Life Rewritten: Applications and Implications of Gene Editing and Synthetic Biology

Department of Biology

Syllabus

BIOL 3037.03 Winter 2024

10:05 - 11:25 Wednesday, Friday

LSC Room C202

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Patrice Côté	patrice.cote@dal.ca	By appointment
Erin Bertrand	erin.bertrand@dal.ca	By appointment
Clarisse Paron	clarisse.paron@dal.ca	By appointment
Rebecca Stevens-Green (TA)	r.stevens-green@dal.ca	By appointment

Course Description

Calendar Description: This course introduces students to gene editing and synthetic biology tools (eg. CRISPR) as well as both current and future applications of those tools for conservation, medicine, and food production. This course empowers students to develop informed opinions about the ethics of using such tools in science and society.

Extended Course Description: Humans have been employing techniques to modify the genomic content of organisms for centuries. However, recent advancements in our understanding of CRISPR/Cas9 and related tools have enabled us to conduct targeted and efficient gene editing on an unprecedented scale. This is, literally, changing life as we know it. This course introduces students to gene editing and synthetic biology tools as well as both current and future applications of those tools for medicine, conservation and food production. This course empowers students to develop informed opinions about the ethics of using such tools in science and society.

Lectures: *2 x 80 min lecture time blocks per week*

Course delivery: in person

Course Prerequisites

A mark of B- or better in both BIOL 2020 Cell Biology and BIOL 2030 Genetics and Molecular Biology.

Course Structure

Course Delivery

This course is taught in two lecture time blocks per week of 80 minutes. For a subset of the lecture blocks, students will be expected to have become familiar with course content through reading, watching videos and tutorials, and completing worksheets ***prior*** to coming to class. Rather than encountering content in class via lecture, students will instead use classroom time to work in small groups to synthesize content, guided by input from the instructors. *Lectures*

Groupwork

Students will answer a short questionnaire before class starts (Due Jan 10 at 10:00am); answers from this questionnaire will be used to put students in teams. These teams will be designed to provide everyone with the necessary experiences and skillsets to work together effectively on a series of projects.

Course Materials

Assigned readings, videos, and tutorials for each class will be available one weeks ahead of time on the course Brightspace page.

Resources will be designated as '**primary**' if they are explicitly examinable, '**background**' for material that will provide additional context to examinable topics and, finally, '**extensions**' if they are useful for broader understanding, but not directly examinable.

There is no required textbook to purchase.

The Applied Ethics Primer that we will be using is available for free as an e-book on Brightspace. However, those who wish to obtain a hardcopy can purchase one at the King's Co-op Bookstore.

Meynell, L. & Paron, C. (2023). *Applied Ethics Primer.* Broadview Press https://kingsbookstore.ca/item/Mgtiw5Oa4vfMJJ91Vr3O7w/lists/LahWYZmu8lr4/

Students may find the following books to be useful:

"A Crack in Creation" by Dr. Jennifer Doudna, "Altered Inheritance: CRISPR and the Ethics of Human Genome Editing" by Dalhousie's Dr. Françoise Baylis, and 'Biotechnology' textbook, 2nd edition, by David Clark and Nanette Pazdernik. We are working to make digital copies of these books available to you.

Assessment

Component	*Weight (% of final grade)*	*Description/ Due Date*
Worksheets	30%	Worksheets (see below) are evenly weighted, lowest mark dropped. For worksheet days and style see Appendix A. Lowest mark is dropped.
Peer evaluation and participation (PEP)	15%	Your participation in will sometimes (for example on Primary Literature Discussion days, see below) be evaluated by your peers. The PEP score for each class will be evenly weighted, lowest mark dropped.
Midterm	15%	See Appendix A
Podcast	20%	See Appendix A for deadlines and 'Podcast Instructions&Resources' document for details
Final Exam	20%	Final Exam Period.

Worksheets

There will be seven worksheets assigned throughout the semester. There will be two types of worksheets - style A and style B. Students will complete part one of the worksheet assignments before they come to class based on assigned readings, videos, and tutorials.

Worksheet style A : Students will complete multiple choice questions before class and work together as a group to arrive at answers to a new short answer question worksheet in class. Each student will receive a mark for their multiple-choice answers (50%) and for the group's short answer questions (50%).

Worksheet style B : This style of worksheet is called "Ask an Expert". On these days, students will review provided materials and prepare three **single-part** questions for an expert who will visit the class, either in person or virtually. These questions will be submitted on Brightspace before class. In class, students will work in small groups to select **THREE** questions to submit for asking the expert the following class period. Student will be marked based on the quality of their group questions, but will not receive any points unless they submit their independent questions before class starts.

No points will be awarded for the group portion of any worksheet if the student is not in attendance.

Show and Tell

Students will work in assigned groups to select a clip from a song, TV show, movie, piece of literature etc. that has something to do with genome editing or synthetic biology. Each group gets 5-7 minutes to present their clip/ description and 2-3 questions that they had about the scientific basis of the content of their 'show and tell' piece.

On **Day 2 of Week 1**, each group will submit a PowerPoint slide on Brightspace that has a) weblink to clip and b) 2-3 questions, and be prepared to share these slides themselves during our class meeting. Students will be marked by their peers based on preparedness and ability to work well within the team. (See **Peer Evaluation Rubric** below)

Primary Literature Discussion

On Primary Literature Discussion days, students will come prepared to discuss a paper from the primary literature. Each student will be assigned to become an "expert" in one specific part of

the paper. In class, students will get together with all the other students who are experts in the same part and discuss for 30 minutes. Then, students will re-group to pre-assigned groups where each member is an expert in a different aspect. The group is tasked with making sure each member understands the paper well by the end of the class period. Students will be marked by their peers based on preparedness, ability to work well within the team, and their ability to adequately explain their section of the paper (see **Peer Evaluation Rubric** below).

Midterm

This test will occur during class time (**see Appendix A for date**) and will serve to examine student's understanding of material covered in weeks 1-6 including worksheet and primary literature discussion materials. This exam will consist of multiple choice and short answer questions.

Podcasts

See **Appendix A** for deadlines and '**Podcast Instructions & Resources**' document for details. As teams, students will make a 10-minute podcast episode that defends one side of a debate topic. The target audience for the podcast is fellow undergraduate students with a basic knowledge of biology. There will be several debate topics to choose from, each with two stances ("for" or "against"). Groups will have the chance to submit their top three choices for debate topic and stance and will be assigned a topic with those choices in mind. Students will be provided with access to high quality, open access sound editing tools to create their podcasts. We will listen to all podcasts during class time during the last class of the semester. Each student will record their opinion before and after hearing podcasts arguing each side. This is in the style of an Oxford debate: The goal is to change as many minds as possible. Along with a 10-minute audio file, each group will submit an outline as well as a "*production document*" including a transcript and explaining the role each student played in the preparation of the podcast and providing detailed reference list for the content used to create your podcast.

Component	% of podcast grade
Outline	20
Podcast and production document	80

Final Exam

The final exam is designed to examine student's understanding of material discussed throughout the semester, concentrating on weeks 8-12, as well as student's ability to apply

their new knowledge to advocate for specific ethical stances or policy solutions related to gene editing. The final exam will be scheduled by the Registrar during exam week.

Rubrics for non-multiple choice or short answer aspects of the course

Worksheet style B "Ask and Expert" question-marking Rubric

Criteria	**Indicators**
Clarity (33%)	The phrasing of the question is clear and concise
Relevance (34%)	Demonstrates that the student has read and understood background materials provided for this class by being previously unanswered and relevant to the topics the expert works on
Insight and synthesis (33 %)	Demonstrates a deep understanding of the subject matter by bringing together disparate information from previous classes to ask a question that is synthetic and shows particular insight

Peer Evaluation Rubric (completed by all peers in your group, mean grade is assigned)

In class, each person will fill out a survey about each student they work with that day,

ranking their participation 0-2:

0- disagree with four or five statements below
1- disagree with one, two or three statements below
2- agree with all statements below

- The team member was present for all discussions
- The team member was well prepared and did their best to understand the material
- The team member made a good effort to participate
- The team member was willing to consider and respect other's ideas and opinions
- Overall the quality of the team member's contribution was very good- excellent

To receive full participation marks, students will need to complete their peer evaluations in the last five minutes of class on each day that includes a peer evaluated task (**See Appendix A for dates**).

Podcast Outline Marking Rubric

Criteria	Indicators
Teamwork (25%)	The outline conveys that the team has found a way to work effectively, using the strengths of each person to build the project together.
Background (25 %)	The outline describes plans to include sufficient, clear background so that the target audience can understand the scientific content at the heart of the debate.
Clarity and synthesis (35%)	The outline describes plans to convey three scientifically supported arguments in an accessible, clear, cohesive manner and synthesizes available information to provide a convincing overarching argument
Support (15%)	The content is sufficiently supported by primary literature and avoids plagiarism. The supporting literature is properly cited.

Podcast Episode Marking Rubric

Criteria	Indicators
Format (10%)	Follows all time and formatting guidelines for the audio file and production document
Teamwork (15%)	The production document and podcast episode convey that the team found a way to work effectively, using the strengths of each team member to build the project together.
Background (25 %)	The episode provides sufficient, clear background so that the target audience can understand the scientific content at the heart of the debate.
Clarity and synthesis (35%)	The episode conveys scientifically supported arguments in an accessible, clear, cohesive manner and synthesizes available information to provide a convincing argument
Support (15%)	The content in the episode is sufficiently supported by primary literature and avoids plagiarism. The supporting literature is properly cited in the production document
Bonus (2%)	The team that changes the most minds (for or against) earns 2 bonus points out of 100

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	**B+** (77-79)	**C+** (65-69)	**D** (50-54)
A (85-89)	**B** (73-76)	**C** (60-64)	**F** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

Course Policies on Missed or Late Academic Requirements

Complete attendance of all lectures is highly recommended, and class participation is key and will be reflected in worksheet and literature discussion marks directly.

Late assignments: 10% reduction in grade for every day an assignment is late. Extenuating circumstances will be considered; contact the instructors as soon as possible, within two days of the assignment due date, for consideration.

Course absences: No points will be awarded for the group portion of the worksheets and there will likely be consequences for peer evaluations if the student is not in attendance. However, two (2) Student Declaration of Absence (SDA) may be used during the term and submitted via Brightspace. Acceptable SDAs will result in the student not losing points for missing the relevant class period. Please remember that students MUST contact instructors prior to the academic requirement deadline or scheduled time for which they seek to apply the SDA. Out of courtesy, students should also notify their team in advance if they are to miss groupwork. For further information, see the University policy here.

Course Policies related to Academic Integrity: Policy on collaboration: Many assignments in this class are meant to be completed collaboratively in groups and those assignments are clearly designated as such. Individual assignments are *not* meant to be completed in groups. If plagiarism is found for individual assignments, a mark of zero will be assigned.

We reserve the right to use plagiarism software (e.g., Turnitin) as we see fit. The use of Large Language Model (LLM) AI tools such as ChatGPT is allowed. HOWEVER, it must be indicated somewhere on the assignment that an LLM was used.

Brightspace will be used for regular updates and announcements; students are responsible for regularly monitoring this space.

Learning Objectives

Students will come away from this class being able to discuss:

- How current techniques for gene editing and synthetic biology work
- How natural biological phenomena are leveraged by scientists to conduct gene editing
- Examples of current and future applications of gene editing and synthetic biology tools in:
    - Medicine
    - Ecology and conservation
    - Food production
- Ethical and policy considerations surrounding the use of gene editing

Students will have gained practical experience in:

- Scientific writing
- Working constructively in small groups
- Producing podcasts to convey scientific information

Course Content

Specific Course Content and Important Dates

See **Appendix A** for the course schedule

University Policies and Statements

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:
https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.

Faculty of Science

Student Resources and Support

University Policies and Programs

Important Dates in the Academic Year (including add/drop dates): http://www.dal.ca/academics/important_dates.html

Classroom Recording Protocol: https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html

Dalhousie Grading Practices Policies: https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Grade Appeal Process: https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html

Sexualized Violence Policy: https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html

Scent-Free Program: https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html

Learning and Support Resources

General Academic Support – Advising (Halifax): https://www.dal.ca/campus_life/academic-support/advising.html

General Academic Support – Advising (Truro): https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness.html

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): https://www.dal.ca/campus_life/academic-support/On-track.html

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Indigenous Connection: https://www.dal.ca/about-dal/indigenous-connection.html

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at elders@dal.ca or 902-494-6803: https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf

Black Student Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre.html

South House Sexual and Gender Resource Centre: https://southhousehalifax.ca/about/

LGBTQ2SIA+ Collaborative: https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html

Dalhousie Libraries: http://libraries.dal.ca/

Copyright Office: https://libraries.dal.ca/services/copyright-office.html

Dalhousie Student Advocacy Services: https://www.dsu.ca/dsas?rq=student%20advocacy

Dalhousie Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Human Rights and Equity Services: https://www.dal.ca/dept/hres.html

Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Study Skills/Tutoring: http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Faculty of Science Advising Support: https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html

Safety

Biosafety: http://www.dal.ca/dept/safety/programs-services/biosafety.html

Chemical Safety: https://www.dal.ca/dept/safety/programs-services/chemical-safety.html

Radiation Safety: http://www.dal.ca/dept/safety/programs-services/radiation-safety.html

Laser Safety: https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html