Zoology 470 ~ Introduction to Animal Development
Spring, 2016

MWF, 1:20-2:10 pm, 132 Noland Hall
optional discussion section: W 2:25-3:15 pm, 342 Noland Hall

Instructor

Jeff Hardin, Professor and Chair, Department of Zoology
327 Zoology Research, phone: 262-9634
email: jdhardin@wisc.edu
Office Hours: W,F 4-5 pm, 145 Noland Hall, or by appointment

Teaching Assistant

Xiangqiang Shao, Graduate Student, Genetics
phone: 265-2520
email: xshao5@wisc.edu
Office Hours: by appointment

Required Materials

Text: S. Gilbert, *Developmental Biology*, 10th ed. Sinauer and Associates, 2014
We will seek to place copies on reserve at Steenbock and College Libraries.

Required Additional Materials: Lecture handouts and additional readings will be available online, and will be announced in class and via email.

What's this course all about? Unifying Concepts

Zoo 470 is designed to provide an overview of the major features of early embryonic development in animals, and the mechanisms that underlie them. We'll focus on several major aspects of developmental biology:

(1) How do developmental biologists think about embryos? We'll look at major big ideas in developmental biology, and how they guide modern experimental approaches to studying development. In many cases, classic experiments define the major problems being attacked at the molecular level today.

(2) How do developmental biologists study embryos? We'll look at molecular and cellular techniques that developmental biologists use, as well as basic properties of cells that we'll need to know for the rest of the semester.

(3) **How do genes control development?** We'll look at how the regulation of specific genes influences the ways in which parts of the embryo become different. We'll look at how are specific genes are turned "on" and "off" in different parts of an embryo, and why that's important for building an embryo.

(4) How does an animal embryo arise from a fertilized egg? We'll look at how sperm and egg are produced, how they unite, and what the consequences are for the onset of embryonic development. We'll look at how **the basic body plan established, and** how the basic organization of the embryo arises from the fertilized egg. In addition, we'll look at the cellular mechanisms underlying morphogenesis, or "body building". We'll look at several well-studied invertebrate model systems to help us understand the molecular controls underlying pattern formation, including nematodes and fruit flies. We'll study gastrulation: how the primary axes of the body are constructed.

(5) How are different parts organized properly? We'll also look at how key structures become patterned in the vertebrate embryo, using the mesoderm, the anterior-posterior axis, and the limb as case studies.

(6) How does developmental biology impact society? Although this is a science course, the science we study has many implications for society. At several points throughout the semester, we'll stop briefly to examine the knotty problems created by modern developmental biology. At least in one case (stem cells), UW-Madison is at the heart of the controversies. Although what we'll cover is no substitute for a real course in bioethics, our goal in stopping to think about the greater context in which science takes place is to help us to be better citizen scientists

Schedule of Lectures/Readings

Because developmental biology is a field that is undergoing so much change, be prepared for some flexibility! The daily topics and associated readings are a guide to your study, but we may stop for breaking news when appropriate. This makes developmental biology an exciting field, because we are in a period in which a lot of the "stories" are getting written. In addition, there will be additional readings that touch on the ethical and newsworthy aspects of developmental biology. We'll remind you where you should be in the readings each week, and we'll provide text readings to accompany the various sections of your reading packet. **A detailed list of readings is at the end of this handout. Important study tip:** *When there is a difference in the level of detail of coverage for a particular unit, you should always use the level of presentation in lecture as your guide.* Sometimes the text will be less detailed than lecture; in other cases, it will be more detailed.

Readings: Assigned readings will often reinforce lecture material. In other cases, they will supplement your text in specific areas (such as the intersection of developmental biology and ethics, or to provide more information on a technique or biological process). **In some cases, you will be directly responsible for readings not covered in lecture.** ***You will always be told when this is going to happen.*** Additional handouts will supplement your texts, and will be available on the course web site. In addition, there will be WWW links to additional readings on the course web site.

Accessing Course Materials

Zoo 470 course materials are available via Learn@UW. Non-copyrighted materials may also be found at the following URL:

http://worms.zoology.wisc.edu/classes/Zoo470.html

PDF versions of the reading assignments, the syllabus, study guides, old exams, and other material of interest to students of developmental biology will be available at these sites. Electronic distribution will be the only way you'll have access to most materials. Note: copyrighted materials will only be available on Learn@UW.

Prerequisites

Because there are few course offerings in biology at the intermediate level, the only official prerequisite for this course is an introductory course in animal biology (Zoo 101/Botany 130, Bio 151/152, or the Biocore curriculum). However, ***experience has shown that if the only course you have had is Zoo 101 or Bio 151, you must make sure that you have mastered the concepts covered in that course.*** In particular, ***the basic concepts of the "central dogma" (how DNA encodes proteins) and the basic concepts of cell structure and function must be well understood for this course to make sense.*** If you're unsure about your preparation, please schedule an appointment with us now to get guidance about how to bolster your preparation. An "Intro Bio Jump Start", with a list of suggested reinforcement readings, keyed to Campbell and Reece, *Biology*, 8 and 9e (Pearson), is on the course web site for those who need a refresher. In addition, there are several excellent introductory biology web sites with synopses of key ideas that are helpful for this course.

Assignments (ugh!)

Non-graded activities to aid student learning: This year we will be experimenting with additional interactive problem-solving exercises in class. Although these will not be graded, these are designed to aid your learning, and for us to assess how you are mastering key concepts prior to exams. Some of these exercises may involve actual exam questions from previous years. These will typically occur on Wednesdays when there is no quiz.

Exams: There will be 3 **(three) exams**; each carries equal weight. The third exam is during the final exam period; it will be largely non-cumulative, but may contain a few integrative questions that do not require detailed knowledge of material in prior units. Review sessions, **including my wife's brownies**, will be held before each exam (times to be announced), and review guides will be handed out prior to each exam to help you organize your study time (these will also be posted on the course web site). In order to allow

more time for those who need it, exams will be scheduled in the evenings on the dates listed. Exam times and room locations will be announced well prior to each exam, and will depend on available lecture hall space, but will always be in the evening. **Exams in Zoo 470 are not multiple-choice exams**; they contain a mixture of short answer, true/false, and matching. The exams strike a balance between factual knowledge and the ability to analyze experiments. **Your best preparation for the exams is to download and digest the previous exams posted on the course web site.**

If you know you have an exam conflict, or if you need extra time due to documented learning differences via the McBurney Center, see Xiangqiang Shao or Jeff Hardin well in advance to arrange for an alternate exam time.

Quizzes
There will be 6 machine-graded quizzes, typically on Wednesdays, designed to assess your understanding of basic facts regarding several areas: (1) molecular biology techniques; (2) molecular signaling pathways; (3) cleavage patterns; (4) morphogenetic movements; (5) basics of anterior-posterior axis patterning in flies; (6) basics of gastrulation in frogs. These are designed to make sure that you are conversant with key ideas in these areas.

Problem Sets: You will be assigned **three** take-home problem sets during the course of the semester, typically due on Mondays. Problem sets are due at the end of class on the dates listed. Problem sets will be distributed approximately one week before they are due. **Problem sets are designed to be answered in 1-2 handwritten pages.**

Ethics position paper and discussions: There will be two opportunities for in-class discussions of ethics material in this class. **Although no points will be assigned for attendance at these discussions, participation in and attendance at these sessions will be logged and will be used at the discretion of the staff during final grade assignments**. If you know you will miss one of these sessions, or you have a valid reason for missing these sessions, contact us. **In addition, there will be a one-page graded assignment on bioethics.** The position paper is designed to stimulate you to think about ethical issues in developmental biology, but should not require a great deal of time to complete.

Total points:
Exams (60%)+ Problem sets (15%) + quizzes (20%) + ethics position paper (5%) = 100%

Grading policy: **This course is graded on a scale, NOT a curve**; the following scale guarantees certain whole-letter grades, but we reserve the right to adjust grade cutoffs to benefit students when necessary, depending on overall class performance. You may find the following useful as a guide:

A: 100-90% B: 80-89% C: 70-79% D: 60-69% F: below 60%

Note that these are minimum targets; if there is any adjustment, it will always benefit you. The mean in this course is typically a low "B".

Study Aids

Optional discussion section: This year, we will again have a teaching assistant for Zoo 470. Our T.A., Xiangqiang Shao, will be holding a weekly optional discussion section, where you can come to have questions answered, discuss topics of interest to the course, and to interact with other students who have questions like you. **The optional discussion section will meet Wednesdays, 2:25 pm, 342 Noland Hall.**

Computer tutorials: Several award-winning interactive multimedia modules are available on the course web site as a reinforcement for lecture material. There are links from the main course page to these tutorials. We will announce when you should be perusing these materials.

Zoology 470 – 2016
Lecture Schedule & Reading Assignments

Note: Chapter references are from **Gilbert, 10th edition**. Please omit *Sidelights & Speculations* (S&S) sections unless instructed otherwise. "Supplementary Readings" are available via Learn@UW.
DD = Dynamics of Development tutorial: http://worms.zoology.wisc.edu/embryo_main/embryology_main.html
The new, improved site, where you should go for echinoderm materials, is:
http://worms.zoology.wisc.edu/dd2/

Introduction: The Nature and Tools of Developmental Biology

Week	Lecture	Date	Lecture Topic	Readings
1	1	1/20	Introduction to developmental biology	Ch. 1, pp. 1-11, 12-16; P2, pp. 107-116
	2	1/22	Intro (cont); genomic equivalence	Ch. 2, pp. 31-35; 49-51
2	3	1/25	Genomic equivalence (cont)	Supplemental readings part 1
	4	1/27	Human cloning; intro to stem cells	Ch. 8, pp. 298-303 (skip S&S, p. 300); P3, pp. 319-322; 327-330; Ch. 16, pp. 598-600
	5	1/29	Human ES cells (cont)	Supplemental readings part 2
3	6	2/1	Intro to mol. bio. techniques	Supplementary handout on molecular biology; also see the DevBio.com web site, sections 2.3-2.4
	7	2/3	Mol bio (cont); intro to cell biology	Ch. 3, pp. 69-79, 84-86, 88-93
	8	2/5	**Ethics Discussion #1**	
4	9	2/8	Cell biology (cont)	Ch. 3, pp. 99-102; Supplementary handout on cell biology
	10	2/10	Gametogenesis; **Quiz 1: Molecular Biology Techniques**	Ch. 1, pp. 10-11 (meiosis review), Ch. 17, pp. 610-612; 616-623; Ch. 4, pp. 117-123

Preparing to Make a Body: From Egg to Zygote

	11	2/12	Gametogenesis (cont); Fertilization	Ch. 4, pp. 123-129; DD: sea urchin fertilization
5	12	2/15	Fertilization (cont)	Ch. 4, 143-146
	13	2/17	Egg activation; **Quiz 2: Cellular Signaling Pathways**	Ch. 4, pp. 130-140; DD: sea urchin materials on egg activation
	14	2/19	Egg activation (cont);	Ch. 4, pp. 146-147
6	15	2/22	Cleavage; **Problem set #1 due**	Ch. 5, pp. 153-158, 161-163; 179-182; Ch. 7, pp. 217-219; 242-244; 273-275; 286-287
	16	2/24	Cleavage and the blastula	DD: sea urchin & frog materials on cleavage

Review Session: Tuesday, Feb. 23 at 4:30 pm, room TBA
Exam 1: Wednesday, Feb. 24 at 7:15 pm, room TBA

Prelude to Axis Specification – Regulation of Gene Expression

	17	2/26	Intro to Central dogma	Ch. 2, pp. 36-39
7	18	2/29	Transcriptional regulation	Ch. 2, pp. 40-47, (+ *S&S on p. 46*)
	19	3/2	Non-transcriptional regulation; **Quiz 3: Cleavage patterns**	Ch. 2, pp. 51-65
	20	3/4	Sex determination	Ch. 14, pp. 519-532
8	21	3/7	Sex determination; Germ plasm	Ch. 16, pp. 591-605
	22	3/9	Germ plasm (cont.); Intro to morphogenesis	Ch. 5, pp. 158-161
	23	3/11	Blastomere specification and gastrulation in *C. elegans*	Ch. 5, pp. 170-177
10	24	3/14	*C. elegans* (cont); *Drosophila* anterior-posterior axis (intro)	Ch. 6, pp. 179-186;

Specifying the Body: Axis Specification and Gastrulation – Invertebrates

	25	3/16	Anterior-posterior patterning in *Drosophila*: maternal genes; **Quiz 4: Morphogenetic movements**	Ch. 6, pp. 194-204
	26	3/18	*Drosophila*: segmentation	Ch. 6, pp. 204-213

UW Spring Break
March 19-27

11	27	3/28	Sea urchin patterning/gastrulation; **Problem Set #2 due**	Part II, pp. 112-116 (review); Ch. 7, pp. 217-232; DD: materials on sea urchin gastrulation
	28	3/30	Intro. to amphibians; **Quiz 5: Fly A-P patterning**	Ch. 1, pp. 6-11; Ch. 8, pp. 241-244

Specifying the Body: Axis Specification and Gastrulation – Chordates

	29	4/1	Amphibian axis specification: early events	Ch. 8, pp. 252-261
12	30	4/4	Amphibians: early events (cont)	

Week	Lecture	Date	Lecture Topic	Readings
	31	4/6	Amphibian axis specification (cont)	Ch. 8 pp. 251-265

Review session: Wednesday, April 6, 4:30-6 pm, TBA
Exam 2: Thursday, April 7, 7:15-8:45 pm, TBA

	32	4/8	Amphibian axis specification: organizer & neural induction; gastrulation	Ch. 8, pp. 266-271; pp. 245-251
13	33	4/11	Gastrulation (cont); organizer	DD: materials on frog gastrulation
	34	4/13	Other vertebrates: zebrafish and chick; **Quiz 6: Frog gastrulation**	Ch. 8, pp. 271-282; Ch 9, 285-297
	35	4/15	Other vertebrates (cont): mammals	Ch. 9, pp. 298-311 (including S&S)
14	36	4/18	Mammals (cont); Left-right axis specification	Ch. 8, pp. 270-271; 280-281; Ch 9, pp. 297-298, 314-315
	37	4/20	Preimplantation diagnosis/**Ethics Discussion #2**	Supplemental readings part 4
	38	4/22	Neurulation, brains, and ectoderm	Ch. 10, pp. 333-345; 359-361
15	39	4/25	Mesoderm;	Ch. 12, pp. 415-421; 420-426

Building the Body: Organ Systems in Vertebrates

	40	4/27	Mesoderm (cont); endoderm; **Ethics position paper due**	Ch. 12, pp. 432—434; Ch. 13, pp. 449-456; 457-458; 460-467;
	41	4/29	Endoderm (cont); branching morphogenesis	Ch. 13, pp. 476-481; Ch. 12, pp. 434-435; 436-438
16	42	5/2	Neural crest **Problem set #3 due**	Ch. 11, pp. 375-391
	43	5/4	Axon guidance	Ch. 11, pp. 394-405; 404-412
	44	5/6	Limb patterning	Ch. 14, pp. 489-514 (+ *S&S* on p. 506)

Review session: TBA
Exam 3: Wednesday, May 11, 5:05-7:05 pm, Room TBA