MOL BIOL 3II3
Molecular Genetics of Eukaryotes
Winter 2021 Course Outline

Course Details

Instructor: André Bédard, abedard@mcmaster.ca; 905-525-9140 x23149

Office hours: To be discussed in class.

TAs: TBA

Lectures: Tu We Fr 12:30-1:20PM, Locations to be Determined

Tutorials: T01 Wed. 1:30-2:20PM
T02 Wed. 11:30AM-12:20PM
T03 Tu. 1:30-2:20PM

Course Description

The Molecular Genetics of Eukaryotes has progressed rapidly with the initiation and completion of several projects on the human genome and the genome of model organisms (yeast, worm, fly, *Arabidopsis*, zebrafish, mouse, etc…). In addition, the characterization of gene expression at the RNA level (transcriptome) revealed the existence of numerous genes encoding non-coding RNAs. Long known as products of the "*Dark Genome*", these genes code for RNAs playing a role in a wide variety of processes ranging from the maintenance of genome integrity to the fine control of gene expression. In this course, we will describe the recent advances in the characterization of the eukaryotic genome, the control of gene expression and the role played by epigenetics in these processes. Regulatory mechanisms described in model organisms (plant, worm, fly, in particular) and epigenetic processes involved in trans-generational inheritance will be emphasized. A wide variety of topics ranging from transcriptional and post-transcriptional regulatory processes to ethical questions arising from this new knowledge will be presented in lectures and tutorials.

Course Learning Objectives

The **central objective** of this course is to present the recent advances on the characterization of eukaryotic genomes particularly in light of the recent genome sequencing data and transcriptomic analyses of gene expression. Mechanisms of gene expression and epigenetic processes will be discussed more thoroughly. By the end of this course, it is expected that students:

- Will have a good understanding of the structure or eukaryotic genomes

- Will be able to integrate data obtained from sequencing analyses, transcriptome characterization and genome-wide association studies (GWAS).
- Will know the basic mechanisms of eukaryotic gene expression with a particular focus on transcription and coupling mechanisms of transcriptional and post-transcriptional regulatory processes.
- Will have a good knowledge of processes depending on the state of chromatin condensation including the molecular machinery controlling this state(s).
- Will understand the role of long and short non-coding RNAs in the control of gene expression, chromatin condensation and the maintenance of genome integrity.
- Will understand the role of pioneering transcription factors in cell reprogramming.
- Will have significant understanding of processes of epigenetic transgenerational inheritance.

Course Schedule and List of Topics for 2021

Each "Unit" corresponds to about three lectures or one week of lecturing according to the following order:

1- Introduction: Characterization of the Eukaryotic Genome – A Work in Progress

- Insight provided by genome and transcriptome sequencing projects
- How much of the genome is transcribed?
- The "*Dark Genome*"
- What is a gene?
- Why study the "non-protein-coding" regions of the genome? Answers from "*Genome-Wide Association Studies*" (GWAS)

2- Control of Gene Expression: Review of Basic Principles
- Transcription Initiation – Recruitment of the Basic Transcription Machinery
- Coupling in transcriptional and post-transcriptional processes

3- Histone Code
- Readers, Writers and Erasers
- Principles in Chromatin Modification

4- Active vs Repressed Chromatin States: Overview
- Euchromatin vs Heterochromatin
- DNA methylation and DNA methylases recruitment
- DNA methylation in monozygotic twins.

5- Control of Gene Expression at the Chromatin level
- Chromatin Modification and Chromatin Remodeling Complexes
- "Noise" vs Spurious Transcription in the absence of Repression
- Trx and PcG Complexes
- HP1 and Chromatin Silencing

6- Role of Noncoding RNAs in chromatin modification and gene expression
- LncRNAs in scaffolding/recruitment of Chromatin Complexes
- DNA methylation is coupled to the recruitment of chromatin modification complexes
- Control of gene expression by miRNA and other small non-coding RNAs (sncRNAs)

7- Pioneering Transcription Factors in Gene Activation
- Pioneering Transcription Factors; Definition
- Cell Reprogramming by Pioneering Transcription Factors
- Inducible Pluripotent Stem Cells - iPSC

8- Epigenetic Processes in the Maintenance of Genome Integrity
- Maintenance of the Chromatin State during Cell Replication
- Maintenance of Genome Integrity: piRNAs & Transposon Silencing

9- Epigenetic Mechanisms of Transgenerational Inheritance
- Starvation Response in Worms: siRNAs
- Stress Response in Fly: Role of PgC Complexes
- Stress Response in Plants

10- Transgenerational Inheritance in humans?
- Epigenetic Reprogramming during Gametogenesis
- Stress Response and Stress Markers
- *"Lifestyle in the sperm"*: Role of small RNAs

11- Personalized/Precision Medicine and Current Questions in Bioethics
- Definition and Goals of Precision Medicine
- Cancer Epigenetics, the "*Cancer Genome Project*", the "*Canadian Epigenetics, Environment and Health Research Consortium*" (CEEHRC)
- Bioethical Questions: - "*Don't Blame the Mothers*" (Longitudinal Studies on stress response genes)

12- Genome Editing
- CRISPR and other approaches
- Case study and ethical issues

IMPORTANT NOTE

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If any modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes. Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.

Course Materials

There is no textbook recommended for this course but reference/review articles will be provided in Avenue to Learn. All lecture notes/presentations will also be made available through Avenue.

Course Evaluation

COURSE EVALUATION:

Midterm I ("in class")	25%
Midterm II ("in class")	25%
Tutorial presentation	9%
Tutorial summary	6%
Tutorial participation	5%
Final Exam	30%

The mid-term tests will be given in-class at the regular lecture time. The exact date of the first and second mid-term will be discussed with the class during the semester.

TUTORIALS SESSIONS:

The class will be divided into two groups for tutorial sessions. The tutorials will consist in the short presentation (15-20 min) of a research article on current topics of interest by the students. These articles will be selected by the course coordinator. A summary of the article, worth 6% of the final grade, must also be provided by the student presenting the article. A schedule of these presentations will be established early in the semester. Participation to the tutorials will be evaluated though completion of forms by students attending the tutorials. Guidelines, including the marking scheme, for the presentation and summary of the article will be discussed in class/tutorials and posted on Avenue to Learn.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads:

"Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Authenticity/Plagiarism Detection

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, Echo360, Microsoft Teams, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx, Echo360, Microsoft Teams or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

Requests for Relief for Missed Academic Term Work

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

View the McMaster Student Absence Form (MSAF) for more information.

Academic Accommodation for Religious, Indigenous or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.