Dr. Allison Edgar
BIOL 342: Developmental Biology
Fall 2024

Schedule:
M/W 10:00-11:30 FMH 305

Office hours: After class and by appointment using the provided link: https://calendar.app.google/yDawBKGmZhvzM4ij7 Please book at least 2 days in advance and send me a message on Canvas to let me know you have booked, whether you would like to meet in person on on Zoom, and the subject(s) you wish to discuss.

Semester schedule summary

Date	Topic	Date	Topic
Sept 4	Overview, concepts, and **informational quiz**	Oct 28	Neural crest and **discussion**
Sept 9	Cell identity; **discussion and pre-assessment**	Oct 30	Germ layers, homology, differentiation and **quiz III**
Sept 11	Gene regulatory networks	Nov 4	Hox code
Sept 16	Gametogenesis, **discussion and quiz I**	Nov 6	Plants
Sept 18	Fertilization, **discussion**	Nov 11	**Exam II**
Sept 23	Maternal provisioning and polarity, **discussion**	Nov 13	Metamorphosis, **discussion**
Sept 25	Cortical rotation, **discussion**	Nov 18	Arthropods, **discussion**
Sept 30	Cleavage, germ layers, axes	Nov 20	Segmentation and **quiz IV**
Oct 2	Echinoderm early development, **discussion**	Nov 25	Tetrapod limb, **discussion**
Oct 7	Comparative gastrulation, **discussion**	Nov 27	No class
Oct 9	Protostome early development and **quiz II**	Dec 2	Brains, **discussion**
Oct 14	**Exam I**	Dec 4	Eyes, **discussion**
Oct 16	Ectoderm	**Dec 9**	Sex determination, **quiz V and post-assessment**
Oct 21	Endoderm, **discussion**	Dec 11	Regeneration, **discussion**
Oct 23	Mesoderm, **check in**	TBD	**Final exam (Exam III)**

Semester schedule detail

Week 1 Overview

• Sept 4: Class overview and advice; key concepts and methods in developmental biology
In class: Informational quiz

Reference reading: Gilbert Ch. 1, 2; Gilbert Ch. 3 subsection "The Developmental Mechanics of Cell Specification"

Week 2 Principles of embryology: Specification, determination, and differentiation

• Sept 9: Cell identity, gene regulation, and cell-cell signaling
In class: Graded pre-assessment

• Sept 11: Is development historical or programmatic?: Gene regulatory networks for development
In class: GRN activity

Reference reading: Gilbert Ch. 1, 2, 3, 5; Gilbert Ch. 3 subsection "The Developmental Mechanics of Cell Specification"

Week 3 Gametogenesis and fertilization

• Sept 16: Meiosis, gametogenesis, gamete structure
In class: Quiz I
Last day for 90% refund on course withdrawals
Discussion: Byrnes and Newman "Ernest Everett Just: Egg and Embryo as Excitable Systems" J Exp Zool 2014

• Sept 18: Gamete structure, recognition, and fusion
Discussion: "Boveri's Long Experiment" (Laubichler and Davidson, Developmental Biology 2008)

Reference reading: Gilbert Ch. 7; Ch. 19; Gilbert Ch. 4 subsection "The Embryological Origins of the Gene Theory"

Week 4 Early development I

• Sept 23: Comparative maternal provisioning and polarity in the egg
Discussion reading 2: "macho-1 encodes a localized mRNA in ascidian eggs that specifies muscle fate during embryogenesis" Nishida and Sawada, Nature 2001

• Sept 25: Cortical rotation and other structural rearrangements of the 1-cell embryo
Discussion: "High-frequency twinning of *Xenopus laevis* embryos from eggs centrifuged before first cleavage" (Black and Gerhart, Developmental Biology 1986)

Reference reading: Gilbert Ch. 6, 7, 10, 11, 19

Week 5 Early development II

• Sept 30: Cell behaviors of cleavage and morphogenesis; germ layers and body axes
In class: Quiz I

Last day for 50% refund on course withdrawals

• Oct 2: Early development in sea urchins and other echinoderms
Discussion: "A complete second gut induced by transplanted micromeres in the sea urchin embryo" (Ransick and Davidson, Science 1993)

Reference reading: Gilbert Ch. 3 subsection "Morphogenesis and Cell Adhesion"; Gilbert Ch. 6, 8, 10, 11

Week 6 Early development III

• Oct 7: Gastrulation in Xenopus and across vertebrates
In class: Modeling gastrulation
Discussion: "An experimental analysis of the role of bottle cells and the deep marginal zone in gastrulation of *Xenopus laevis*" (Keller, Journal of Experimental Zoology 1981)

• Oct 9: Early development across protostomes
In class: Quiz II
Discussion: "Formin is Associated with Left-Right Asymmetry in the Pond Snail and the Frog" (Davison et al. Current Biology 2016)

Reference reading: Gilbert Ch. 8, 10, 11, 12

Week 7 Germ layers I

• Oct 14: Exam I (In-class test on material weeks 1-6)

• Oct 16: Ectoderm

Reference reading: Gilbert Ch. 8, 10, 11

Week 8 Germ layers II

• Oct 21: Endoderm

Last day for 25% refund on course withdrawals

Discussion reading: "Villification: how the gut gets its villi" Shyer et al., Science 2013

• Oct 23: Mesoderm
In class: In class: Heart morphogenesis activity and check in

Reference reading: Gilbert Ch. 8, 10, 11, 16, 20

Week 9: Germ layers III

- Oct 28: Neural crest
- Discussion: "Evolution of the new head by gradual acquisition of neural crest regulatory circuits" Martik et al. Nature 2019

- Oct 30: Germ layers wrap-up: homology and differentiation

In class: Quiz III

Reference reading: Gilbert Ch. 15, 17, 18, 19

Week 10 Patterning logic, life history, and evolution I

- Nov 4: Drosophila anterior-posterior patterning; the hox code and homeotic mutations

Discussion: "Establishment of developmental precision and proportions in the early Drosophila embryo" Houchmandzadeh et al. Nature 2002

- Nov 6: Plant patterning and homeotic mutations; development outside animals

Reference reading: Gilbert Ch. 9; Ch. 18; Ch. 20; Ch. 22 subsection "Hox Genes: Descent with Modification"

Week 11 Patterning logic, life history, and evolution II

- Nov 11: Exam II (In-class test on material weeks 1-11, with focus on weeks 6-11)

Last day to withdraw from classes

- Nov 13: Metamorphosis

Discussion: "What is metamorphosis?" (Bishop et al. ICB 2006)

Reference reading: Gilbert Ch. 18

Week 12 Patterning logic, life history, and evolution III

- Nov 18: Comparative arthropod development; imaginal disks

Discussion: "Neofunctionalization of a Duplicate *dachshund* Gene Underlies the Evolution of a Novel Leg Segment in Arachnids" (Turetzek et al. MBE 2015)

- Nov 20: Segmentation, somitogenesis, and positional identity across animals

In class: Quiz IV

Reference reading: Gilbert Ch. 2, 9, 14, 18; Ch. 22 subsection "Hox Genes: Descent with Modification"

Week 13 Organ systems I

- Nov 25: Patterning and growth of the tetrapod limb

Discussion reading: “Positional signalling and specification of digits in chick limb morphogenesis” Tickle and Wolpert, Nature 1975.

- Nov 27: No class (Friday classes meet)

Week 14 Organ systems II
Dec 2: Brain development; sensory placodes
Discussion reading: “Human brain organoids assemble functionally integrated bilateral optic vesicles” Gabriel et al., Cell Stem Cell 2021

Dec 4: Comparative eye development
Discussion reading: “Co-option of the limb patterning program in cephalopod eye development” Neal et al., BMC Biology 2022

Reference reading: Gilbert Ch. 12, 13, 16; Ch. 22 subsection “Homologous Pathways of Development” Gilbert

Week 15 Organ systems III
Dec 9: Sex determination and development of vertebrate sexual phenotypes
In class: Quiz IV and post-assessment

Dec 11: Regeneration
Discussion reading: “Ethel Browne, Hans Spemann, and the Discovery of the Organizer Phenomenon” Lenhoff, Biological Bulletin 1991

Course Information
Required materials:
1. Course packets and handouts
2. 4 or more colors of pen, colored pencil, marker, crayon, etc. that are visually distinguishable for you

Texts:
1. Required reading will be provided through the course site, the course packet, or paper handouts.

2. Primary reference textbook: Developmental Biology (any edition 6th or later) by Barresi and Gilbert (or Gilbert alone for older editions). Current version is 13th edition which has lots of online interactive content). The 8th and 12th editions are on hold in the library (course reserves). An older version (6th Ed) is free online (but must be searched to pull up each section) here: https://www.ncbi.nlm.nih.gov/books/NBK9983/ Chapter assignments are based on the 6th edition, with the assumption that most students would prefer a free, online resource vs buying a newer book. However our best current understanding of how people learn suggests that we learn better from doing this type of reading on paper.

3. Secondary reference textbook: Slack and Dale (or Slack alone on older editions), Essential Developmental Biology. This has a different focus and presents some key information differently than the Gilbert text. You may find it helpful. The current (3rd) version is on reserve at the library for the course.

4. Additional textbook that may be useful focused on early development: Gastrulation (Stern), also available in the library course reserves.

5. Molecular Cell Biology or Molecular Biology of the Cell (either one, any edition should be fine, the latter's 4th Edition is available online for free, just like the 6th edition of Developmental Biology, here: https://www.ncbi.nlm.nih.gov/books/NBK21054/)

Study guides: Study guides are a tool to organize lecture notes and textbook material so that you can increase your comprehension and memory. I have provided a page for shared note consolidation for each major course section and exam. Please feel free to use these as much as you like. This collaborative work will serve as a study guide that everyone in the class can use to prepare for exams. Please use the course question forum to ask questions about course content.

Practice tests: You will notice that quizzes are always scheduled close to exams. That is because these quizzes effectively serve as practice tests, and are meant to help us all figure out what material needs to be reviewed or clarified. There are no ungraded practice tests available.

Students will learn:

1. How key experiments are designed, performed, and interpreted in developmental biology
2. To relate gene regulation with cell identity, morphology, and physiology
3. How cell-to-cell signaling coordinates the behaviors and identities of cells in multicellular organisms, and to describe the main signaling pathways that play important roles in development
4. To appreciate the deep conservation of molecular pathways of development, and how evolutionary changes in developmental programs cause both major and minor changes in phenotype
5. To name, describe and order the main stages of development common to most animals
6. To identify the cellular behaviors that lead to morphological change during development

Grading:

Item	Points
Informational quiz (full points or none – graded only for submission)	5
Pre-assessment	10

Item	Points
Quiz I	15
Quiz II	15
Exam I	75
Quiz III	15
Quiz IV	15
Exam II	75
Quiz V and post-assessment	25
Final exam (comprehensive)	100
Participation (in-class activities and discussions, primary literature reading, attendance)	25
Reading responses and unannounced quizzes	25
TOTAL	400

I cannot accept late work without prior arrangement. No late work can be accepted after the final exam. I aim to grade and/or return (as appropriate) all work within 2 weeks. However, everyone's have to be turned in before I can return any.

Regrade policy: If you do not understand your grade or think I have made an error in grading, please submit your request using the request form on the course site within 1 week. Any regrades (beyond trivial issues such as addition errors, misspelling leading to an incorrect mark on a fill-in-the-blank via Canvas, etc.) will require a full regrade of the entire assessment and may therefore result in either gaining or losing points. Grading issues need to be discussed in writing but discussions about how to improve answers can be in any format.

Please use the course question forum in Canvas to ask questions about course content.

Grade	Percentage	Minimum points to receive grade	Significance (per NJIT grading policies)
A	90-100%	360	Superior
B+	86-89%	344	Excellent
B	80-85%	320	Very Good
C+	75-79%	300	Good

Grade	Percentage	Minimum points to receive grade	Significance (per NJIT grading policies)
C	70-74%	280	Acceptable
D	65-69%	260	Minimum
F	0-64%		Inadequate

Extra credit: The only extra credit available will be available to everyone. There will be no ad-hoc extra credit. Extra credit will be available through Canvas assignments/quizzes noted as extra credit, unannounced quizzes, and questions embedded within the regular exams (some of which may appear to be regular questions). These cannot be made up or accepted late, and they are exempt from regrade requests.

Exams: Exams and quizzes will be comprehensive, but with a focus on recent material. Any assessment may include material covered at any prior point in the class; this spaced repetition is intended to improve your learning and help you integrate concepts across units.

You may bring 1 sheet of paper containing any information you like to each of the three exams. These must be labeled with your name and turned in with the exam.

Quizzes and exams will include a variety of question styles, including multiple choice, short answer, and fill-in-the-blank questions.

Make up exams/quizzes will be written or oral, at my discretion, and may include very different material from the rest of the class. Students arriving late to a quiz/test will not be given extra time. If the University is officially closed on an exam day, the exam will be held on the next regularly scheduled class day. Accommodations for religious or cultural holidays must be requested via the informational quiz during the first week of classes.

Exams are designed to be completed in 40 minutes. Scheduled quizzes are “two-stage”, meaning you are graded on your final answers after a round of discussion, so they are closer to an in-class activity.

Academic honesty: All assessments will clearly indicate if they may be completed in collaboration with partners and whether notes, books, or other tools are allowed. If not otherwise specified, then no collaboration or resources may be used. Any suspected use of generative AI, cheating, and plagiarism will be referred to the Dean of Students office.