BIOL 354
Developmental Biology

M W F 9:30 – 10:20 am ISC 137
Th lab 10:00 am -12:50 pm ISC 306

Instructor:

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Office hours:

Wednesdays 10:30 am - 11:20 pm
Thursdays 3:30 am - 5:30 pm
Or by appointment

Textbook

Developmental Biology 12th Edition
Gilbert and Barresi

Optional Laboratory Notebook

Marble cover composition notebook
10" X 7 7/8" 80 sheets maximum 5 X 5 quad ruled, 20# paper

Course Description

This course will introduce the principles and concepts of genetics, epigenetics, metabolism, growth, morphogenesis, and differentiation in developing organisms. In the laboratory, you will make observations of, and perform experiments on, a variety of developing organisms, demonstrating a number of fundamental events of development.

Learning Outcomes

- Analyze and discuss the genetic, cellular, and tissue control of development.
- Compare and contrast developmental strategies of model organisms.
- Read primary literature critically and explain strengths and weaknesses.
- Propose experiments to test hypotheses and interpret experimental data.
- Test hypotheses with self-designed experimentation.
- Relate discoveries from model animals to human conditions.
- Communicate findings orally and in writing.

How will you know that you are learning?

You will receive feedback on your progress with frequent assignments, including quizzes, as well as midterms, and a final exam. Each exam builds on previous concepts (is cumulative).

You can use the provided assignments to prepare for the midterms and the final exam. Please expect mistakes to be a natural part of the learning process. Midterms and the final exam are cumulative to provide you with multiple opportunities to improve your understanding of difficult concepts. Each exam will stress concepts covered during that quarter of the semester. Midterms and the final exam will contain a variety of questions, including multiple choice, fill-in-the-blank, and mini essay format, and ask you to recall, apply, and synthesize your knowledge. Midterm exams are designed to take 20 minutes.

Your grades are primarily determined by your work as an individual. In addition, a portion of your grade will be calculated by your work in a team. For each midterm, during the first 30 minutes you will first answer questions on your own. Then, you will immediately have 20 minutes to retake the midterm exam with your teammates. Working with your team will benefit you, because a portion of your team effort will be added to your individual score, as follows:

Your exam score = your initial score points + 1/2 (team retake midterm points - your team's average initial midterm points)

For example.
You earn a score of 90 points.
1st groupmate earns 70 points
2nd groupmate earns 80 points. Thus: Initial Group Average = 80 points or 240/3

Team retake score is 85 points. → ½(Team Retake – Initial Group Average) = ½(85-80)
= 2.5 points

You earn 92.5 points (90 initial points + 2.5 retake points)
1st groupmate earns 72.5 points
2nd groupmate earns 82.5 points

The instructor exercises the right to deny any student this team midterm benefit if there is evidence that a student is not contributing fairly to the team effort. In the event of an excused absence on a midterm date, group points on the make-up midterm will be determined by taking the average of group points over the whole semester.

Grading

About 40% of course credit comes from lecture assignments, journal clubs, laboratory assignments, and experiments. The remaining credit comes from individual and group exams. Find rubrics with the assignment instructions on Canvas.
Note on letters of recommendation: Many students ask a letter of recommendation because this class gives opportunity to consider your critical thinking and lab attentiveness skills. I write letters using examples from your coursework. If you plan on asking for a helpful letter, make sure your work is impressive not merely passing.

Grading scale:

93 – 100%	A	83 – 86.9%	B	73 – 76.9%	C
90 – 92.9%	A-	80 – 82.9%	B-	70 – 72.9%	C-
87 – 89.9%	B+	77 – 79.9%	C+	60 – 69.9%	D

Midterm Exams	300 points
Final Exam (comprehensive)	(100 points optional as part of 600 points)
Assignments (lab and class)	110 points
Experiment proposals	20 points
Written lab reports	50 points
Experiment presentation	20 points
Total	500 points (or 600 points)

Schedule of Exams

EXAM 1: 18 February
Core Concepts, Sea Urchins, Fertilization
EXAM 2: 28 March
Model organisms, axis specification, invertebrates, and vertebrates.
EXAM 3: 6 May
Neurulation, ectodermal derivatives, paraxial mesoderm, limbs, aging, and regeneration.
FINAL: Friday, May 20
8 am
Comprehensive

Course materials

We will be using the 12th edition of Barresi and Gilbert's *Developmental Biology,* ISBN: 9781605358222 or equivalent. Exam questions will be based concepts found in the textbook, additional assigned readings, lecture material, and laboratory work. Materials other than the textbook will be posted online for your convenience. Because this is a course at the highest undergraduate level you will be expected to read before class. I will provide you a .pptx file of my lecture notes for download so you can print off figures of note. Posting parts of someone else's work is illegal because it violates their copyright. Do not post online materials about this course that you do not create in full.

Assignments

In-class activities, homework assignments, and quizzes will combine for your final "Assignments" grade. To receive points for in-class activities, you must be present at the beginning of the exercise. Homework is designed to help you understand if you are learning the material necessary to do well on an exam. Most homework assignments will be completed in groups. For group homework assignments, each person is required to fully complete the assignment before meeting with the group. Often each person will submit their initial answers and then the group will submit a consensus document. You will receive the group assignment grade if your individual assignment is complete and you attended the group meetings (see *Evaluating group peers*). Homework is due at the start of class on the due date (there will be a 10%/day penalty for late homework). Upload a legible image to the course management software. One major group assignment will be posted online for free access by any person with internet access. Share with your friends and family!

Journal Clubs

We will critically evaluate current primary literature in this class using Journal Club formats. Each student should come prepared to present the paper; meaning being prepared to explain what the authors did in each experiment. Participation in the class discussion will contribute to the *Assignments* grade.

Laboratory experiments and reports

You will be evaluated on multiple phases of experimentation. 1) the experimental proposal 2) the oral presentation to your class 3) the written lab report. Further instructions and rubrics will be posted on Canvas during the course of the semester. 4) the investigative laboratory notebook. You'll find it is important that you update the notebook during labs, recording results, and experiments and other notes and thoughts. The notebook will be graded only at the end of the course, however, please give me the chance to look it over before the last week of the semester so I can give you feedback to ensure you earn an A grade. Make sure you have access to all of your notes in lab *at all times*. Some laboratory work is observational, and so only the lab report is graded. Choose from the following options to create a laboratory notebook.

Google Doc notebook

Record your work in a "living" document that you create in the shared Google folder I create for you. Or alternatively you can share with me an alternative online file.

Paper laboratory notebook

Record your work in a paper laboratory notebook (Composition Book at Walmart is ~$0.80 – 1.00). Get either the quad ruled 5x5 or lined. Do not use loose leaf or books of other sizes.

Evaluating Group Peers

In order to practice interpersonal skills you will evaluate the contributions of you and your group partners to assignments. The kind of partner you are judged to be by your peers you will factor into your *Assignments* grade and has the potential to alter your grade up to half of a grade. There will be up to four people in each group. You will evaluate each other regarding professional integrity. You may divide up the work, but each person should understand what everyone in the group is doing. Unparticipating people who force the others in the group to take up their share of the work will not receive full credit for group assignments.

Wireless Policy:

Laptop and hand-held computers are fine tools for learning, but can easily become a great distraction. Don't allow the tool to become a disruption. I use TopHat, which will use your smart phones or laptops to do in-class quizzes. Please keep them charged and handy. Bring a laptop to laboratory for ease of reference.

Course Schedule and Considerations

The lecture portion of this course is divided into three sections according to exams. The laboratory portion will be divided mainly into two sections. I will provide more detailed learning objectives outside of the syllabus for each section. The following pages have a table of the expected timeline. I may have to alter this plan. Living organisms are often uncooperative. For the most up-to-date scheduling, please consult Canvas.

Plan to be flexible with your schedule. It can take time to see the interesting stages. Group work allows for the sharing of time commitments. Let me know if there are religious observances and interviews that we need to work around.

In this course, we will explore how organisms develop from a single cell – the fertilized egg. We will begin examining the event of fertilization and then progress chronologically through several important events in development coming back to the establishment of germ cells. Although I will include more detailed learning objectives for each section on Canvas, the following broadly describes some of the major topics that we will cover:

SECTION 1

Specification: How is sex determined? What is known about gender determination? How do stem cells "decide" what part of the body they will organize? How do tissues take form during development?

Fertilization: What are the cellular and molecular mechanisms that occur during fertilization? How do eggs ensure that they are fertilized only once? What changes happen upon fertilization that initiate development?

Early development and gastrulation: How do fertilized eggs divide and arrange daughter cells into germ layers (blastula, gastrula and later stages)? How do cells accomplish the movements that drive gastrulation?

Development of Model organisms: How can the studies of different animals help us understand human development?

SECTION 2

Axis and cell fate specification: How do embryos distinguish their head from tail? Back from front? Left from right? Tip from stump? How is cell identity determined? What are morphogens, activators, inhibitors, signaling loops, and cell autonomy and cell non-autonomy?

Invertebrates and Vertebrates: How do flies, frogs, fish, mice, and humans establish initial germ layers? What tissues and organs derive from the primary layers? What are maternal and zygotic genes? What is an Organizer?

SECTION 3

Organogenesis: How do different cells of tissues combine and remodel to make organs (example: the brain and limbs)? How is early development studied?

Regeneration: How are developmental processes utilized in repair of lost or damaged tissue?

Environment: What environmental factors influence development and in what ways?

For these topics, we will be focusing on the **genetic, molecular, and cellular influences** on these events. We will examine how genetic and non-genetic regulation informs cellular behaviors, which in turn drive the physiological changes that occur during development. Background reading (to be read before class) and class lectures will provide the knowledge base. Student presentations and "journal club" will give you an opportunity to explore current research conducted in these fields. Laboratory experiments will allow you to practice techniques used by successful scientists.

	Day	Date	Topic	Emphasis	Chapter
1	W	26-Jan	Developmental Biology	Introduction	Chapter 1
	Th	27-Jan	Introduction to the Laboratory		
2	F	28-Jan	Urchins		Chapter 10
3	M	31-Jan	Fertilization	Urchins	Chapter 7
4	W	2-Feb	Fertilization	Gametes	Chapter 7
	Th	3-Feb	Sea Urchin fertilization and early development		
5	F	4-Feb	Fertilization	Fertilization	Chapter 7
6	M	7-Feb	Determination of Cell Fate	Pathways	Chapter 2
7	W	9-Feb	Cell-to-Cell Communication	Cell Adhesion	Chapter 4
	Th	10-Feb	Sea Urchin experiment proposals		
8	F	11-Feb	Cell-to-Cell Communication	Cell Signaling	Chapter 4
9	M	14-Feb	Journal Club (Sperm and axis)	Fertilization	Canvas post
	W	16-Feb	**Diversity Summit**		
	Th	17-Feb	Sea Urchin experiment		
			Exam 1		
10	**F**	**18-Feb**	**Pattern formation, Fertilization, Urchins**	**Chapters 1, 2, 4, 7, parts of 10**	
11	M	21-Feb	Exam 1 review & Drosophila axis specification	Drosophila	Chapter 9
12	W	23-Feb	Drosophila segmentation	Drosophila tools	Chapter 9
	Th	24-Feb	Sea Urchin experiment (if needed)	exchange for peer review of laboratory notebooks	
13	F	25-Feb	Drosophila segmentation and genetic tools	Drosophila tools	Chapter 9
14	M	28-Feb	Amphibians	The Organizer	Chapter 11
15	W	2-Mar	Amphibians	Gastrulation	Chapter 11
	Th	3-Mar	Sea Urchin research presentations		
16	F	4-Mar	Amphibians and Fish	Neural Induction	Chapter 11
17	M	7-Mar	Chicken	Amniotes	Chapter 12
18	W	9-Mar	Chicken	Gastrulation and Germ Layers	Chapter 12
	Th	10-Mar	Urchin Reports - Zebrafish introduction		
19	F	11-Mar	Mouse	Gastrulation and Comparisons	Chapter 12

		14-18-Mar	Spring Break		
20	M	21-Mar	Mouse and mammals	Gastrulation and Comparison	Chapter 12
21	W	23-Mar	Ectoderm	Neurulation	Chapter 13
	Th	24-Mar	Zebrafish proposals		
22	F	25-Mar	Journal Club (ectopic fly eyes)	Specification Mechanisms	Canvas post
23	**M**	**28-Mar**	**Exam 2 Gastrulation, Invertebrates, vertebrates**	**Chapters 9, 11 - 13**	
24	W	30-Mar	Evaluate Exam 2 OMDS introduction		
	Th	31-Mar	Zebrafish RT-PCR		
25	F	1-Apr	Ectoderm derivatives	Evaluate and Placodes	Chapter 16
26	M	4-Apr	Ectoderm derivatives	Placodes	Chapter 16
27	W	6-Apr	Neural Crest	Regionalization	Chapter 15
	Th	7-Apr	Zebrafish subcloning		
28	F	8-Apr	OMDS project time for work	Developmental Subject	
29	M	11-Apr	Neural Crest	Migration	Chapter 15
30	W	13-Apr	Paraxial Mesoderm	Somites	Chapter 17
	Th	14-Apr	Zebrafish gel analysis		
31	F	15-Apr	Paraxial Mesoderm	Somitic Derivatives	Chapter 17
32	M	18-Apr	Tetrapod limb	Hox genes	Chapter 19
33	W	20-Apr	Tetrapod limb	Patterning	Chapter 19
	Th	21-Apr		**Great Day**	
34	F	22-Apr	Regeneration	Model systems	Chapter 22
35	M	25-Apr	Zebrafish regeneration	Adult Regeneration	Canvas post
36	W	27-Apr	OMDS Project	Sustainable Development	
	Th	28-Apr	Sequence analysis of fe cDNA		
37	F	29-Apr	Sex Determination		Chapter 6
38	M	2-May	Sex Determination		Chapter 6
39	W	4-May	**Ectopic eyes Xenopus tadpoles**	Regenerative potential	Canvas post
	Th	**5-May**	Presentations Zebrafish - Start Planarians		
40	F	**6-May**	**Exam 3 Neurogenesis, Axial patterning, Limb development, Regeneration**	**Chapters 6, 15 - 17,19,22**	
41	M	9-May	Topic TBD	Topic TBD	
42	**W**	11-May	Lab Books - All reports etc. due by 9:30 am	Topic TBD	
	Th	**12-May**	**Finish Planarians - OMDS Project Due**	**Sustainable Development**	
	F	13-May	Reading Day		
	F	20-May	**Final Exam 8 am**	**Comprehensive**	