink. Note that you will need your Central Login ID and password in order to access items on reserve.

For further instructions on accessing reserve resources, visit [How to Get Course Reserve Materials](#).

If at any point during the course you have difficulty accessing reserve materials, please contact the e-Learning Operations and Reserve Services staff at:

Tel: 519-824-4120 ext. 53621

Email: [libres2@uoguelph.ca](mailto:libres2@uoguelph.ca)

<https://www.lib.uoguelph.ca/find/course-reserves-ares/how-get-course-reserve-material>

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## 4 Learning Outcomes

The Course Objectives are to provide learning opportunities in:

### 4.1 Course Learning Outcomes

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

1. Integration of structural and functional genomic data into a Systems Biology approach.
2. Transcriptomics and other -OMICS analysis using different software and packages.
3. Functional genomics analysis using different software and packages.
4. Methods for optimizing genetic improvement strategies considering genomic and quantitative information.
5. "-OMICS" technologies and methodologies to accelerate the genetic improvement in livestock.
6. Improving selection efficiency by combining functional and structural genomic data with the estimation of molecular breeding values in livestock species.
7. Graduate level writing and oral presentation skills.

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## 5 Teaching and Learning Activities

## 5.1 Lecture

### Topics:

#### **BLOCK 1. - Genomics and fine mapping of positional candidate markers**

- Genome-Wide Association Studies (GWAS). Identification of candidate genes/variants using results obtained from GWAS, whole genome sequencing, exome, etc. Summary of the basis of association studies using genomic data. Additionally, the course will introduce the concepts of variant identification and classification including SNP, INDELS and splice variants.

- Fine mapping and identification of positional candidate genes. Identification of genes mapped in candidate regions identified by association studies using genomic annotation data provided by public repositories (Ensembl, NCBI, UCSC, etc.) Identification of haplotype blocks and linkage disequilibrium pattern analysis.

- QTL mapping positional candidate genes. Identification of QTLs mapped in regions where candidate genes were identified using the public QTLdb (<https://www.animalgenome.org/cgi-bin/QTLdb/>).

### Topics:

#### **Block 2. - Genetical Genomics to identify functional candidate genes using GWAS and other genomic data.**

- Identification of functional candidate genes among statistical and positional candidates using functional genomic approach.

- Enrichment analysis or Gene Ontology terms, metabolic pathways and gene network analysis. Definition of GO terms categories and structure. To introduce data bases for metabolic pathway information.

- Prediction of gene networks to identify groups of related genes.



**Topics:****Block 3. - Transcriptomics analysis using RNA - Sequencing technology**

- Definition of transcriptomics and RNA-Seq technology.
- RNA-Sequencing analysis using different software and packages. Quality control analysis. Identification of differentially expressed genes using RNA-Sequencing data. Prediction of key regulatory genes and transcription factor.
- SNP Discovery and variant detection using RNA-Sequencing. Differences between variants identification using genomic and transcriptomic data. Pipelines for structural variant identification using RNA-Seq data. Annotation and functional impact prediction and consequences.

**Topics:****Block 4. - Functional Genomics**

- Functional Genomics analysis to identify the key regulatory genes and transcription factors using different software/approaches. GO enrichment, metabolic pathway and gene network analysis using gene expression data.
- Introduction to Metagenomics, Metabolomics and other - OMICS technologies analysis.

**Topics:****Block 5. - Systems Biology**

- Importance of other -OMICS approaches, such as proteomics, metabolomics, metagenomics, in the identification of candidate genes for complex traits.
- Impact of data integration over accuracy of selection. Integration of multi-omics using results from different tissues, breeds and even organisms.
- Interpretation of the biological meaning of statistical results obtained by multi-OMIC and functional genomics

approaches.

- Transition from theoretical assumptions to applicability.

- The use of genomic tools to accelerate the genetic improvement in livestock. Improving selection efficiency by combining functional and structural genomic data with the estimation of molecular breeding values in livestock species.

## 5.2 Lab

### Computer Labs

#### Topics:

Computer Lab 1:

Fine mapping of positional candidate markers: Gene and Genome regions annotation using Biomart. Haplotype blocks and LD analysis using haploview.

### Computer Labs

#### Topics:

Computer Lab 2:

Practical exercises/data analysis using different software, package and approaches such as CateGORizer, and AmiGO software for Gene Ontology and enrichment analysis; DAVID, and Reactome software for metabolic pathways analysis; STRING and NetworkAnalyst software for gene network analysis. Identification of functional candidate genes (GO, metabolic pathways and Gene network) using associated software and R packages.

### Computer Labs

#### Topics:

Computer Lab 3:

Predicting Functional Consequences of SNPs using ariant effect predictor.

### Computer Labs

**Topics:****Computer Lab 4:**

Integration data - Systems Biology. Integration of 4 groups of data from the previous results obtained from Computer Lab 1, 2, and 3 such as list of genes with significant SNP from GWAS (Computer Lab 1), list of genes involved in significant metabolic pathways (Computer Lab 2), list of genes connected in gene networks (Computer Lab 2) and list of genes with SNP with functional consequences (Computer Lab 3)

**Computer Labs****Topics:****Computer Lab 5:**

Practical exercises. Integration of structural and functional data from multi-omics using results from different tissues, breeds and species. To perform the Ven diagram with the Integration of 5 groups of data from the results/inputs provided from transcriptomics analysis using RNA-Sequencing technology including the list of differentially expressed genes between healthy and sick sheep from two different breeds of sheep, list of SNP significant associated with health in sheep from a GWAS study, list of Ensembl IDs for the genes associated with the intestinal immune network for IgA production pathway in sheep and list Genomic Regions also associated with health in sheep.

## 6 Assessments

### 6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Report Project based on the computer labs	75
Paper review and oral presentation	25
Total	100

### 6.2 Assessment Details

**Report Project based on the computer labs (75%)**

**Date:** Dates to be determined and listed in CourseLink

**Learning Outcome:** 1, 2, 3, 4, 5, 6, 7

The structure of the course combines both theory and practical (Computer Lab) lectures. Based on the topics and section covered in the course, the students will perform 5 computer Labs.

The students will prepare a draft report showing their progress in the data analysis for each of the five computer Labs. The instructor will review and grade them.

The Computer Lab reports are due at the end of every section (specific deadline will be provided at the beginning of the course). Each computer Lab will count the 15% of the final grade (15% grade x 5 computer Lab = 75%).

All reports can be submitted via Dropbox on CourseLink.

**Paper review and oral presentation (25%)**

**Date:** Dates to be determined

**Learning Outcome:** 1, 2, 3, 4, 5, 6, 7

The paper review is designed to provide an opportunity to discuss course topics as they relate to current research in Systems Biology. Student will find a research paper to review, which must be approved by the instructor. Each student will present their review in a short (8-10 min) presentation during the class toward the end of the semester (date to be determined). Grades will be based on students' own presentation and participation in discussing others' papers. Titles and citations of two potential papers should be submitted to the Dropbox by the end of week 7 of the course (beginning of March). Paper review and oral presentation will count for 25% of the final grade. Oral presentations will be determined if they will be in-person and/or on-line depending of COVID-19 situation and following UofG guidelines.

## 7 Course Statements

### 7.1 Dropbox Submissions

Assignments should be submitted electronically via the online **Dropbox** tool. When submitting your assignments using the **Dropbox** tool, do not leave the page until your assignment has successfully uploaded. To verify that your submission was complete, you can view the submission history immediately after the upload to see which files uploaded successfully. The system will also email you a receipt. Save this email receipt as proof of submission.

Be sure to keep a back-up copy of all of your assignments in the event that they are lost in transition. In order to avoid any last-minute computer problems, your instructor strongly recommend you save your assignments to a cloud-based file storage (e.g., OneDrive), or send

to your email account, so that should something happen to your computer, the assignment could still be submitted on time or re-submitted.

It is your responsibility to submit your assignments on time as specified on the Schedule. Be sure to check the technical requirements and make sure you have the proper computer, that you have a supported browser, and that you have reliable Internet access. Remember that **technical difficulty is not an excuse not to turn in your assignment on time**. Don't wait until the last minute as you may get behind in your work.

If, for some reason, you have a technical difficulty when submitting your assignment electronically, please contact your instructor or CourseLink Support.

<http://spaces.uoguelph.ca/ed/contact-us/>

## 7.2 Netiquette Expectations

- Posting inflammatory messages about your instructor or fellow students
- Using obscene or offensive language online
- Copying or presenting someone else's work as your own
- Adapting information from the Internet without using proper citations or references
- Buying or selling term papers or assignments
- Posting or selling course materials to course notes websites

- Having someone else complete your quiz or completing a quiz for/with another student
- Stating false claims about lost quiz answers or other assignment submissions
- Threatening or harassing a student or instructor online
- Discriminating against fellow students, instructors and/or TAs
- Using the course website to promote profit-driven products or services
- Attempting to compromise the security or functionality of the learning management system
- Sharing your user name and password
- Recording lectures without the permission of the instructor

### 7.3 Late Policy

If you choose to submit assignments to the **Dropbox** tool late, the full allocated mark will be reduced by 5% per day after the deadline for the submission of the assignment to a limit of six days at which time access to the **Dropbox** folder will be closed. Late Graded Homework Assignments will NOT be graded if they are submitted after the solutions have been posted to CourseLink.

Extensions will be considered for medical reasons or other extenuating circumstances. If you require an extension, discuss this with the instructor as soon as possible and well before the due date. Barring exceptional circumstances, extensions will not be granted once the due

date has passed. These rules are not designed to be arbitrary, nor are they inflexible. They are designed to keep you organized, to ensure that all students have the same amount of time to work on assignments, and to help to return marked materials to you in the shortest possible time.

## 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 make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

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>

## 8.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

This includes on-campus scheduling during the semester, mid-terms and final examination schedules. All University-wide decisions will be posted on the COVID-19 website (<https://news.uoguelph.ca/2019-novel-coronavirus-information/>) and circulated by email.

## 8.10 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

## 8.11 Covid-19 Safety Protocols

For information on current safety protocols, follow these links:

- <https://news.uoguelph.ca/return-to-campus/how-u-of-g-is-preparing-for-your-safe-return/>
- <https://news.uoguelph.ca/return-to-campus/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University, Public Health or government directives.

