

## FINAL REPORT

Collaborative Research Initiative in Biological Modeling and Data Analysis

ACS Mellon Faculty Renewal Program

*Dates of Project:* May, 2010 through May, 2011

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### **Abstract:**

During the 2010-2011 academic year, an ACS Faculty Development Grant was awarded to Christine Shannon (MAT and CSC programs) and Chris Barton (BIO program) at Centre College. The primary goal of this grant was to foster a stronger awareness of interdisciplinary opportunities in computational biology relevant to both collaborative research and classroom activities. During the summer of 2010, the funds from this grant were used to support attendance at Computational Modeling workshops and meetings as well on site visits with fisheries biologists working on computational research/management problems in Ann Arbor, MI and Portland, OR. These activities led to the development of two fisheries related computational research projects that are being undertaken by two Centre College students during the summer of 2011. In the fall of 2010, grant funds supported a half day workshop that brought together over 40 professional scientists and both faculty and students from several Kentucky and Indiana schools for a number of informative sessions and lively discussions relevant to the integration of computational biology approaches in the liberal arts academic experience. In January, 2011, Dr. Ami Radunskaya, a computational scientist from Pomona College, spent two days at Centre meeting with faculty and students and sharing her research experiences using computational approaches to study cancerous tumor growth patterns. During the spring of 2011, a new, one hour data base course (BIO 265) gave students the opportunity to work with a fisheries database to address independent research questions. A faculty pedagogy lunch featuring four different groups of faculty currently pursuing interdisciplinary research was also sponsored by the ACS grant. The ACS grant has generated a stronger sense of awareness of the value of interdisciplinary collaborations among both faculty and students at Centre College. The Biology Program is currently undergoing some significant curricular changes that are likely to result in higher expectations regarding the computational skills of future biology majors.

### **Final Report:**

There were five specific goals listed in the original grant proposal:

1. To establish a stronger network between Centre College and professional scientists working on interdisciplinary BIO/MAT/CSC projects whereby Centre faculty could enhance their expertise in conducting this type of research
2. To identify specific interdisciplinary research projects that could be pursued collaboratively using the data accessible from selected fisheries databases

3. To attract students to interdisciplinary research projects in BIO/MAT/CSC and to broaden the exposure of students who double major in biology and math or computer science to interdisciplinary opportunities in graduate studies and careers
4. To encourage advisors to alert students to interdisciplinary research opportunities and the kind of preparation they will need to participate
5. To encourage broader interdisciplinary collaboration on Centre's campus and provide a model for interdisciplinary research efforts at other ACS institutions

During the past year, we have been engaged in activities that address all of these goals. Some of the goals (ex. #1 and #2) have been met; all of these goals will continue to guide our collaborative efforts as the seeds established by this ACS Faculty Development Grant continue to germinate. In this final report, we will outline the specific activities that were funded by the ACS grant and discuss how these activities helped address the goals of the grant, the impacts of these initiatives, and the dissemination of relevant results from these events.

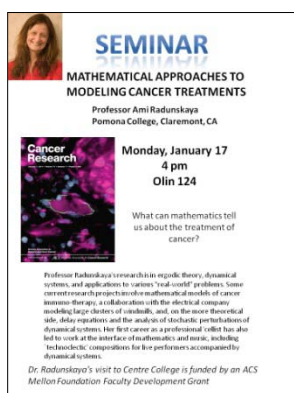
#### *Summary of grant funded activities*

During the summer of 2010, grant funds were used to support attendance at Computational Modeling workshops and meetings; in addition, on site visits were made to fisheries biologists working on computational research/management problems in Ann Arbor, MI and Portland, OR. Collectively, these activities addressed goals 1-3. In June, both Christine Shannon and Chris Barton attended the "Mathematical Biology: Beyond Calculus" MAA-PREP workshop at Sweet Briar College in Virginia. The workshop gave us the opportunity to collaborate with other faculty interested in computational biology research and gave Chris Barton an opportunity to gain exposure to several types of modeling efforts and data analysis using biological datasets. After the workshop, both faculty members traveled to Ann Arbor, MI, where we met with fisheries biologists at the USGS Great Lakes Fisheries Research Center. This research facility collects large data sets for many species of fish living in the Great Lakes. While some of these data sets have already been thoroughly analyzed, there are still a wealth of long term data that would lend themselves very readily to student collaborative projects focused on both data analysis and computational modeling. One specific data set for bloaters (*Coregonus hoyi*) looks like it will provide a good research project for one or more students. During the summer of 2011, one student will begin to work on the development of a life history model for these fish. In July, 2010, Chris Barton traveled to Portland, OR, and met with NMFS/NOAA fisheries biologists who are working with the PTAGIS database, an extensive database for Columbia River salmon which are tagged as juveniles and tracked at specific interrogation sites throughout their life history. This visit provided the background for the introduction of a one hour Biological Database course which was offered to 6 students in the spring term of 2011. During the summer of 2011, one student will continue to work on several data retrieval and analysis projects arising from the individual studies performed by students in the database course. In August, 2010, Christine Shannon attended the MAA MathFest in Pittsburgh, PA; this meeting featured a special session on mathematical biology where the Etta Z. Falconer Lecture was presented by Professor Ami Radunskaya of Pomona College. As a follow up to the MathFest meeting, Christine Shannon was able to invite Dr. Radunskaya to visit Centre College during January, 2011.



science to biological systems. In addition, the speakers addressed the type of academic preparation that is needed for similar interdisciplinary post baccalaureate career paths.

Following these formal presentations, there was a student panel comprised of current students and very recent graduates who discussed some of the collaborative research opportunities that they had pursued in computational biology both at Centre College and at other institutions (Vanderbilt, Ohio State and Virginia Commonwealth University). These were particularly beneficial because they illustrated the opportunities that are available to students who are prepared to combine solid training in biology with strong mathematical and computational skills. Several of the student panelists also brought research posters that were displayed during the workshop. The fall workshop addressed all five of the goals initially outlined in our grant proposal and was very well received by students and faculty alike.



During the January term of 2011, we invited Dr. Ami Radunskaya (Pomona College) who gave a seminar presentation on “Mathematical Approaches to Modeling Cancer Treatments.” This was well attended by faculty from biology, mathematics and computer science, chemistry and physics as well as by over a dozen students. In addition, Dr. Radunskaya taught a class for students enrolled in CSC 261 (Introduction to Computational Science) in which she discussed how a variety of the models presented in the class could be used to model cancer growth. One of the students in the class subsequently developed a small independent project based on Dr. Radunskaya’s

research presentation. She also took the time to meet with faculty members on the committee to develop a proposal for the Howard Hughes Medical Institute. Dr. Radunskaya’s on campus visit addressed goals # 1, 3, and 4.

During the spring term of 2011, we organized one of the Pedagogy lunch programs for faculty at Centre College to encourage faculty to consider interdisciplinary collaborations in their research endeavors; nearly 40 faculty attended this particular lunch program. This activity allowed us to address the objectives outlined in goal #5 and continued our efforts at dissemination of information that was initiated at the fall workshop. This program featured faculty from a broad range of disciplines who were involved in interdisciplinary projects. The pairings included: computer science and behavioral neuroscience, biology and computer science, education and Spanish, as well as religion and chemistry. From the questions and general response of those present, this was clearly an informative session which was very well received. The Pedagogy lunch programs are hour long programs organized by faculty members; the cost of the lunch is partially subsidized by the dean’s budget but faculty are asked to contribute \$5 per lunch. The ACS grant allowed us to cover the cost to the faculty members so the 39 faculty who attended received a “free lunch”. More information about this program can be found in the Pedagogy Newsletter

( <http://ctl.centre.edu/teaching%20resources/newsletters/pedagogy%20newsletter-summer11.pdf>.)

Finally, we have used the remaining funds from this grant to provide lunches for students who will be engaged in collaborative research endeavors in the sciences at Centre College this summer. These students typically meet once a week to present some of their research results during the lunch hour. We will be sponsoring two of these students who will work on two computational biology projects associated with the Great Lakes bloater data and the Columbia River PTAGIS database. Since the lunch seminars are attended by both students and faculty, they are an excellent opportunity for encouraging interdisciplinary collaborative research activities. Assuming they obtain some interesting results, these seminars will also be a good opportunity for our students to disseminate their preliminary research findings in anticipation of a more formal presentation at a regional science or math meeting.

Overall, we have been very satisfied with the activities that have been supported by the ACS funds. Both of us have grown professionally in our understanding of each other's disciplines and we have significantly expanded our horizons in terms of future research collaborations. Most importantly, we can begin to see the development of a "culture" on campus for students who express strong abilities and interests in the disciplines of biology, mathematics, and computer science. The "take home message" from the professional scientists and mathematicians that we met during this past year suggests very strongly that there is a market for students in graduate programs who demonstrate capabilities in computational science. Our own efforts have been reinforced by the ongoing development of the college's HHMI proposal and a recent hire to the MAT/CSC faculty (both discussed below). In hindsight, we wish we had provided an exit evaluation form for the participants in the October workshop. Although the numbers were fairly small, we might have been able to better document the impact the workshop had on the participants' attitude toward computational biology and its importance in the education of our students.

### **Impacts of grant funded activities**

There were a number of short term impacts resulting from the grant-funded activities. First of all, the collaboration inspired by this grant encouraged the investigators to participate in each other's courses. Chris Barton attended many sessions of the Computational Science class taught by Christine Shannon and reciprocally, Christine Shannon attended a number of the classes on the PTAGIS database taught by Chris Barton. While the Computational Science class had already been in existence, the presence of a biology faculty member added a significant dimension to the course. Furthermore, the creation of the one hour course dealing with biological databases was a direct result of the travel funded by this grant and provided a splendid new opportunity for the students. The six students enrolled in this course obtained an introduction to the PTAGIS database and spent half of the term pursuing independent research projects developed from "mining" the PTAGIS database. Their final presentations and papers clearly went beyond the 1 credit hour that they earned for the course; several of the students commented very positively on being given the opportunity to "broaden their horizons" in such an interdisciplinary class. The response of the students to the Computational Science course as revealed in the course evaluations was excellent with multiple comments about the value of the interdisciplinary nature of the course. Several noted that the course inspired them to

consider computational modeling as a career path. Many students commented on the quality of their interaction with Professor Radunskaya and her interactions with faculty, especially those on the HHMI proposal committee, were very beneficial. During the summer of 2011, two students will undertake summer research projects based directly on the research and data sets available from the Great Lakes Fisheries Center and the PTAGIS database.

The students and faculty who attended the workshop in October and the Pedagogy Lunch in May certainly had their horizons broadened in regard to interdisciplinary opportunities and one faculty member volunteered that, because of his encouragement, there were now a number of biology students who were planning to enroll in the computational science course the next time it was offered. A number of members of the biology program attended the lecture presented by a candidate for a new joint position in mathematics and computer science and voiced their support for his candidacy because of his interest in interdisciplinary work including the life sciences. It is also likely that the decision to put a major emphasis in the HHMI grant on computational biology was influenced at least in part by the reports of the current graduate students at the October workshop. The Biology program is also undergoing major curricular revisions and there has been much discussion of how to include a stronger, more integrated computational pedagogical approach in the teaching of our biology courses, particularly in the laboratory components of these classes.

In the long term, we hope that this collaboration, the changes in the biology requirements, and hopefully a successful HHMI grant, will have a continued impact on the interdisciplinary preparation of our students. As more biology faculty incorporate quantitative methods and tools into their courses and labs, it will seem more natural for students to engage in similar activities as part of their research projects.

#### *Dissemination of grant funded results*

The pedagogy lunch allowed us to share some of the interdisciplinary ideas and projected collaborations in both collaborative research endeavors and in the classroom in the near future. Most importantly, both the pedagogy lunch and the workshop allowed us to plant seeds and to establish a stronger focus on interdisciplinary collaborations among both the faculty and the students at Centre. During the summer of 2011, we will expand our dissemination of some of these initial seeds and ideas through a blog that our research students will write as they pursue their summer projects. Eventually the blog will be accessible to faculty and students at other institutions.

This summer, two students are pursuing interdisciplinary projects directly arising from this interdisciplinary collaboration in computational biology. If either student is able to obtain some interesting results from her project, we anticipate that the results would be formally presented at either regional math or biology meetings (ex. Kentucky Academy of Sciences, Kentucky MAA, southeastern Tri Beta conference).

### *Future directions*

The activities supported by this ACS grant have already fostered a stronger discussion of interdisciplinary efforts—both in terms of pedagogical practices and in collaborative research endeavors. If funded, the HHMI grant proposal that will be submitted this fall will also strengthen the academic opportunities available in computational biology at Centre College. During the next year, the Biology faculty will work on a major revision of the laboratories for the introductory Biology course; the discussion of ways in which we can better integrate a computational approach to these labs has already begun. The implementation of these curricular changes is likely to involve interdisciplinary collaborations with the faculty in MAT and CSC. This fall, Professor Forrest Stonedahl will join the math faculty in a tenure track position. Based on his academic training in biological modeling, we anticipate new opportunities for collaborative endeavors between the Biology and Math faculty.

### *Financial statement*

The summary of expenses paid for by the ACS funds is presented in the following table:

<b>Description</b>	<b>Total Amount Spent</b>
<u>Travel</u>	\$2,400
<u>Fall Workshop</u>	\$2,029
<u>Pedagogy Lunch</u>	\$190
<u>Pomona speaker (Jan 2011)</u>	\$924
<u>Lunches for summer research students</u>	\$350
<b><u>TOTAL BUDGET</u></b>	<b>\$5,893</b>

The travel budget line covered the expenses associated with travel to meet with scientists at the Great Lakes Fisheries Center in Ann Arbor, MI, and the National Marine Fisheries Service in Portland, OR; in addition, the travel funds covered expenses associated with the MAA-Prep Workshop at Sweet Briar College and the Mathfest MAA meetings in Philadelphia. The fall workshop budget line was used to cover travel expenses, honoraria for the participants, lunch for all attendees, and printing costs for flyers and programs. The Pedagogy lunch budget line covered the cost of the lunch normally paid by attending faculty; the remaining lunch costs were assumed by the dean's budget. The Pomona speaker budget line covered the travel, lodging, food, and honorarium expenses associated with the on campus visit by Dr. Radunskaya in January, 2011. Gift cards were purchased with the remaining funds to provide lunches for students and faculty attending the summer collaborative research seminar programs. A more detailed spreadsheet of activities and expenditures is submitted as part of a separate Excel file.