

# IB 270: THE EVOLUTION OF MOLECULES & CELLS

## FALL 2023

**Lecture time:** MWF 11.00 - 11.50am (Natural History Building 4014)

**Lab time:** Th 1.00pm – 5.00pm (Natural History Building 4016)

**Required Text:** Genomes 4 by T.A. Brown (full-text pdf available free through UIUC Library)

**Prerequisite courses:** IB 150 or MCB 150.

### COURSE OVERVIEW

Life on earth is characterized by a mind-boggling organismal diversity. Incredibly, the same set of core molecules (DNA, RNA, proteins, carbohydrates, and lipids) is used to construct all this diversity. This first course in the IB Honors Program, IB270: The Evolution of Molecules and Cells, explores how these fundamental building blocks shape life around us and delves into the technological advances that have helped us uncover, study, and manipulate these processes. Through lectures and discussions, you will be exposed to diverse research areas including molecular biology, genetics, genomics, bioinformatics, and systems biology. Your Discovery Projects in lab will let you put concepts and experimental approaches into practice to ask how genotypes influence phenotypes. Throughout the semester, we will also touch on the historical and societal context of these concepts and research.

### Learning Objectives

- Understand and execute the scientific process, from hypothesis-testing, to experimental design, to data collection, to interpretation and presentation.
- Critically read and evaluate primary literature on a range of topics.
- Hone writing skills for popular and scientific audiences.
- Apply knowledge of molecular processes to design and complete an original research project.
- Describe the molecular and cellular processes responsible for regulating biological systems, and how these systems vary across organisms.
- Understand how underlying genetic and molecular processes have evolved, and how they in turn influence evolutionary outcomes.
- Appreciate how rapid technological advances in your lifetime have fundamentally re-shaped biological research.
- Integrate an understanding of diverse topics to build a systems-biology perspective of fundamental biological processes.
- Discuss the history of the field and modern-day context of biological research, in particular genome sequencing and editing.

## CONTACT INFORMATION

**Instructor:** Dr. Eva K Fischer

**Office location:** Morrill Hall 683

**Email:** efischer@illinois.edu

**One-on-one support:** Thursdays after lab (~5pm – 6pm, NHB 4014), Friday 10am – 11am (NHB 4014), or by appointment

**About Me:** I am faculty in the Department of Evolution, Ecology, and Behavior at UIUC. My research explores how the brain makes behavior and how behaviors evolve. I'm particularly interested in natural, ecologically relevant behaviors and my research therefore combines field and lab work. To learn more and see some pictures of the awesome frogs we work with, visit [ekfischerlab.com](http://ekfischerlab.com). I grew up in Colorado, got my BA at Cornell University, my PhD at Colorado State University, and spent time as a postdoc on both coasts (MA and CA). In between I worked and taught for a year in the middle east. In addition to science my favorite things are my friends and family, my very silly cat, being outside, and baked goods (making and consuming).

**Teaching Philosophy:** My teaching philosophy relies fundamentally on the idea that the classifications of teacher (one who has knowledge) versus learner (one who seeks knowledge) are context dependent and non-mutually exclusive. Teaching has been central to my own learning, often in ways that go beyond the immediate subject material. Diverse research and learning communities magnify the ability of all members to teach and learn, leading to more efficient and creative outcomes. As an educator, I strive to create communities of learning that instill students with curiosity and critical thinking skills and empower students to realize their potential as learners and architects of their own education.

**Teaching Assistant:** Abby Weber

**Office location:** Shelford Vivarium 202

**Email:** aweber8@illinois.edu

**Office hours:** If you would like to request group office hours or one-on-one support send me an email with the following info:

- Who is coming?
- What are the topics or questions you would like to discuss?
- How have you already attempted to solve the problem or confusion on your own (this helps me troubleshoot with you!)?

**About Me:** I am a third year Evolution, Ecology, and Behavior PhD student in the Anderson Evolutionary Biomechanics lab. My dissertation is focused on understanding how the form of parasitoid wasp ovipositors evolved and affects their function. I graduated from IBH in 2020, so feel free to ask me any questions about my time in the program and how it influenced where I am now! Outside of work I like hanging out with my cat Toof, going for runs, and watching garbage reality TV!

## COURSE SCHEDULE

| week of                  | Lecture   | Topic  | Reading              | Lab & Assignments   |
|--------------------------|-----------|--|----------------------|---|
| <b>Week 1</b><br>Aug. 21 | Monday    | Central Dogma:<br>DNA, RNA, and proteins       | Ch. 1                | <u>LAB</u><br>Orientation, Pipetting, Worms<br><br><u>Assignment 1:</u> Wormbase  |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Paper Discussion 1                             |                      |   |
| <b>Week 2</b><br>Aug. 28 | Monday    | Studying Nucleic Acids                         | Ch. 2, 18.1          | <u>LAB</u><br>Worm mini-lab<br><br><u>Assignment 2:</u> DataClassroomU #1   |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Studying Genomes 1:<br>mapping and sequencing  |                      |   |
| <b>Week 3</b><br>Sep. 4  | Monday    | NO CLASS - LABOR DAY                           |                      | <u>LAB</u><br>DNA extraction, PCR<br><br><u>Assignment 3:</u> DataClassroomU #2   |
|                          | Wednesday | Studying Genomes 1:<br>mapping and sequencing  | Ch. 3, 4.1, 4.2      |   |
|                          | Friday    | Paper Discussion 2                             |                      |   |
| <b>Week 4</b><br>Sep. 11 | Monday    | Studying Genomes 2:<br>assembly and annotation | Ch. 4.3, 4.4, 5, 6   | <u>LAB</u><br>PCR gel, RNA extraction<br><br><u>Assignment 4:</u> Project Proposal<br><b>Project Proposal DUE Sep. 17</b> |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Paper Discussion 3                             |                      |   |
| <b>Week 5</b><br>Sep. 18 | Monday    | Studying Genomes 3:<br>types of genomes        | Ch. 7, 8.1, 8.2, 9.1 | <u>LAB</u><br>qPCR, worm methods, project prep<br><br><u>Assignment 5:</u> DataClassroomU #3                              |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Paper Discussion 4                             |                      |   |
| <b>Week 6</b><br>Sep. 25 | Monday    | Genome Expression 1:<br>DNA modification       | Ch. 10, 11           | <u>LAB</u><br>qPCR analysis, project prep<br><br><u>Assignment 6:</u> qPCR analysis                                       |
|                          | Wednesday |  |                      |   |
|                          | Friday    | <b>EXAM 1</b>                                  |                      |   |
| <b>Week 7</b><br>Oct. 2  | Monday    | Genome Expression 2:<br>transcriptomes         | Ch. 12               | <u>LAB</u><br>BLAST, primer design, project prep<br><br><u>Assignment 7:</u> Human Cancer Atlas                           |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Paper Discussion 5                             |                      |   |
| <b>Week 8</b><br>Oct. 9  | Monday    | Genome Expression 3:<br>proteomes, metabolomes | Ch. 13               | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 8:</u> Central Dogma<br><b>Methods Draft DUE Oct. 15</b>             |
|                          | Wednesday |  |                      |   |
|                          | Friday    | Paper Discussion 6                             |                      |   |

|                                  |           |  |                      |   |
|----------------------------------|-----------|--|----------------------|---|
| <b>Week 9</b><br><b>Oct. 16</b>  | Monday    | Genome Evolution 1:<br>generating variation                              | Ch. 18.2, 18.3, 18.4 | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 9:</u> Paper pieces - Extras   |
|                                  | Wednesday |  |                      |   |
|                                  | Friday    |  |                      |   |
| <b>Week 10</b><br><b>Oct. 23</b> | Monday    | Genome Evolution 2:<br>changing size and complexity                      | Ch. 14               | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 10:</u> Introduction Draft<br><b>Introduction Draft DUE Oct. 29</b>                  |
|                                  | Wednesday |  |                      |   |
|                                  | Friday    |  |                      |   |
| <b>Week 11</b><br><b>Oct. 30</b> | Monday    | Genes in Cells & Organisms 1:<br>environmental responses,<br>development | Ch. 8.3<br>Readings  | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 11:</u> TBD  |
|                                  | Wednesday |  |                      |   |
|                                  | Friday    |  |                      |   |
| <b>Week 12</b><br><b>Nov. 6</b>  | Monday    | Genes in Cells & Organisms 2:<br>endosymbiosis and<br>multicellularity   | Readings             | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 12:</u> Article Spotlight<br><b>Results Draft DUE Nov. 12</b>                        |
|                                  | Wednesday |  |                      |   |
|                                  | Friday    |  |                      |   |
| <b>Week 13</b><br><b>Nov. 13</b> | Monday    | Genes in Cells & Organisms 3:<br>microbiomes                             | Readings             | <u>LAB</u><br>DISCOVERY Project <b>PEER REVIEW</b><br><br><u>Assignment 13:</u> Phinch App<br><br><b>FULL DRAFT DUE Nov. 19</b>           |
|                                  | Wednesday |  |                      |   |
|                                  | Friday    |  |                      |   |
| <b>Nov. 20</b>                   | Nov. 20   | <b>FALL BREAK</b>  |                      |   |
| <b>Week 14</b><br><b>Nov. 27</b> | Monday    | Manipulating the Genome  | Readings             | <u>LAB</u><br>DISCOVERY Project<br><br><u>Assignment 14:</u> Genetics & Society   |
|                                  | Wednesday | Ethics and Genomics  |                      |   |
|                                  | Friday    | Paper Discussion 11  |                      |   |
| <b>Week 15</b><br><b>Dec. 4</b>  | Monday    | Genetics & Society Discussion  | Readings             | <u>LAB</u><br><b>DISCOVERY PRESENTATIONS</b><br><br><u>Assignment 15:</u> Self-reflection<br><br><b>DISCOVERY Final Draft DUE Dec. 10</b> |
|                                  | Wednesday | <b>EXAM 3</b>  |                      |   |
| <b>Week 16</b><br><b>Dec. 11</b> | Dec. 11   | <b>FINALS WEEK</b>   |                      |   |

## COURSE STRUCTURE & ACTIVITIES

This is a 5 credit (!) course with both a lecture and a lab. Typically, each credit is ~3 hours of work a week, so you should plan on spending ~15 hours per week on this class. Note that actual time commitments will vary week to week, as well as depending on your motivation, needs, and study habits. All course material for both the lecture and the lab will be posted on Canvas where you will also submit most of your assignments, so make sure you familiarize yourself with the course site and check it often.

### Lecture

We will have a pretty traditional lecture style, with lots of opportunities for questions, active learning, and discussion. Coming to class ready to take notes, participate, and engage with your classmates and instructors will maximize your gains during lecture. The general structure will be similar each week. You will have lectures, an assignment, and a discussion section. In addition, you will have review and practice questions in class and through the course website. See more detailed information about course activities and grading below.

### Lectures, Readings, and Resources

Lectures are designed to give an overview of the topic at hand and provide an opportunity for you to ask questions. In class lectures will be supported by readings, additional resources on the course website, and study guides. Study guides list key topics and provide practice questions that are a mixture of multiple choice, true/false, and short answer. Study guides aren't graded – they are meant as a study tool and to prepare you for the exams.

### Discussion Section

Each week we will have a discussion section covering reading(s) on a specific topic. Participation in discussions will consist of three parts: (1) reading and commenting on the reading through Perusall, (2) attending and participating in the discussion section, (3) leading one of the discussion sections. Each reading/topic will be posted on Perusall with an overview on the course website. Perusall is a 'social e-reader' that lets you read, comment, and respond to the questions and comments of others. You can use Perusall through a web browser or their app. It's free, but you'll need to create an account and use our course access code: FISCHER-QF9MR

The goal of using Perusall is to jump-start discussion and deeper thinking about the material (and to help me know what things sparked your interest and/or confused you). I'll post a few questions to get you started, but in general active Perusall engagement includes: responses to any assignment-specific prompts, defining terms you looked up to help classmates who read the paper later, asking questions to clarify content, proposing answers to other students' questions, highlighting places where evidence supporting claims is unclear or weak, or drawing connections between prior knowledge and the new information provided. Unsatisfactory engagement reflects a lack of evidence of thoughtful engagement with content, e.g. commenting on only one paragraph or section or displaying only cursory attempts to understand material, simple restatement of what is written, lacking detail/justification. Critical reading is time-consuming, so please plan at least two hours per paper. Assignments are due the night before so we can read each others comments before in-class discussion.

This year I'm trying something new! Instead of reading paper related to specific topics in class, the theme of our readings is "papers written by people in IB". I hope this will be a fun way for you to get an overview of the exciting research happening right here on campus and help you find labs you are interested in joining.

### Assignments

There are several activities in this course that will make up your Assignment grade. The content and structure of the assignments will have a range of formats, but might include paragraph style answers, drawing diagrams, data interpretation, questions associated with completion of an on-line activity, computational exercises, and/or reflection. Unless otherwise noted, assignments will be available through and submitted vis the course website (due Sundays unless noted otherwise).

### Lab

You will have a four-hour lab session each week. You MUST come to lab prepared and ready to stay the entire time. Being prepared means completing pre-class assignments and wearing appropriate attire. Sometimes you will also have follow-up activities/assignments to complete after lab. For the first few weeks the lab will vary week-to-week as you learn a range of techniques, but once you get going on your Discovery Projects you'll be working very independently.

**Discovery Projects** are really the highlight of IB270! Using *C. elegans* nematode worms as a model system you will work in groups of 2-3 to complete an independent project. You will go from background research, to hypothesis general, to experimental design an implementation, to data collection, to data analysis, to presentation in both a written and oral format. Your projects are original research and you will probably find it both exciting and a bit unnerving to be completing a big project where no one knows what the outcome will be! **NOTE:** Completing your Discovery Projects will include coming to regularly scheduled lab times as well as coming in outside of regular lab sessions to monitor your worms and collect data!

### Community Participation & Attendance

Community participation is essential to your commitment to the course and the honors program. Given the structure of the class, it is impossible to do well in the class without attending and participating. I hope you won't see 'participation' as just another box to check, but rather as an additional opportunity for learning and a meaningful way of building and engaging in our course community!

## COMMUNITY STANDARDS

We will develop these together on the first day of class. Come prepared to share your ideas!

Some examples to get you started:

- Support each other in learning.
- Be respectful of differences in background and experience.
- Let classmates finish points, raising hands as placeholder.
- Invite others to speak.
- Listen actively.
- Distinguish whether you are stating you opinion or a fact.
- Tell your own story rather than others (unless requested).

- When space needed, ask for time or take a break from the room.
- Be open to discussion.
- Think before you speak to use considerate language.
- Assume others have good intentions.

## ASSESSMENT INFORMATION

In addition to standard grading you're probably used to (points, letter grades), we're going to adopt some non-standard grading approaches. These include un-grading and specifications grading. Here are some resources if you're interested to learn more: [Contract grading](#), [Specifications grading](#), [Ungrading](#), [Ungrading FAQ](#).

Exams and your final Discovery Project paper will be standard graded using points/percentages. Perusall discussion posts, your Discovery Project Presentation, in class activities, and assignments will be graded based on a outstanding/satisfactory/unsatisfactory scheme and specifications standards explained below will be converted to a points/percentage at the end of the semester.

### Standards for non-traditional grading

- C :** Active participation in all classes (up to 5 absences)  
 Satisfactory contributions to Perusall discussion for 9 papers  
 Satisfactory completion of 13 assignments  
 Satisfactory completion of all Discovery Project Pieces  
 Final presentation displays basic knowledge of project and research context
- B :** Active participation in all classes (up to 3 absences)  
 Satisfactory contributions to Perusall for 10 papers, strong contributions for 2+  
 Satisfactory completion of all 14 assignments, outstanding completion of 2+  
 Good completion of all Discovery Project Pieces  
 Final presentation displays strong knowledge of project and research context
- A :** Active participation in all classes (up to 2 absences)  
 Satisfactory contributions to Perusall for all 11 papers, strong contributions for 4+  
 Satisfactory completion of all 15 assignments, outstanding completion of 4+  
 Satisfactory completion of all Discovery Project Pieces, outstanding completion of 2+  
 Final presentation displays excellent knowledge of project and research context

Pluses and minuses will modify the above grades when students' achievements fall between the criteria for two letter grades. For example, students who have an excellent knowledge of their project outcomes but only some knowledge of the research context of their work would receive an A-. Failing grades will be given in the unlikely case that a student fails to achieve the C bundle.

Because everyone has different priorities, students who aim for a grade other than an A are welcome to omit assignments without penalty. You are responsible for setting their own goals and achieving them with support and guidance from your instructors. We are here to support you and to make this process transparent. Please clarify expectations at any time, as I'm still working on optimizing this system.

Built into this grading scheme is some flexibility and room for failure, as our best learning can occur through failure and no one learns best under stress. Each of you will have two *tokens* to 'trade in' to help meet the specifications of their letter grade goal. Tokens can be used to erase an absence or allow you to revise and resubmit an assignment. Tokens will be traded in at the end of the semester when final grades are assigned, but you are encouraged to keep track of probable token usage for planning.

### Grade percentage assignments

A+ = 98-100; A = 93-97, A- = 90-92, B+ = 88-89, B = 83-87, etc.

### Grade composition (percent of total)

|                                |             |
|--------------------------------|-------------|
| Exams:                         | 20%         |
| Assignments:                   | 20%         |
| Perusall Discussions:          | 15%         |
| Discovery Project pieces:      | 15%         |
| Project Proposal               |             |
| Methods draft                  |             |
| Introduction draft             |             |
| Results draft                  |             |
| Peer review                    |             |
| Full draft                     |             |
| Discovery Project FINAL:       | 15%         |
| Discover Project Presentation: | 5%          |
| Community participation:       | 5%          |
| Self-assessment:               | 5%          |
| <b>TOTAL</b>                   | <b>100%</b> |

**You will receive an automatic 0% on an assignment if you have caught cheating/plagiarizing!** Completing assignment for others or having others complete your assignments is also considered cheating (by both parties).

## GUIDELINES & EXPECTATIONS FOR COMMUNICATION

Come to class and office hours and get your questions answered. Your instructors are here to help you! Outside of class, the Canvas Q&A forum is your first line of defense for all course related questions. Please post general questions about the course logistics and course materials here. This way you are mostly likely to get your questions answered as quickly as possible and others can benefit by being part of the discussion. Note that your instructors may move questions from email to the Q&A forum for this same reason. Questions of a private/personal nature should be sent to you instructors via email or discussed with them in person.

We will always do our best to respond to email in a timely fashion. This means that we will get back to you within 24 hours or less Monday – Friday, 9am-6pm CST. Be aware that response times for emails sent late at night or on the weekends may be longer.

### Assessment Feedback Turnaround Time



Please reference your Canvas grade book frequently to ensure your assessments are being submitted properly and that you are earning credit for your work. We recommend keeping all graded assignment until the end of the course in case of discrepancies. Please allow up to 1 week for exam, assignment, and draft grading.

## TIPS FOR SUCCESS

- Communicate, communicate, communicate. We are here to help and want you all to succeed and be well. The best way to ensure this is to communicate early and often about anything that you're worried about or struggling with.
- Log in to Moodle frequently to manage announcements, activities, and messages. If you let things pile up for three to four days, you might be overwhelmed. You should start working on new module content right away as it is posted.
- Stay on track. We've built in deadlines to help, but also recommend making a schedule for yourself to work through the material. This will help you manage your time better, especially in the flipped class-room format.
- Take good notes! Even with the online lecture format and slides provide taking notes is key. [Did you know taking notes by hand may be better than typing?](#)
- Use the lecture materials as a guide for what you need to know. Lectures are geared toward the material your instructors think is most important.
- Focus! When you're studying, try to minimize distractions and do focused work for a chunk of them. Then take a mental break (check your phone, check the fridge, check in with a friend). Do NOT do both at the same time.
- Find a study buddy! Explaining things to other is one of the best ways to learn!
- Come to office hours! This is a great way to get your questions answered, learn by listening in on others' questions, and get to know your instructors.

## ACADEMIC INTEGRITY

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: <http://studentcode.illinois.edu/>. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

## INCLUSIVITY

The effectiveness of this course is dependent upon the creation of an encouraging and safe classroom environment. Exclusionary, offensive or harmful speech (such as racism, sexism, homophobia, transphobia, etc.) will not be tolerated and in some cases subject to University harassment procedures. We are all responsible for creating a positive and safe environment that allows all students equal respect and comfort. I expect each of you to help establish and maintain an environment where you and your peers can contribute without fear of ridicule or intolerant or offensive language.

## SUPPORT RESOURCES & SUPPORTING OTHERS

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (1-217-333-0050) or online at [odos.illinois.edu/community-of-care/referral/](https://odos.illinois.edu/community-of-care/referral/)

As a Community of Care, we want to support you in your overall wellness. We know that students sometimes face challenges that can impact academic performance (examples include mental health concerns, food insecurity, homelessness, personal emergencies). Should you find that you are managing such a challenge and that it is interfering with your coursework, you are encouraged to contact the Student Assistance Center (SAC) in the Office of the Dean of Students for support and referrals to campus and/or community resources. The SAC has a Dean on Duty available to see students who walk in, call, or email the office during business hours. For mental health emergencies, you can call 911 or contact the Counseling Center.

## ACCOMODATIONS

To obtain disability-related academic adjustments and/or auxiliary aids, you must contact your instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail [disability@illinois.edu](mailto:disability@illinois.edu) or go to the DRES website. NOTE: all DRES accommodation are from the date the letter is issued and cannot be applied retroactively!

For accommodations related to Religious Observances, please see:

<https://odos.illinois.edu/community-of-care/resources/students/religious-observances/>.

This links to the Community of Care's Request for Accommodation for Religious Observances form that should be completed for those students seeking religious accommodations.

## SEXUAL MISCONDUCT POLICY AND REPORTING

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: <https://wecare.illinois.edu/resources/students/#confidential>

Other information about resources and reporting is available here: [wecare.illinois.edu](https://wecare.illinois.edu)

## FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See <https://registrar.illinois.edu/academic-records/ferpa/> for more information on FERPA.

## EMERGENCIES

Emergency response recommendations can be found at the following website: <http://police.illinois.edu/emergencypreparedness/>. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. <http://police.illinois.edu/emergency-preparedness/buildingemergency-action-plans/>.