IB 270: EVOLUTION OF MOLECULES AND CELLS
FALL 19

Class location: Natural History Building 2083
Class times: Monday, Wednesday, Friday; 11 - 11:50 am
Lab times: Wednesday; 1 - 4:50 pm
Required text: Genomes 4 by T.A. Brown

Instructor: Dr. Mikus Abolins-Abols
Email: abolins@illinois.edu
Office: Morrill Hall 477, back office
Office hours: Wednesday and Friday, 9-10am or by appointment

About me

I am a Postdoctoral Research Associate in the Department of Ecology, Evolution, and Behavior, School of Integrative Biology, UIUC. I have broad research interests that revolve around three main topics: the developmental biology of feathers; stress physiology and ecology; hormonal and neural mechanisms that regulate maternal behavior. I study these topics using experimental studies in wild and captive birds, using a combination of approaches that include genomics, neuroscience, physiology, and classical behavioral ecology. Find more about my science by watching my TEDx talk https://www.youtube.com/watch?v=DOYA_AY7dO4 and visiting my website https://mikusabolins.weebly.com/.

Course overview

Life on Earth is incredibly diverse, yet, remarkably, this diversity arises from the same suite of core biomolecules (e.g., DNA, RNA, proteins, carbohydrates) and consists of the same fundamental units – cells. This IB Honors course IB270 "Evolution of Molecules and Cells" facilitates student exploration of the major building blocks of life and the major evolutionary transitions that have shaped the diversity of life on Earth. In the class, students will be exposed to diverse advanced research areas, including molecular evolution, molecular biology, genetics, genomics, bioinformatics, metabolomics, and systems biology. These topics will be reinforced as students use both wet-lab (e.g., RNAi) and computational biology approaches in the laboratory section to unravel how genotypes influence an organism's phenotype.

Learning objectives

- Students will be able to describe the molecular processes responsible for regulating biological systems, and how these processes have evolved.
- Students will apply their understanding of molecular processes to develop individual research projects.
- Students will be able to use state-of-the-art molecular and computational approaches to study biological processes.
- Students will integrate their understanding across various fields of cell and molecular biology to gain a systems-biology perspective about biological processes.
- Students will discuss the history of molecular biology as well as the ethics issues regarding genome sequencing and editing.

Prerequisites:

- Admission to IB Honors (see http://sib.illinois.edu/honors): To be accepted, students must have a 3.0 GPA by the end of their second semester, show evidence of success in math and science courses, and have a strong interest in biology. General chemistry should be completed before beginning IB Honors courses.
- IB150: Organismal & Evolutionary Biology
- MCB150: Molecular & CellularBasisofLife

Lectures/Discussions/Exercises

Classes will be held in Natural History Building 2083 on MWF from 11:00 – 11:50AM. The classes will be a mixture of lectures, discussions, and exercises. Please check the class schedule below to prepare for specific activities.

For **lecture** days, you will have to read the assigned reading before coming to the class (see Class Schedule or Moodle for the specific readings). At the beginning of class, you will complete a short quiz or recall exercise on the assigned reading. At the end of class, you will complete a reflection exercise on the lecture topics. This will also be your chance to inquire about any content that may not have been clear to you. Lecture slides and any handouts will be posted on the Moodle before the lecture.

For the **paper discussion** days, you will need to read the assigned scientific paper and fill out the discussion handout (available on Moodle) before coming to class. Both the paper and the handout will be posted on Moodle a couple of days before the class. This handout has to be submitted before or at the beginning of class; the other will serve as your worksheet during the discussion and you will submit it at the end of the class. You will be randomly called upon during the paper discussion, so reading the paper before the class is imperative.

For **computational exercise** days, you will need to bring a laptop with WiFi capabilities to complete and fill out the computational handout by the end of class

I reserve the right to edit or modify schedule and assignments as deemed necessary during the semester. For the most up-to-date schedule and assignments please refer to the Moodle page.

Exams

Two midterm exams and one cumulative final exam will be given on key concepts from the discussion and lecture materials (see grading details below). Students with a valid excuse for missing an exam will be given an opportunity to take a make-up exam at the discretion of the instructor. Excuses are given only for medical reasons (with a note from McKinley), tragedy in your immediate family, or religious observances and practices (see attendance policy). The make-up exam will differ in format, content, and length from the original exam.

Midterm Exams: two midterm in-class exams will cover the 5 weeks of material preceding the exam. Once the exams are returned, students will have the opportunity to respond to and/or dispute any unexpected outcomes. The purpose of these responses is to give students the opportunity to argue and support their case — similar to the "response to reviewers" submitted during the peer review process. These responses will be typed, and students will have one week following the exam to submit their responses. Responses will address each issue (i.e., question) independently and must be at least 2–3 sentences for multiple choice/fill in the blank questions and at least 500 words for short answer questions. Academic references (e.g., journal articles, books) are required and book citations must include page numbers. Full credit will be given for any well supported disputes (any question type). For short answer questions, partial credit (up to 50% question value) will be given for any supported logical arguments demonstrating the students thought-process, why the particular thought process led to an incorrect answer, and what the appropriate argument/answer should have been.

Final Exam: The final exam for this course is scheduled for 1:30 – 4:30 pm, Thursday Dec. 19, 2019 (https://registrar.illinois.edu/courses-grades/final-exam-schedule-public/). The final exam will be multiple choice / fill in the blank only. Due to the date and time of the exam, there will not be an opportunity for exam responses. Final grades will be submitted by January 3, 2020. As per the student code, all exam accommodations and exam conflict resolutions must be arranged prior to the last day of class (http://studentcode.illinois.edu/article3_part2_3-201.html).

Laboratory

Laboratory will be covered in the Laboratory Syllabus at the end of this document. However, see the overall course grading details below. The orientation meeting on the first week of class will cover the use of the lab and Honors common space and issues related to safety and conduct. During the rest of semester, you will be learning how to use state-of-the-art molecular tools, and design a research project together with your peers. Real science takes a lot of time, it will likely be necessary to conduct certain steps outside of the regularly scheduled lab period, sometimes on weekends. It will be your group's responsibility to ensure that these steps are performed.

Computer Requirement

Students are required to have a laptop computer for in-class computational exercises in class and lab (see syllabus for specific dates). If a student cannot bring a laptop then they must pair up with someone that has a laptop for in-class assignments and discussion. Most of the work in this class will require computer access in and out of class.

Reading Assignments

Required text: Genomes 4 by T.A. Brown. This book is available at:

- Illini Union Bookstore (new/used): https://illini.verbacompare.com/comparison?id=720142
- Amazon (rent/buy): https://www.amazon.com/Genomes-4-T-Brown/dp/0815345089
- On the reserve in the ACES Library

Primary literature: All primary literature will be posted to the Moodle at least one week prior to class. Any additional primary literature will be added as needed and announced.

Students are expected to read the assigned reading material **prior to class** and be prepared for lecture material, computational problems, and discussion questions. *See Moodle for the schedule of reading assignments along with corresponding links.*

Course Expectations

Attendance and Punctuality: My primary expectation is that you come to the class ready to learn or participate. As such, both your attendance and punctuality are essential – for you as students and also for me as instructor. Students are expected to attend all scheduled classes and labs as per the attendance policy below.

Participation: Students are expected to participate during in-class discussions, computational exercises, and group projects. Prior to class, students are expected to prepare by reading and thinking about the assigned readings. During class, students are required to mute phones, laptops, and tablets. Laptops and tablets are permitted for note taking and in-class assignments but are not permitted for non-course related web-browsing and e-mailing. To maximize participation, lecture slides and outlines will be posted on Moodle before classes. Slides are subject to change after the lectures are delivered, but significant changes will be announced on the Moodle forum.

Grading

TOTAL GRADE = LECTURE + LAB GRADE = **400 points**

LECTURE GRADE (250 points; 62.5% of the total grade):

- **Midterm-Exam 1** – 20% (50 points); covers the first 5-week period
- **Midterm-Exam 2** – 20% (50 points); covers the second 5-week period
- **Final Exam** – 30% (75 points); covers the last section of lectures *as well as* comprehensive questions from previous materials.
- **In-Class Assignments/Quizzes** – 30% (75points)
  Other assignments include: in-class quizzes (beginning of lecture days, 20 points), reflections (end of lecture days, 10 points), paper discussion handouts (paper discussion days, 40 points), and computational handouts (computational exercise days, 5 points). Quizzes will be closed-book and will be based on the assigned readings. For each student, the top 20 quiz scores will be used for grading. For reflections, you will have to provide 2–5 sentences about the reading/lecture material. These are closed book and should summarize what you remember, your interpretations, and/or how the content relates to larger topics (e.g., science, medicine, society). These should be your thoughts and there are no "correct" answers. For discussion handouts, download handout from course Moodle, fill out the message box, answer questions, and bring 2 copies to class. One copy should be turned in at the start of lecture and the other should be used during class discussion and turned in at the end of class. For computational handouts, fill out handout during the in-class computational exercise and turn in at the end of class. If you are absent, makeup assignments will be determined at the discretion of the instructor. 1 point will be deducted for every day you are late without an excuse (e.g., medical note). Makeups submitted after answer keys are posted will be accepted for 50% credit.

***Students will receive 0% ("F") on an exam or assignment if they cheat and/or plagiarize**. Completing assignments, exams, or in-class exercises for other students is also considered cheating (by both parties).*

LAB GRADE

TOTAL= 150 points; 37.5% of total course grade
See a detailed breakdown in the Laboratory Syllabus at the end of this document.

Overall course grades are assigned based on the % of points accumulated.

- 90-100% = A
- 80-89% = B
- 70-79% = C
- 60-69% = D
- <60%=F

Minus (90-92, 80-82, ...) and plus (88-89, 78-79, ...) grades will be given within each range.
Grades will not be rounded up (e.g. 89.6% will not be rounded to 90%).

Important Websites

Course website on Moodle (https://learn.illinois.edu); you should have an account if you are enrolled in this course (Navigation: My Courses; IB 270 A FA19). If you do not have access to the site or this class, please contact the instructor or TA immediately at the start of the course.

Office Hours

Wednesday and Friday 9-10am in 477 Morrill Hall (back office), or by appointment (email: abolins@illinois.edu)

Course Policies

As members of the University of Illinois academic community, all students are expected to act in accordance to the University of Illinois "Student Code". The Code is available online at: http://studentcode.illinois.edu/. Student Code violations will be handled based on the "Student Discipline" policy as outlined in Article 1, Part 3. Students are responsible for knowing and complying with the student code as well as other university, college, and departmental regulations. **Students will receive an "F" on an exam or assignment if they cheat and/or plagiarize**. Completing assignments, exams, or in-class exercises for other students is also considered cheating (by both parties).

Academic Integrity: All students are expected to know and abide by the University "Academic Integrity" policy as outlined in Article 1, Part 4 of the University of Illinois Student code. This includes refraining from infractions and conduct that aids others in infractions. Infractions include: (a) cheating, (b) plagiarism, (c) fabrication, (d) facilitation, (e) bribes, favors, and threats, and (f) academic interference. The code is available online at http://studentcode.illinois.edu/.

Attendance Policy: All students are expected to follow the "Class Attendance" policy as outlined in Article 1, Part 5 of the University of Illinois Student Code. The code is available online at http://studentcode.illinois.edu/.

Accommodations: If you are unable to complete your assignments or exams due to professional, personal obligations, or emergency situations, you should notify the instructor IMMEDIATELY. Accommodations must be clear and brief. Decisions will be made on an individual basis. If you have a disability, please send the instructor a Letter of Academic Accommodations within the first two weeks of the semester. You can learn how to get a Letter of Academic Accommodations from DRES by following this link (http://disability.illinois.edu/academic-support/accommodations).

***Note: This syllabus is subject to minor adjustments during the semester to build in flexibility. The instructor reserves right to edit or modify schedule and assignments as deemed necessary during the semester. For the most up-to-date schedule and assignments please refer to the Moodle page.**

Class Schedule

Week	Date	Day	Class Type	Class Focus	Reading	Lab Activity
	26-Aug	M	Lecture	Central Dogma: Discovery of DNA	Ch 1.1	
1	28-Aug	W	Lecture	Central Dogma: Transcriptome and Proteome	Ch 1.2-1.3	Orientation
	30-Aug	F	Lecture	Origin of life	Ch 18.1+paper	
	2-Sep	M	No class	Labor Day		
2	4-Sep	W	Lecture	Studying Genomes	Ch 2	DNA extraction
	6-Sep	F	Paper Discussion	Human Migration Paper	Primary literature	
	9-Sep	M	Lecture	Sequencing Genomes	Ch 4	
3	11-Sep	W	Lecture	Genome Annotation	Ch 5	RNA extraction and Gel Electrophoresis
	13-Sep	F	Lecture	Identifying Gene Function	Ch 6	
	16-Sep	M	Paper Discussion	RNAi paper	Primary literature	
4	18-Sep	W	Lecture	Eukaryotic Genomes	Ch 7	Intro to *C. elegans*
	20-Sep	F	Lecture	Genomes of Bacteria, Archaea, and Organelles	Ch 8	
	23-Sep	M	Computational exercise	Wormbase Computation Exercise		
5	25-Sep	W	TBD	Guest Lecture/Discussion	TBD	Develop hypotheses with *C. elegans*
	27-Sep	F	Exam	Midterm Exam 1		
	30-Sep	M	Lecture	The Human Genome: Advancements	Primary literature	
6	2-Oct	W	Lecture	Gene and Genome Engineering	Primary literature	CRISPR Activity
	4-Oct	F	Paper Discussion	CRISPR Discovery Paper	Primary literature	
	7-Oct	M	Lecture	Genome Expression	Ch 10	
7	9-Oct	W	Lecture	DNA Binding Proteins	Ch 11	CRISPR Activity, Work on Discovery Project
	11-Oct	F	Paper Discussion	Evo-Devo paper	Primary literature	
	14-Oct	M	Lecture	Transcription and Regulatory Networks	Ch 12	
8	16-Oct	W	Lecture	Proteomes and Metabolomes	Ch 13	Work on Discovery Project
	18-Oct	F	Paper Discussion	Cancer Transcription Paper	Primary literature	
	21-Oct	M	Lecture	Gene Expression: From Cells to Organisms	Ch 14	
9	23-Oct	W	Lecture	Genome Replication	Ch 15	Work on Discovery Project
	25-Oct	F	Paper Discussion	DNA Harpoon Paper	Primary literature	
	28-Oct	M	Lecture	Mutation and DNA repair	Ch 16	
10	30-Oct	W	Lecture	Recombination	Ch 17	Work on Discovery Project
	1-Nov	F	Exam	Midterm Exam 2		
	4-Nov	M	Lecture	Genome Evolution	Ch 18.2-18.4	
11	6-Nov	W	Lecture	Evolution of multicellularity	Primary literature	Work on Discovery Project
	8-Nov	F	Paper Discussion	Yeast Genome Duplication	Primary literature	
	11-Nov	M	Lecture	The Evolution of Organelles and Symbionts	Primary literature	
12	13-Nov	W	Lecture	The Human Microbiome	Primary literature	Work on Discovery Project
	15-Nov	F	Paper Discussion	Microbiome paper	Primary literature	
	18-Nov	M	Computational exercise	Omics		
13	20-Nov	W	Lecture	Epigenetics	Primary literature	Work on Discovery Project
	22-Nov	F	Paper Discussion	Personalized Medicine Paper	Primary literature	
	25-Nov	M	No class	Thanksgiving		
	27-Nov	W	No class	Thanksgiving		
	29-Nov	F	No class	Thanksgiving		
	2-Dec	M	Paper Discussion	Ethics of Genomics	Primary literature	
14	4-Dec	W	Debate	Ethics of Genomics	Primary literature	Work on Symposium PPT
	6-Dec	F	Group Work	Discovery Project Presentation Prep		
	9-Dec	M	Group Work	Discovery Project Presentation Prep		Discovery Project Symposium
15	11-Dec	W	Group Work	Discovery Project Symposium		
16	19-Dec	Th	Exam	Final Exam		

IB 270: Evolution of Molecules and Cells Laboratory Fall 2019

TA: Charles Dean
Email: cedean2@illinois.edu
Phone: (614) 260-3612
Office Hours: By appointment

Lab outline:

This semester you will learn how and when to employ common laboratory techniques pertinent to molecular biology, how to critically assess experimental design, and how to present your work in the form of scientific writing and oral presentation. During the first half of the lab you will be trained in various skills that are needed to complete their Discovery Project. The Discovery Project will require you to make a novel hypothesis about a particular gene's function and then test it using the model organism *Caenorhabditis elegans*.

Lab assignments:

During the first part the semester you will have three quizzes and a CRISPR activity report due. These assignments represent 30% of your lab grade. The quizzes will be given during the first 15 minutes of class, if you arrive late you will not be given extra time.

The second part of the semester will be devoted to your discovery project. You will conceive, design and run your experiments within your groups. At the end of the semester you will hand in a Discovery paper and present your results in a class symposium. To help you write your final draft of the Discovery paper you will hand in a paper proposal and a first draft of your scientific paper for credit.

Discovery Research Project:

Preparation for this lab begins early in the semester. For this project, your group will make a hypothesis about a particular gene's function – and then test it! Your hypothesis should be 1) well justified, 2) novel, 3) important, and 4) testable using the model organism *Caenorhabditis elegans*. Gene function can be "knocked down" via RNA interference or using existing strains that have mutations in your gene. Within reason, we will make every effort to obtain material or resources necessary to conduct your experiment. The *novel* requirement is that there should be no proven relationship between the particular gene in *C. elegans* and the particular function (or phenotype) that you hypothesize. However, that does not mean you should just "make it up." Instead, you need to be smart and creative! This means doing some library and computer research on a particular molecular/cellular process to be able to present a putative gene function hypothesis that is supported by a plausible justification, based on other known functions described in literature and/or on-line databases. The effort here should be towards reading, assimilating a connection, generating a testable hypothesis, performing the test in the laboratory, and interpreting results. You must also indicate why this hypothesis is important. Perhaps it will provide insight into general mechanisms of cell proliferation and cancer. Or perhaps it will say something specific about *C. elegans* evolution or ecology. This is meant to be a creative assignment to teach you about the scientific process from personal, independent, hands-on experience. This project will also teach you how to work together in a group, which is how research labs, academia, and medical professions realistically operate.

Lab Point Allocation:
(150pts. total – 37.5% of total course grade):

- Lab Safety Certificate 5%
- 4 quizzes 5%
- Scientific writing exercise 5%
- CRISPR Activity 15%
- Discovery Project Proposal - 10%
- Discovery Project Lab Report <*first draft*> - 10%
- Discovery Project Lab Report <*final draft*> - 30%
- Discovery Project Oral Presentation (PPT)- 20%

How to succeed
1 - Come to class prepared and ON TIME. Complete any necessary reading beforehand. If you come unprepared or late, your whole group suffers and your individual grade will suffer.
2 - Do not miss a lab or leave early
3 – Participate. By actively participating, you will get the most out of this class.
4 - Ask questions. Please don't hesitate to ask questions. I am here to help you learn and I can only do that if you let me know when things are not clear.

Special Needs
If you have any special needs and/or require accommodations, please see Dr. Abolins-Abols as soon as possible.

Basic lab rules:

- Closed toed shoes
- No cell phones (unless you are taking a picture of the material)
- No food and drink
- Keeping the lab clean is everyone's responsibility. Your TA is not responsible for cleaning up your group's mess.

Lab groups:
You will be working in groups for all labs. As you all know groups in which everybody participates are the most successful. It is also important for you to know that you will be assigning your group mates a score at the end of each lab report.

Attendance
DO NOT MISS A LAB!!! But, things happen. If you are absent due to a conflict, it must be cleared with me **at least one week in advance** of the anticipated conflict. If you do miss a lab, you have **24 Hours** to contact me with the reason for the absence. **Excuses are given only for medical reasons (with a note from McKinley), tragedy in your immediate family, or religious observances and practices. Makeup labs will be determined at the discretion of your instructor.**

Academic Integrity:
Any form of cheating is unacceptable. Incidences will be dealt with according to the University-wide standards in the Code of Policies and Regulations Applying to All Students. (http://admin.illinois.edu/policy/code/). **It is your responsibility as a student at the University to have read and understand the Academic Integrity Policy**.

Expectations:
I am here to help you learn, as such you can expect me to always be prepared, enthusiastic and respectful. I expect the same of you. I am always happy to meet with you to talk about questions that you have about lab. If you send me an email (***with IB270 in the subject line***), you can expect me to respond within 48 hours. Since you will be working on your projects sometimes outside of your regularly scheduled lab period, you may call/text me if you have questions that need immediate answers. Please do not call or text after 10 pm unless there is an emergency.

Here is to a great semester!

Lab Schedule

Date	LAB	Assignment/Quiz Schedule
28-Aug-19	Orientation / Experimental Design/ Paper Writing	
4-Sep-19	DNA extraction and PCR	**Lab Safety Assignment Due**
11-Sep-19	RNA extraction and Gel Electrophoresis	**Lab quiz 1**
18-Sep-19	Intro to *C. elegans*	**Scientific Writing Exercise**
25-Sep-19	Develop hypotheses with *C. elegans*	**Lab quiz 2**
2-Oct-19	CRISPR Activity	**Lab quiz 3**
9-Oct-19	CRISPR Activity /Work on Discovery Project	**Discovery Proposal Due**
16-Oct-19	Work on Discovery Project	**Lab quiz 4**
23-Oct-19	Work on Discovery Project	**CRISPR Assignment Due**
30-Nov-19	Work on Discovery Project	
6-Nov-19	Work on Discovery Project	
13-Nov-19	Work on Discovery Project	**Discovery Draft Due**
20-Nov-19	Work on Discovery Project	
4-Dec-19	Work on Symposium Ppt	**Discovery Final Report Due**
11-Dec-19	**Discovery project symposium**	**Powerpoint DUE**