



The Phage Genome Research Initiative at the College of William and Mary: Overview & Assessment of Year 1

Mark H. Forsyth, Margaret S. Saha, and Kurt E. Williamson
Department of Biology, College of William and Mary, Williamsburg, VA



I. Abstract

Background: Two significant challenges in undergraduate science education are (1) incorporating substantive research experiences into freshmen introductory laboratory classes to engender and maintain excitement and interest in science, and (2) retaining students with diverse backgrounds during and following large introductory science courses. The HHMI Phage Genome Research Initiative at the College of William and Mary has focused on specifically addressing both of these issues.

Methods: The WM PGRI program targeted enrollments from admitted William and Mary students potentially interested in science who participated in summer bridge programs. In addition, in order to ensure a diverse group of participants, students who actively sought out the opportunity to join the program and those who successfully competed via an application process were accepted into the class. We employed a strategy for intense faculty involvement in the progress of the students in the PGRI as well as in all other courses, including review sessions, meetings for study strategies, and post-exam reviews. Additional strategies for creating a genuine research experience included: a non-syllabus driven course; grading based upon performance and notebooks; conducting classes as lab meetings; inviting notable speakers (Dr. Hatfull) for a seminar; and taking students to a national meeting where they presented the results of their own research efforts.

Results: Current data suggest preliminary success in both fronts. Retention of "at risk" students increased over previous years; with some exceptions, these students also performed better in their introductory science classes. Overall, student evaluations of the laboratory were extremely enthusiastic, particularly compared to similar evaluations of the standard introductory laboratory. Notably, a significantly higher percentage of students from the PGRI lab applied to and were accepted for our HHMI Freshmen Research Program.

II. Introduction & Overview



- Target "at risk" students, but aimed for diversity
- Began with 30 students; two sections per week
- In place of the "regular" lab; students in same lecture
- Had 3 faculty instructors plus graduate student and undergraduate teaching assistants
- Met in newly opened Integrated Science Center (in molecular lab, same floor as research labs)

III. Methods

Pedagogical Strategy for Phage Lab Research Activities:
Make this as close to an authentic research experience as possible !

- One "formal" meeting per week; however, lab kept open and accessible
- Syllabi for course kept to a minimum; stressed that instructors do not know outcomes and was students' responsibility to determine next steps
- Our mantra: "real research" does not have a syllabus
- No quizzes or exams, only notebooks and participation used for grading
- Held several group lab meetings to discuss data interpretation
- Had students present at the William and Mary Annual Undergraduate Research Symposium
- Sponsored seminar by Dr. Hatfull and invited neighboring institutions for a collaborative lab meeting
- Sponsored five students to present their phage data at national ASM meeting:



W&M Undergraduate Research Symposium Phage Phest



Strategy for Enhancing Overall Student Academic Performance:
Involvement and Mentoring—Early and Often

- Discuss content of Introductory Biology lecture course and relate, when possible, to phage lab
- Provide mock quizzes to ensure preparedness
- Review lecture exams to analyze mistakes
- Hold after class sessions on "how to study" and active learning strategies
- Meet individually with students for study habit and time management review

Assessment Plan (In addition to that provided and utilized by HHMI)

- Comparisons with students not in phage lab—from previous years and in current year: grades, course selection, retention, participation in research opportunities; use modified Logic Model
- Use of focus groups and written evaluations to determine attitudes toward science and research
- Analysis and comparison of standard William and Mary course evaluations
- Comparison with previous data from SURE and CURE surveys from W&M

On seeing the EM images:

"It was the most excited I have ever been at ten in the morning in my life!"

"Oh my God, this is like watching my baby being born"
(from an 18 year old male)

IV. Results & Outcomes

- Significantly more enthusiastic ratings for phage lab than for standard Introductory Biology Laboratory in all categories
- Overall increased retention of phage lab students in science track, including at risk students, although on an individual level, variable results:
- Deeper student understanding of knowledge discovery and dissemination in science: hypothesis development, testing, and refinement; data analysis; scientific writing
- Significant increase percentage of phage lab students pursuing research: 43% of phage lab students conducted freshmen research compared to ~5% of the non-phage lab students

V. Continuing Challenges & Possible Solutions

- **Challenge:** Retention of an even greater percentage of at risk students
Solution: even more aggressive intervention/mentoring earlier and more often (even before the first set of freshmen year science exams!)
- **Challenge:** How to continue a (too successful) program beyond HHMI support
Solution: incorporate into Introductory Lab as an alternative lab using TAs (grad. and veteran phage lab undergrads); adapt more (all?) Intro. labs to specific faculty research projects
- **Challenge:** Students have taken ownership of the project and wish to extend and expand upon this year's research
Solution: Make this the focus of a new upper level Molecular Genetics

