

Evo-Devo: Evolution of Developmental Mechanisms

BIOL 443 (3 units); Spring 2017

Monday, Wednesday, Friday 12:20 – 1:10 PM
106 Wartik Lab

Instructor:

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Office Hours: Monday 3:30 – 4:30 PM or by appointment. *Please visit me!*

Description

Evo-Devo is an interdisciplinary field that combines developmental biology, comparative genetics and genomics, and evolution to understand how organisms have attained diversity in form. While the field of developmental biology aims to understand how a given organism develops, evo-devo focuses on how heritable changes alter developmental mechanisms to impart the variation in form observed across life. Course instruction involves lectures and discussion on major principles in this field and of several case studies from the primary literature.

Course Objectives

The goal of this course is to educate on the major underlying principles and themes that have emerged from the study of how developmental mechanisms evolve. Most broadly you will learn how body plans form, how their development varies across organisms, and the underlying genetic mechanisms in their formation and modification. Major take home points from this course will involve an understanding of the multiple levels of homology (morphological, developmental, genetic); how modularity in body form and gene regulation have enabled developmental evolution; how changing the timing (heterochrony), spatial distribution (heterotopy), extent (heterometry), and kinds (heterotypy) of gene expression results in diversity; how the environment can change developmental trajectories (eco-evo-devo); and how developmental processes have changed across the tree of life with examples from the first multicellular life to plants, vertebrates (including humans) and invertebrates. This course integrates concepts in evolution, development, and genetics providing a supplemental or all-encompassing course for those fields. Compared to development this course will cover less of the detailed aspects of how cells and pathways interact and more about how such processes are modified to create heritable variation. It will cover aspects of evolution pertinent to the modification of form and genetics from the prospective of gene regulation and gene interactions, the primary mechanisms responsible for evolutionary change. This course will provide exposure to the tools used in Evo-Devo studies and experience with synthesizing the primary scientific literature.

Course Outline

Basics of Genetics, Evolution, & Development			
1	1-9	M	Introduction; What is Evo-Devo?
2	1-11	W	Genetics I
3	1-13	F	Genetics II
	1-16	M	NO CLASS – Martin Luther King Day
4	1-18	W	Evolution I
5	1-20	F	Evolution II
6	1-23	M	The Diversity of Life and Key Innovations I
7	1-25	W	The Diversity of Life and Key Innovations II
8	1-27	F	Development
9	1-30	M	Establishing The Insect Body Plan
10	2-1	W	Hox genes & Building Body Parts
11	2-3	F	Establishing the Vertebrate Body Plan
12	2-6	M	Exam I
Creating Variation			
13	2-8	W	Genome Diversification & The Origin of Complexity
14	2-10	F	Hox Gene Diversification across Life
15	2-13	M	Segmental Evolution in Arthropods
16	2-15	W	Evolution of Arthropod Appendages
17	2-17	F	Student Led Talks: Topics 2/8 - 2/15
18	2-20	M	Vertebrate Skeletal Evolution
19	2-22	W	Vertebrate Limb Diversity (& Loss)
20	2-24	F	Student Led Talks: Topics 2/20 - 2/22 + 2/10
21	2-27	M	Evo-Devo of Plants I
22	3-1	W	Evo-Devo of Plants II
23	3-3	F	Student Led Talks: Topics 2/27 - 3/1
	3-6	M	NO CLASS – SPRING BREAK
	3-8	W	NO CLASS – SPRING BREAK
	3-10	F	NO CLASS – SPRING BREAK
24	3-13	M	Mechanisms of Macroevolutionary Change
25	3-15	W	Mechanisms of Microevolutionary Change
26	3-17	F	Student Led Talks: Topics 3/13 - 3/22
27	3-20	M	The Predictable Genome: Targets of Evolution
28	3-22	W	Genetic Engineering
29	3-24	F	Evolution of Sexual Dimorphism
30	3-27	M	Exam II
Advanced Topics			
31	3-29	W	Evo-Devo under Domestication
32	3-31	F	Student Led Talks: Topics 3/24; 3/29
33	4-3	M	Eco-Evo-Devo I
34	4-5	W	Eco-Evo-Devo II
35	4-7	F	Student Led Talks: 4/3 - 4/5
36	4-10	M	Color Pattern I

37	4-12	W	Color Pattern II
38	4-14	F	Student Led Talks: 4/12 - 4/17
39	4-17	M	Other Evolutionary Novelties
40	4-19	W	Evo-Devo of Eyes
41	4-21	F	Student Led Talks: 4/17 - 4/26
42	4-24	M	Human Evo-Devo I
43	4-26	W	Human Evo-Devo II
44	4-28	F	Exam III

Final Exam – Take-home. Due during the scheduled exam period (to be determined).

Course Management in Canvas

Course management will take place on CANVAS. Your literature assignments should be uploaded to this webpage in the appropriate folder. Questions can be addressed to the instructor through CANVAS. Handouts from the course, study guides, and course reading materials will be provided through this interface.

Recommended Readings

Recommended readings will be posted on CANVAS for most lectures. You will be tested only on material covered in class. However, readings can help clarify points you may have missed in lecture and are especially helpful for non-auditory learners. If you are interested in purchasing a book to help guide you, readings will be selected primarily from the textbooks below, with the most relevant listed first.

From DNA to Diversity: Molecular Genetics and the Evolution of Animal Design 2nd Ed., Sean Carroll, Jennifer Grenier, Scott Weatherbee, 2005

Evolution: A Developmental Approach, Wallace Arthur, 2011

Ecological Developmental Biology: Integrating Epigenetics, Medicine, and Evolution, Scott Gilbert, David Epel, 2009

Developmental Biology, 10th Ed. Scott Gilbert, 2014

Quirks of Human Anatomy: An Evo-Devo Look at the Human Body, Lewis Held Jr., 2009

Learning Materials

Lectures will be made available as PDFs on CANVAS by 11AM before class.

Study guides & questions: To help you pace your studying, online study resources will be provided. Weekly study guide points and questions will be posted on Friday on CANVAS. These will be combined before each exam into a study guide sheet available on CANVAS.

Exams, Assignments and Grading

Percentage Breakdown by Activity:

Exam I: 20%

Exam II: 25%

Exam III: 15%

Take-home Final Exam: 15%

Presentation: 15%; Assessment of Peer Presentations: 5%

Participation/Attendance: 5%

Grading Scale:

Final grades will be assigned based upon the following percentages:

A	94-100%	A-	90-93		
B+	87-89	B	83-86	B-	80-82
C+	76-79	C	70-75		
D	60-69				
F	< 60				

Grades will be rounded to the nearest integer (e.g. 93.6 = 94; 93.3 = 93).

Exams – You will be tested on course material in three in-class exams and in one final take-home exam. In-class exams will include multiple choice, short answer, and critical thinking short-essay components. *The final exam* will be handed out in class on Friday, April 22 and is due during the scheduled final exam period. This final will consist of explaining the meaning of major concepts in Evo-devo and providing examples of each concept gleaned from class. This will include a subset of general concepts for the course provided in a worksheet at the beginning of the semester (i.e., you can work on building on each concept throughout the semester). The final exam must be completed on your own and can utilize course materials and textbooks to enhance your understanding of concepts, however, as always, essay answers should be written in your own words. Exam essays will be graded using a letter grade for each essay which will be translated into a percentage (A=100; A- = 92; B+ = 88; B = 85; B- = 82; C+ = 78; C = 75; D = 60). Answers that are mostly or completely incorrect will be assigned a percentage between 1 and 50%; no answer at all = 0%.

Symposia – In 8 class periods throughout the semester we will hold symposia on recently covered lecture topics. In each symposium, 5-6 students will each give a presentation on a scientific research article. Each student will select a topic at the beginning of the course (during week 2), identify a scientific paper of interest on that subject, and give a presentation on the contents of that paper (7 minutes long with 1-2 minutes for questions). The presentation should be done using Powerpoint and provide a general overview of the background, methods, results, and conclusions of the paper synthesized in the presenters own words. The goal is to excite the audience about the paper, emphasizing the take home points and what is particularly innovative about the work. The goal of this exercise is to expose students directly to research being done in evo-devo, to gain experience with reading and interpreting the scientific literature, and to gain experience presenting scientific work. Students will provide feedback on each presentation. The presentation grade (15% of grade) is based both on student evaluations and the evaluation of the professor. Your completion of peer evaluations comprises 5% of your grade.

Deadlines for Symposium – Your paper citation must be sent to me 1 week in advance of your symposium for approval and your presentation must be uploaded to CANVAS by 8AM the day of your presentation. If you miss either of these deadlines without an official excuse, your grade will be deducted by 10%. Your presentation must be uploaded prior to class.

Participation/Attendance – This course is taught largely from the primary literature, making attendance in lectures essential for good performance. Participation by you and your peers is what makes for a vibrant in-class learning environment. Your participation is part of your assessment in this course comprising 5% of your grade. It will be graded based on the following point scale. 0 = never attended; 1 = attended <50% of classes; 2 = 50-75% of classes attended with minimal to no in class participation; 3 = 50-75% attendance and moderate to high participation; 4 = 75-85% attended and moderate to high participation OR 85 – 95% attended and low participation; 5 = >95% classes attended or 85-95% attended with moderate to high participation. Attendance apply to days where student talks are not held, as you are graded for your completion peer assessments as part of the Presentation grade.

Missed Exams – If you miss an exam you must notify the instructor within 24 hours of the missed exam. The exam must be rescheduled and taken within one week of the original exam date. You must provide a legitimate and preferably documented excuse (please see http://studentaffairs.psu.edu/familyservices/academics_support.shtml for University policies on legitimate excuses) for missed exams. If you miss an exam and do not have a legitimate excuse (for example, sleeping in or a social event), you will be allowed to take it within one week with a 30% automatic deduction.

Additional Course Policies

Computer and Cell Phone Usage – Studies show (see refs below) that students that engage electronic devices in the classroom outside of exercises meant to be performed on these devices have statistically significant reduction in learning and performance and that the people sitting next to these students suffer even worse information retention than the user. While you might be able to control when you browse the web during class based on what you know, the person next to you might not know that material and your use of devices therefore poses to inhibit their learning more than your own. My recommendation is to avoid electronics use altogether in the classroom. However, if computers are an important part of your learning process, electronic devices will be allowed *in the last row of the classroom only*.

Fried, Carrie B. 2008. “In-Class Laptop Use and Its Effects on Student Learning.” *Computers & Education* 50(3):906–14.

Sana, Faria, Tina Weston, and Nicholas J. Cepeda. 2013. “Laptop Multitasking Hinders Classroom Learning for Both Users and Nearby Peers.” *Computers & Education* 62:24–31

Academic Integrity/Academic Dishonesty

Academic dishonesty is not limited to simply cheating on an exam or assignment. The following is quoted from the "PSU Faculty Senate Policies for Students" regarding academic integrity and academic dishonesty (<http://www.psu.edu/ufs/policies/47-00.html#49-20>): “Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle. Consistent with this expectation, the University's Code of Conduct states that all students should act with personal integrity, respect other students' dignity, rights and property, and help create and maintain an environment in which all can succeed through the fruits of their efforts. Academic integrity includes a commitment by all members of the University community not to engage in or tolerate acts of falsification, misrepresentation or deception. Such acts of dishonesty violate the fundamental ethical principles of the University community and compromise the worth of work completed by others.” All University and Departmental policies regarding academic integrity/academic dishonesty apply to this course and the students enrolled in this course. Refer

to the following URL for further details on the academic integrity policies of the Eberly College of Science: <http://www.science.psu.edu/academic/Integrity/Policy.htm> . You are responsible for ensuring that their work is consistent with Penn State's expectations about academic integrity.

Disability statement

Penn State welcomes students with disabilities into the University's educational programs. In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled (<http://equity.psu.edu/ods/dcl>), participate in an intake interview, and provide documentation: <http://equity.psu.edu/ods/guidelines>. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible.