BIOL 4480/6480 Evolutionary Developmental Biology – How to Build an Organism

Monday 3:05 – 4:55 PM; Cherry Emerson 320

Instructor
Todd Streelman:
todd.streelman@biology.gatech.edu
Office: ES&T 2244
Office Hours: by appointment

Honor Code: Students are expected to abide by the Academic Honor Code (viewed online at http://www.honor.gatech.edu/).

Course Summary: Evolutionary Developmental Biology
Nobel Laureate Sydney Brenner said two decades ago that 'genetics is dead.' He meant that biologists have solved the major questions of genetics – what DNA is made of, how it is replicated, transcribed and translated into proteins. He said further that the major questions remaining to solve in Biology were: (i) How does consciousness work? and (ii) How do organisms develop? Our class deals with this latter fundamental question. We are concerned not only with why things stay the same in development (i.e., why a bird develops like a human), but significantly, why and how things are different (i.e., why cavefish populations lack eyes and pigment).

So how does development shape evolution? We can think of evolution as consisting of two steps: 1) the generation of organismal variation in form and function, and 2) the differential survival of variants within a population. The "Modern Synthesis" of the 1930s and 1940s united evolutionary biology and population genetics to explain the origin and maintenance of adaptive variation within populations of species. It's focus, in other words, was on step 2, or the "survival of the fittest." The Modern Synthesis did not, however, identify the specific genetic changes that underlie evolutionary change (or adaptive variation), nor could it account for the origin of novel forms and functions. Evolutionary developmental biology (evo-devo) seeks to compliment the Modern Synthesis by identifying the developmental genetic changes that underlie evolution. The emphasis of evo-devo is on step 1, or the "arrival of the fittest," and is grounded by the idea that changes in evolution are caused by heritable changes in development.

Evo-devo is motivated by many of the same questions first asked by biologists in the late 1800s. How does nature make wings, fins, heads and flowers? What goes wrong in development when disease occurs? Significant technological advances in genomics, molecular biology and developmental genetics have allowed biologists to begin to understand how genes control development, and how development drives evolution.

How This Class Works
Class Discussions
Most of our meetings will be devoted to in-class discussion of that day's assigned topic. Thus, all readings should be done before the date for which they are assigned. Assigned research articles will be available for download from T-Square, or will be sent by email. Most days, a group of students will help to lead class (with this class of ~10

students, pairs of students will lead for each topic). Discussion leaders may want to discuss their plans for each topic with me. Please note that your class participation grade will be based on my assessment of your preparation for, and participation in, class discussions regardless of whether or not you are leading discussion that day. In other words, be prepared for class every day. It is, after all, 20% of your grade!

1-page Blurbs

Each student will submit a 1-page blurb describing the most exciting aspects of research covered for each of the six class topics. This will be good practice for your research papers and will sharpen your writing skills.

Undergraduate Student Research Papers

Undergraduate students must turn in a 5-7 page (1.5 line spacing) research paper. Topics for research papers may be an extension of the one you chose for class discussion or it may be entirely separate. Research papers should (i) be a written evaluation of a body of literature, (ii) assess the questions addressed, the underlying assumptions, methods, basis for conclusions, and (iii) provide a synthesis of what you find most interesting.

Graduate Student Research Papers

Graduate student research paper guidelines (slightly different):

1. The paper will be 7-10 pages (1.5 line spacing) long.
2. Topics for research papers may be an extension of the one you chose for your presentation or it may be entirely separate; the topic may be close to one's dissertation/thesis topic.
3. The paper must be more than a simple review – one way to do this is to include a specific section titled 'what should be done next' – where the student outlines critical experiments that should logically follow the present state of knowledge.

For all students

For those of you who are feeling a bit more creative, here is another option for a research paper – *Build me a hypothetical animal*. Take me from the developmental blueprint, through morphogenesis, and finally the production of the phenotype. This endeavor should be scientifically grounded and based on real processes covered in class or in your readings.

Paper topics are due October 20, Introduction/Literature reviews are due November 10, and full papers are due December 8.

Grading

Class Participation and Discussion	**20 points**
1 page Blurbs	**20 points**
Research Papers – Intro and Lit Review	**20 points**
Research Papers – Final	**40 points**
Total	**100 points**

The final class grades will be standardized and assigned as follows: A = 90-100%; B = 80-89%; C = 70-79%; D = 60-69%; F = < 60%.

Texts for General Reference
-- *Advances in Evolutionary Developmental Biology* (2014) – Streelman, JT, ed.
-- *From DNA to Diversity: Molecular Genetics and the Evolution of Animal Design, 2nd edition* (2005) – Carroll SB, Grenier JK, and Weatherbee SD.
-- *Cells, Embryos, and Evolution: Toward a Cellular and Developmental Understanding of Phenotypic Variation and Evolutionary Adaptability* (1997) – Gerhart J, Kirschner M.
-- *The Evolution of Developmental Pathways* (2001) – Wilkins AS.

Schedule (dates and topics)

August 18 --- Major themes, syllabus, short day (JTS)

August 25 --- **Why things stay the same, why things differ** (JTS)

September 1 --- **HOLIDAY**

Students help to lead discussion from here.

September 8 and September 15 --- **Evolution and development of the brain**

September 22 and September 29 --- **Evolution and development of stem cells**

October 6 and October 20 --- **Evo-devo of animal freaks: snakes, bats, turtles, eyeless fishes**

October 13 --- **HOLIDAY, Fall Break**

October 20 --- **Paper topics DUE**

October 27 and November 3 --- **Genomes and evo-devo: the hourglass hypothesis**

November 10 and November 17 **--- Frontiers: microRNAs, exosomes and new molecules**

November 10 --- **Paper introductions/literature reviews DUE**

November 24 and December 1 --- **Evo-devo of humans**

December 5 --- LAST DAY OF CLASS (Friday)

December 8 --- FINAL EXAMS BEGIN
Research papers due, 5PM

December 15 --- GRADES DUE