MGY460H1 F

Genetic Analysis of Development

Fall 2025 Syllabus

Course Meetings

MGY460H1 F

Section	Day & Time	Delivery Mode & Location
LEC0101	Monday, 3:00 PM - 4:00 PM Wednesday, 3:00 PM - 4:00 PM	In Person: MS4283 In Person: MS4283

Course Contacts

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Course Overview

Basic and advanced principles of genetic analysis applied to the study of the best-understood eukaryotic model organisms including the nematode worm Caenorhabditis elegans, the zebrafish, and the laboratory mouse. We emphasize the use of genetic approaches to address problems in cell biology and development, such as pattern formation, cell fate determination and tissue morphogenesis. Much of the knowledge gained from these experimentally tractable organisms has proven broadly applicable, and the same principles of developmental genetic analysis underlie efforts and insights into human development.

The path from a single cell to a complex organism requires a highly regulated sequence of genetic and molecular events that encompass all known cellular and intercellular pathways and processes. Although there are many fail-safes to ensure that these processes occur accurately and reproducibly, when they do fail, major developmental defects and diseases can occur. This course will provide insight into these steps and pathways, how they are coordinated and how they compare in organisms that range from simple worms to humans. It will also cover past and current genetic and molecular methodologies that have and are being used to understand these processes.

Course Learning Outcomes

Our objective is to provide students with an appreciation of the intricacies that underlie the amazingly reproducible patterning of a complex organism, and an ability to read and understand, not only the most recent research papers involving these model organisms, but also the classics. Students will also be able to appreciate current issues and areas of focus, as well to design effective experiments that can provide new answers.

Prerequisites: BIO260H1/HMB265H1, MGY311Y1/CSB349H1/BCH311H1
Corequisites: None
Exclusions: MGY451H1, MGY452H1
Recommended Preparation: MGY340H1, MGY350H1
Credit Value: 0.5

Course Materials

TEXTBOOK: There will be no required textbook for this course, but students are encouraged to refer to recent texts that review some of the topics that we will cover. References to these texts and to the primary and review literature will be provided in class as appropriate.

LECTURE MATERIALS: Lecture materials (as ppt or pdf) will be provided ahead of each class on Quercus.

Marking Scheme

Assessment	Percent	Details	Due Date
Midterm exam	30%		Oct 15
Quizzes	30%		Sept 08, Oct 08, 22, Nov 5, 10, 17
In-Person Final Exam	40%		Final Exam Period

Quizzes will be a combination of take-home assignments and short in-class quizzes on lectured material or assigned readings.

Late Assessment Submissions Policy

It is the student's responsibility to inform the instructors of a missed deadline for assignment submission or a missed in-person exam/quiz. Though we highly discourage it, this course has a policy to allow a one-time late submission when well justified. If late submission occurs a 2nd time, the assignment will be marked at 0 points. If an in-person exam/quiz is missed with suitable justification, a make-up exam/quiz will be offered, as appropriate.

Course Schedule

Week	Description
Sept 3- 8	Introduction to development and major model organisms. Dr. Protze (all) These lectures will explore the challenges faced by a single cell in order for it to produce a complex animal capable of repeating the cycle. You will be introduced to the invertebrate and vertebrate model organisms that have been chosen by scientists to study these processes, as well as why they were chosen, how they are manipulated and their various pros and cons. You will also be introduced to online tools for accessing experimental information for different model organisms. A take-home quiz ("Webquest"; 5%) will be assigned after the 2nd class.
Sept 10-17	Introduction to intercellular signaling and embryo polarity. Dr. Zhen Invertebrate and vertebrate organisms establish primary anterior-posterior, left-right, and dorsal-ventral axes early in development. Mechanisms used to control these fundamental processes and their timing, will be compared among organisms. A key objective will be to appreciate the signaling pathways reiteratively used in organisms.
Sept 22-24	Metamerization. Dr. Krause The bodies of most animals are divided along the anterior-posterior axis into repeating morphological units, such as the segments of insects or the somites and backbones of vertebrates. This lecture will explore how fields of equivalent cells are divided into repeating units of equal size to generate the precursors of subsequent ‘metameric’ body parts.
Sept 29-Oct 1	Hox genes and epigenetic zippers. Dr. Krause At the same time that metamerization is occurring, these repeating units develop regional identities and structures that are different from the units ahead and behind. This highly conserved process is controlled by ‘homeotic genes'. Homeotic gene mutations cause transformations of one body part into another. These lectures will look at how these genes evolved, how they function and how they themselves are .regulated
Oct 6-8	Compartments and Signaling Centres. Dr. Krause Cellular differentiation can result in permanent borders between groups of cells that prevent subsequent cell mixing. These borders are often the sources of molecular signals that act to maintain these borders and promote differentiation in the adjacent compartment. These lectures will explore how compartments were discovered, how they form and some of their developmental roles. The 2nd lecture will include a discussion of assigned papers and in-class quiz (5%).
Oct 16th, 21st	Developmental timing. Dr. Krause The developmental life cycle of an organism requires an ability to coordinate the rates of growth of various tissues with one another. It also requires coordination with external factors such as temperature, light and available nutrition prior to committing to major energy-requiring developmental transitions. These lectures will look at the molecular sensors and clocks that monitor and control these processes. Post-class

	quiz on discussed papers (5%).
Oct 23rd	
Nov 3-5	Neurogenesis. Dr. Zhen The nervous system is ultimately a network of cells that manage all forms of animal behaviors. During development, neuronal differentiation and progressive specialization into cell types with distinct signaling properties, and with dedicated wiring partners, form distinct neural networks. These lectures will introduce our current understanding of how these processes take place in invertebrate models. A take-home quiz (5%) will be assigned after the second lecture.
Nov 10-17	Organogenesis and heart development. Dr. Protze This topic will begin with how pluripotent progenitors of the inner cell mass in mammals differentiate into complex organs. We will cover the basic principles of germ layer specification and which organs develop from each germ layer. A take-home quiz will be assigned (5%). The formation of complex organs such as the heart requires precise control of signaling pathways. We will cover literature that identified the key signals required for heart development using classical animal models such as mouse and chicken. We will also explore the latest insights into human heart development gained by using human pluripotent stem cells as a model system. In the last lecture of this series, we will take a look at heart regeneration across different species and discuss the genetic models used to study regeneration. A quiz (5%) will be assigned.
Nov 19-24	Germ line determination. Drs. Zhen, Protze Establishing the germ cells is a key feature of sexual reproduction. The essential characteristics of the germline are similar among organisms, yet how germ cells are established differs with respect to place, time and mechanism. How do the different organisms set aside and maintain cells that must be passed to the next generation? Do these cells differ between males and females? What are the consequences of disturbing germ cell development?
Nov 26-Dec 01	Reproduction and sex determination. Dr. Protze, Krause Sexual reproduction is almost universal among animals, and yet the mechanisms that determine sex are enormously diverse. We will examine what genetic analysis has taught us about sex determination mechanisms in worms, flies and mammals, and whether those mechanisms reveal signs of a common origin. How primary sex determination affects the development of tissues throughout the organism will be discussed. As the cyclical process of development starts and ends with gamete production, important aspects of oogenesis and spermatogenesis will also be covered. This is where most genetic evolution occurs.

Policies & Statements

Lecture materials and recording (by Student)

LECTURE MATERIALS: Lecture materials (as ppt or pdf) will be provided ahead of each class on Quercus. Students should be aware that: (1) Faculty are not required to provide the postings and handouts; this is something we do to make the course easier to follow. (2) The lecture itself is the primary conduit of information. (3) Lectures may not follow the posted materials or handouts exactly and are likely to contain information that cannot be gained from the slides alone or the assigned reading material. (4) Exams may include information that is not found on handouts and postings.

Students should also be aware that the lecture materials are the Intellectual Property of the lecturers. Access to this material and to the lectures (and lecturers), who have unique, special, up-to-date expertise in the course topics, is something you have earned through your previous efforts that got you into this course and is also a significant component of what you are paying for with your tuition. Further distribution of the lecture materials (e.g. on other web sites, in computer or paper files accessible by other students or the public, or by giving paper copies to others not registered in the course) without permission constitutes an academic offence, and the instructors have the right to pursue disciplinary action.

The same principles apply to recordings of the lectures. The individual lecturers can decide whether to allow recordings, and distribution of such recordings. Doing so without permission constitutes an academic offence.

Late/Missed Assignments

ABSENCE DECLARATION: Students who are absent from a lecture for any reason (e.g., COVID, cold, flu, other illness, injury or family situation), and who require consideration for missed academic work, should report their absence through the online absence declaration site. This is available through ACORN under the Profile and Settings menu. Students should advise the instructors of their absence as they are not automatically alerted when a student declares absence. It is the student's responsibility to inform the instructors so that any needed accommodation can be discussed where appropriate

MISSED EXAMS, QUIZZES, ASSIGNMENTS: Some quizzes relate to material and discussion covered in class, and may be given during class or immediately after. It is the student's responsibility to inform the instructors of a missed deadline for assignment submission or a missed in-person exam/quiz. Though we highly discourage it, this course has a policy to allow a one-time late submission when well justified. If late submission occurs a 2nd time, the assignment will be marked at 0 points. If an in-person exam/quiz is missed with suitable justification, a make-up exam or quiz may be offered, as appropriate