Integrative Biology 201

Organismal Genetics

Fall Semester 2024

Days & Time: MWF (Contact time: 150 min/week)
Classroom: TBA
Format: Lecture
Duration: 16 week regular semester
Credit Hours: 3

Instructor:

Charles C Roseman
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Department of Evolution, Ecology, & Behavior
School of Integrative Biology

Office: 215 Morrill Hall
Office Hours: 9:00am – 11:00am Thursday
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Teaching Assistants:

TBA

Course Website:

The course website can be found on the University of Illinois Canvas website (https://canvas.illinois.edu/).

Course Description:

Genetics is one of the unifying frameworks shared by the life sciences, social sciences, and medicine. It represents the focus of a large proportion of efforts to build better understandings of how organisms work and how we might use these insights to produce more effective medical interventions, insights into the evolution of organisms, and to breed better food sources. Genetics is also the site of considerable overlap between the sciences and politics through a long and fraught history. This course introduces and critically engages with genetics in the context of complex organisms – like plants, animals, and humans – that have elaborate life cycles involving growth, reproduction, and senescence and exhibit differentiated tissues, organs, and often elaborate behaviors. After developing a holistic sense of several different organisms, ranging from bacteria to

spruce to mice to humans, the course introduces and integrates general principles of heredity at different levels of organization.

Throughout the course, we will keep genetics grounded in the context of a holistic vision of the organism. Special attention will be paid to topics at the intersection of genetics, medicine, and society, such as the intersection between genetics and issues such as racism, sexism, and economic inequality. Material featured on the MCAT, and other life science standardized exam will likewise be emphasized.

This course is distinct from IB 204, which is restricted to Integrative Biology majors and can serve as proof that a non-IB major has completed rigorous genetics training when applying to a post-graduate program in a health profession or biological discipline.

Student Learning Outcomes:

Throughout this course, students will:

1. Integrate a new understanding of genetics across levels of organization in whole organisms.
2. Build a comprehensive understanding about the causes and measurement of variation.
3. Link the resemblances among relatives to the transmission of genetic variation and the ways in which organisms structure their environments through genotype by environment interactions and niche construction.
4. Understand how the molecular mechanisms that permit and regulate DNA replication, transcription of DNA into RNA, retro-transcription of RNA into DNA, and translation of RNA into protein function and permit the generation of variation.
5. Link genetic variation to issues in health and society with special emphasis on the causes and consequences of sexism, racism, and economic inequality.
6. Reinforce points critical to performing well on the MCAT exam and other professional exams.
7. Develop basic quantitative skills involving the tabulation, graphing, and analysis of data.
8. Reinforce skills involving the searching, interpretation, and evaluation of the scientific literature.

Required Material:

Roseman, CC (n.d.) *Organismal Genetics.* (abbv. OG. Available at no charge on the course website).

News items and reviews will be assigned as they are published through the semester.

Schedule of Topics and Assignments:

Week 1: [Reading: Ch. 1 to 3 of *OG*]

Mon Aug. 26:	Course introduction and introduction to living beings and their diversity.
Wed Aug. 28:	The form and flow of life I. Phenotype, genotype, and genomes.
Fri Aug. 30:	The form and flow of life II. Describing and measuring organisms.

Week 2: [Reading: Ch. 3 to 4 of *OG*]

Mon Sep. 2:	*Labor Day. NO CLASS*
Wed Sep. 4:	Relatives, variation, and similarities I. Relatedness, gene pools, and zygosity. **[HOMEWORK 1 DUE]**
Fri Sep. 6:	Relatives, variation, and similarities II. Pedigrees and the resemblances among relatives.

Week 3: [Reading: Ch. 5 to 6 *OG*]

Mon Sep. 9:	Genes and genomes I. Basic chemical makeup of genetic material. **[HOMEWORK 2 DUE]**
Wed Sep. 11:	Genes and genomes II. Levels of organization in the genome from the base pair on up to chromosomes.
Fri Sep. 13:	Replication and inheritance of DNA I. Molecular mechanisms of replication and inheritance.

Week 4: [Reading: Ch. 6 to 7 of *OG*]

Mon Sep. 16:	Replication and inheritance of DNA II. Relating molecular mechanisms of replication and inheritance to Mendel's laws and exceptions thereof (linkage etc.). **[HOMEWORK 3 DUE]**
Wed Sep. 18:	The genome in the organism I. Additivity, dominance, penetrance, and describing alleles and genotypes.
Fri Sep. 20:	The genome in the organism II. Expressivity, cytoplasmic/extranuclear inheritance, and genetic sex determination.

Week 5: [Reading: Ch. 7 to 9 of *OG*]

Mon Sep. 23:	Transcription and gene regulation I. Transcription, properties of RNA, splicing, and post-translational modifications. **[HOMEWORK 4 DUE]**
Wed Sep. 25:	Transcription and gene regulation II. Prokaryotic gene expression and the Jacob-Monond model vs. Eukaryotic gene expression. The roles of genome organization and transcription regulation.
Fri Sep. 27:	Transcription and gene regulation III Transcription factors, alternative splicing, and the regulation of chromatin structure and methylation.

Week 6: [Reading: Ch. 10 of *OG*]

Mon Sep. 30:	**EXAM 1 [Held in the standard classroom]**
Wed Oct. 2:	Mutation and repair I. The causes of mutation ranging from errors in replication to mutagenic influences.
Fri Oct. 4:	Mutation and repair II. A tour of the different varieties of mutation and their effects on genotype and phenotype at different levels of organization.

Week 7: [Reading: Ch. 10 to 11 and part of Ch. 14 of *OG*]

Mon Oct. 7:	Interlude: Cancer I. The demands and risks of multicellularity **[HOMEWORK 5 DUE]**
Wed Oct. 9:	Interlude: Cancer II. Genetic risks for cancer and changes to the genome in cancerous cells.
Fri Oct. 11:	Interlude: Epigenetics. Chemical modifications on DNA and changes to the configuration of chromosomes. Can they be inherited?

Week 8: [Reading: Ch. 11 of *OG*]

Mon Oct. 14:	From genotype to physiology I. How mutation can influence enzyme function and structural proteins. **[HOMEWORK 6 DUE]**
Wed Oct. 16:	From genotype to physiology II. Genotype by environment interactions and metabolism in phenylketonuria.
Fri Oct. 18:	From genotype to physiology III. Lactase persistence and the adoption of dairying in some human societies.

Week 9: [Reading: Ch. 12 of *OG*]

Mon Oct. 21:	From genotype to morphology I. From transcription regulation to the distribution of morphogens. **[HOMEWORK 7 DUE]**
Wed Oct. 23:	From genotype to morphology II. Growth plates in your limbs and head.
Fri Oct. 25:	From genotype to morphology III. Growing the tallest trees in the world.

Week 10: [Reading: Ch.13 of *OG*]

Mon Oct. 28:	**EXAM 2 [Held in the standard classroom]**
Wed Oct. 30:	From genotype to behavior I. Why behavior and cognition are different in important ways from physiology and morphology.
Fri Nov. 1:	From genotype to behavior II. Alcohol and the humble fruit fly.

Week 11: [Reading: Ch. 13 *OG*]

Mon Nov. 4:	From genotype to behavior III. Human behavioral genetics. **[HOMEWORK 8 DUE]**
Wed Nov. 6:	Genes and society I. Whence came genetics and why should we be mindful of its eugenic origins.
Fri Nov. 8:	Genes and society II. Precision medicine, genomic prediction, and the potential for genetics to improve health.

Week 12: [Reading: Ch. 13 to 14 of *OG*]

Mon Nov. 11:	Genes and society III. Asking better questions and evaluating claims about genetics and differences along the lines of class, race, and ethnicity. **[HOMEWORK 9 DUE]**
Wed Nov. 13:	Interlude: Cancer III. Evolution in populations of cancer cells.
Fri Nov. 15:	Interlude: Cancer IV. Evolutionarily informed cancer treatment.

Week 13: [Reading: Ch. 15 of *OG*]

Mon Nov. 18:	Genome structure variation and evolution I. Why are Eukaryotic genomes so messy in comparison to Prokaryotic genomes? **[HOMEWORK 10 DUE]**
Wed Nov. 20:	Genome structure variation and evolution II. Introns, duplications, and other odd features of genomes.
Fri Nov. 22:	Genome structure variation and evolution III. The wild world of transposable elements, repeats, and retroviral inserts inside your genome.

[NOV 23 – DEC 1: FALL BREAK. NO CLASS]

Week 14: [Reading: Ch. 16 of *OG*]

Mon Dec. 2:	Making and breaking life: Biotechnology I. The expanding toolkit for modifying the genomes of organisms at will. **[HOMEWORK 11 DUE]**
Wed Dec. 4:	Making and breaking life: Biotechnology II. Gene therapy and attempting to Crispr our way to a healthier future.
Fri Dec. 6:	Making and breaking life: Biotechnology III. Combining breeding and direct modification of genomes in conservation and stock and crop improvement.

Week 15: [Reading: Ch. 17 of *OG*]

Mon Dec. 9:	Your genome and the world. How genetics simultaneously makes living things different and similar and what that means for our lives today.
Wed Dec. 11:	**EXAM 3 [Held in the standard classroom]**

Important Dates:

Exam 1: Mon Sep. 30
Exam 2: Mon Oct. 28
Exam 3: Wed Dec. 11

Homework is due online on each Monday of the class except for the first week of class, Labor Day (it's due Wed Sep. 4 that week), and the weeks in which exams are scheduled.

Work Required of Students:

Assignments will include three (3) in-class examinations and ten (10) homework problem sets from eleven (11) tries (allowing you to drop one homework. Exam and problem sets will include questions in the short written response, graphing, matching, figure completion, and critical examination of claims formats.

Students should expect to spend roughly (6) hours of time outside of class in the typical week on reviewing course material and working on homework. The weeks leading up to exams may require two (2) or three (3) additional hours of effort.

Keys to Success:

The keys to success in this course are regular engagement with the material, working on your projects in a steady manner, and asking questions. Regular engagement with the material consists of keeping up with the lectures and reading material and their associated homework. Everything is due on a weekly cycle to incentivize this regular engagement.

The most important key to success in Organismal Genetics is asking the right questions. I do not expect you to know everything from the beginning of the class. After all, if you knew everything about genetics in organismal context, this course would be a waste of everyone's time. If you do not understand something after taking time to study it, please ask about it. Between the discussion forums (on the course Canvas website), class discussion, and one on one office hours, you will have opportunities to get your questions answered.

Standards & Criteria for Graded Assignments:

Short written response questions will be graded using a structured rubric based on the structure of the exams. The remainder of the questions will have modular grading components with clear correct answers that are not dependent on one another to ensure that students may maximize their scores in the event that they are not able to answer one or more sub-components of the question correctly.

Final Grade Breakdown:

Points Breakdown:

Exams (Held in class in the regular classroom) [3]: 50% ($16.\overline{6}$% each)
Homeworks (Due on the course website every Monday except Labor day week) [10]: 50% (5% each)

PLEASE NOTE THAT THERE ARE 11 HOMEWORK ASSIGNMENTS. THE LOWEST SCORE WILL BE DROPPED AUTOMATICALLY FOR A TOTAL OF 10.

Final Grade Scale:

A+ 100% to 98%; A 97% to 92%; A- 91% to 90%
B+ 89% to 88%; B 87% to 82%; B- 81% to 80%
C+ 79% to 78%; C 77% to 72%; C- 71% to 70%
D+ 69% to 68%; D 67% to 62%; D- 61% to 60%
F 59% and below.

Final totals will be rounded up to the nearest whole percent value before conversion into letter grades.

There are no opportunities for extra credit.

Late Assignments, Incomplete Assignments, & Revisions:

You will be able to drop one homework grade from your final total for any reason whatsoever. This includes unplanned absences arising from illness etc. Consult the ***Student Code*** for official policies regarding attendance and missed assignments. For policies on absence letters, consult the ***Office of the Dean of Students page*** for policies on letters of absence. Deadlines are a key part of ensuring that there is a structure to the learning experience and make sure that you are equipped to move on to the next part of the class. Without this structure, learning becomes difficult in the extreme.

Students who have obligations as a part of military and emergency services or representing the university in an athletic or academic capacity may re-schedule their assignments at the beginning of the semester. Likewise, if you have religious observations that do not fall on scheduled off days or are going to be fasting at a time when you must be able to perform at the peak of your mental abilities, please let me know and we can make alternate arrangements for exams and assignments.

Communication Policy:

Maintaining timely and active communication is crucial for a course to function. The primary means of communication outside of the scheduled class periods will be through the course discussion boards on the Canvas course website and announcements given redundantly via email and the course website announcement tools. ******, the TA, will be your primary contact via email. She will forward me the messages that only I can deal with. I will also have office hours by appointment.

A weekly announcement email outlining deadlines and highlighting relevant topics that are in the news will be sent to your Illinois.edu email. Please be sure to use your U of I email address as we need to be able to make sure we are communicating with you and not someone else in situations dealing with grades or other matters in which there is a privacy concern.

If your concerns involve issues that require confidentiality, email Prof. Roseman directly.

Class etiquette & Inclusivity Statement:

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 may be 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 all of us to help establish and maintain and environment where we can contribute without fear of ridicule or intolerant or offensive language.

We're also going to be dealing with some difficult issues in this class, including life, death, sexism, and racism. This means that we have to be kind toward and cognizant of everyone around us when we participate in the forums or other discussions. With this in mind, let's follow these best practices

1. Write or speak in a way that is affirming of everyone's right to be a member of the class. We will all get more out of the course if we conduct ourselves in neighborly and gracious ways.
2. Stay on topic. Your contributions to discussion should pertain directly to the topic at hand. Always be sure to avoid even the appearance of anything that might be regarded as harassing or inflammatory. If you have a question about a specific item that you would like to post but are worried that it may not be appropriate, please feel free to consult with me about it.
3. Respect one another's privacy. If someone does not want to engage with you on a topic, respect their decision and leave them be. Likewise, in a highly connected environment, it is very easy to pester someone to the point where they feel they are being stalked. Moderate your communication to what is necessary and respect people's boundaries.

4. Don't type or speak in anger or frustration. It is very easy to type things you wouldn't ordinarily say to someone in a face-to-face setting. If you are feeling upset or excited, take in a breath of fresh air and give what you want to say some thought.
5. Expect to be welcomed and respected. If you find yourself in a situation where you feel put upon by others, be sure to contact me about it and the problem will be dealt with.

Course policies:

Read and abide by the *Code of Policies and Regulations Applying to All Students* at http://www.admin.uiuc.edu/policy/code/index.html.

Please be aware that this syllabus may change during the semester. Changes to the syllabus will be announced in class and on the course website.

Academic Integrity Statement:

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/ 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.

As far as using AI/LLMs or other computer aids to complete written work, if it's more complicated than a spelling/grammar check don't use it. Developing strong writing skills will give you a huge comparative advantage in an environment in which people depend heavily on AI to do their writing. Style and the ability to express yourself in a unique idiom that people haven't seen before has a novel appeal. Moreover, as AI starts to generate more content on which new AI programs are trained, the outputs of AI models tends to degenerate into nonsense and hallucination. This places a premium on you being able to express yourself and think for yourself. The ability to express yourself independent of AI will also help you perform well on the MCAT.

Family Educational Rights and Privacy Act (FERPA) Statement:

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.

Accommodations Statement:

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course 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 or go to the DRES website.

Sexual Misconduct Policy and Reporting Statement:

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.

Support Resources and Supporting Students in Distress:

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/. Based upon your report, staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and safe. Further, 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.

Emergency Response Statement:

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/.

Emergency response recommendations

The Department of Homeland Security and the University of Illinois at Urbana-Champaign Office of Campus Emergency Planning recommend the following three responses to any emergency on campus: **RUN > HIDE > FIGHT**

ONLY FOLLOW THESE ACTIONS IF SAFE TO DO SO. When in doubt, follow your instincts—you are your own best advocate!

RUN

Action taken to leave an area for personal safety.

- Take the time now to learn the different ways to leave your building **BEFORE** there is an emergency.
- Evacuations are mandatory for fire alarms and when directed by authorities. **No exceptions!**
- Evacuate immediately. Pull manual fire alarm to prompt a response for others to evacuate.
- Take critical personal items only (keys, purse, and outerwear) and close doors behind you.
- Assist those who need help, but carefully consider whether you may put yourself at risk.
- Look for **EXIT** signs indicating potential egress/escape routes.
- If you are not able to evacuate, go to an Area of Rescue Assistance.
- Evacuate to Evacuation Assembly Area and remain until additional instructions are given.
- Alert authorities to those who may need assistance.
- Do not re-enter building until informed by emergency response personnel that it is safe to return.

ACTIVE THREAT:

- If it is safe to do so run out of the building. Get as far away as possible. Do not go to the Evacuation Assembly Area.

HIDE

Action taken to seek immediate shelter indoors when emergency conditions do not warrant or allow evacuation, such as for severe weather.

- Take the time now to learn the different ways to seek shelter within your building **BEFORE** there is an emergency.
- If you are outside, proceed to the nearest protective building.

- If sheltering-in-place due to severe weather, proceed to the identified Storm Refuge Area or to the lowest, most interior area of the building away from windows or hazardous equipment or materials.

ACTIVE THREAT:

- Lock or barricade your area.
- Get to a place where the threat cannot see you.
- Place cell phones on **silent**.
- Do not make any noise.
- Do not come out until you receive an Illini-Alert advising you it is safe.

FIGHT

Action taken as a last resort to increase your odds for survival.

ACTIVE THREAT:

- If you cannot run away safely or cannot hide, **be prepared to fight with anything available to increase your odds for survival.**

***Acknowledgement*:** The statements on Academic Integrity, FERPA, Accommodations, Sexual Misconduct Reporting, Inclusivity, Supporting Students in Distress, and Emergency Response were drawn largely from materials provided during the Illinois Online Teaching Academy of June 2020.