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"Eco-Evo-Devo"
Classroom Inovation Grant Project Description

Project Description

Biology is a rapidly growing and enormously diverse field. Successful scientists routinely collaborate across areas of expertise. However, modeling the integrative and iterative nature of science is difficult as students pass through a series of related, but often disconnected courses, where they may hear about similar ideas from different perspectives but are never presented with the opportunity to integrate across courses. Biology majors typically complete Cell Biology as sophomores and Evolution as juniors or seniors. Developmental Biology is an upper-division elective. Although Evolution and DevBio both build on material first presented in CellBio and modern DevBio draws heavily from evolutionary theory and vice versa, there are no explicit links between the three courses. We seek to develop an integrative lab that combines techniques/data from all three courses to better understand a current problem in evolutionary biology, linking cellular processes to development, ecology and evolution of whole organisms (termed Eco-Evo-Devo).

We propose to develop a three-part open-ended laboratory exercise designed to allow students to collect real (we hope, publishable) data that requires the integration of expertise from all three disciplines. We have identified a plant, the Red Ribbons wildflower (Clarkia concinna), for which there are both normal and abnormal floral forms (described in a single paper: Ford & Gottlieb, 1992). Virtually nothing is known about the potential evolutionary advantages or disadvantages associated with the abnormal floral form, very little work has explored physiological or structural differences between the forms, and the specific genes for which mutation generates the abnormal floral form have yet to be identified. Irvin Pan brought seeds of both forms to Stonehill and has already begun propagating them. We envision students in Evolution collecting data on the evolutionary fitness differences between the two forms of the flowers; students in CellBio will collect data on physiological and/or structural differences; and DevBio students will attempt to identify the developmental gene/s responsible for the observed changes in floral structure.

Simply using the same plant in all three classes does not, however, create continuity or interdisciplinary thinking. We propose to create working groups comprised of representatives from each of the three courses that will work together to best understand the full body of data. Students in developmental biology and cell biology will be paired with and act as sub-contractors to Evolution students, modeled after National Science Foundation sub-granting structure, and present their results to evolution students both orally and in a short sub-contractor report. These reports must include the context of basic evolutionary principles learned from their evolution partners. Students in evolution will then lead-author a collaborative report that incorporates data and interpretation from all three classes. As a result, students will develop interdisciplinary knowledge and produce data relevant to current questions in biology.

Time Line

- Summer 2012 - Lab development
- Fall 2012 - pilot of combined data collection
- Spring 2013 - preparation of manuscript detailing results (Bleakley has a pre-tenure course reduction during this semester to focus on writing)

Benefit

Students better understand science as a process, rather than a set of static facts, only by engaging in open-ended exercises for which there is no "right answer." Our students will be better prepared for both upper division course work and the real work of science enterprise after they have engaged in this type of experiential learning. In addition, although students routinely work with a lab partner or small group, there are few opportunities for learning-community type interactions within the sciences. This set of laboratory exercises will better prepare students to integrate disparate types of data and collaborate with diverse groups of co-workers. We expect the relevance of real problems in science to improve student understanding and retention of core biology knowledge.

Last, the focus on plants may additionally improve overall poor student performance on organismal portions of required student assessments (Biology major field test).

Community Outreach
Bleakley, Pan, Hirst and Allison plan to detail the combined pedagogy and laboratory methods in a joint journal article submitted to Evolution: Education and Outreach or a similar journal. We also hope to produce an evolution/developmental biology paper using student-generated data on the Red Ribbons flowers. Upon completion of this project, we would also be happy to hold a teaching round-table discussing the process of creating a multi-class (non learning-community) interdisciplinary project for students.

Budget
We request funds for two work-study students to serve as organizers and coordinators to oversee combined group work. Cell Biology enrolls 120 students, Evolution is currently maxed with 44 and Developmental biology has 14 students. We anticipate groups will typically comprise 2-3 cell biology students and 1 evolution student with consultation from a developmental biology student, given the disparate numbers enrolled in each class.

• Stipend for work study course assistants to coordinate student activities across all three courses: 8 hours/ week (4 hours per student) * $8.25/hr * 10 weeks of active project time = $660
• Laboratory supplies:
• Composition books for laboratory records (44 @ $0.99ea = $44)
• Plant starting and growing supplies such as soil, pots, marking tape ($150)
• Primers and reagents for gene identification ($146; these will actually cost upwards of $500 but we will ask for some money from the lab supplies budget)