Hope College Phage Genomics Research Course: First Year Implementation and Results

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I. Abstract

This past academic year (2008-09) Hope College of Holland, Michigan, offered a phage genomics research laboratory course to 20 first-year college students as part of a new science education experiment, designed and supported by the HHMI and SEA, to test the hypothesis that educational instruction, in the context of an authentic scientific research project, will lead to improved student learning and interest in science. Students were selected from a restricted pool of applicants earning high scores on the ACT and/or SAT college entrance exams. Lab sessions ran twice a week for a total of 5 hours in the fall (phage/DNA isolation semester) and 3 hours in the spring (bioinformatics work). The essential content of the course was delivered, largely in sequence and as described in the manual, and all major goals of the course were achieved. We used the timely shift in course content from phage/DNA isolation in the fall to bioinformatics-based genomic analysis in the spring to introduce several changes involving course mechanics and classroom dynamics to broaden the student learning experience. In the fall students worked independently and presented their findings in research article style written reports whereas in the spring students were organized in teams of five, analyzed only a section of the genome, and highlighted their findings in student-driven journal article discussions and group oral presentations. Multiple efforts were made to bring interdisciplinary coverage to select topics of discussion and to include additional laboratory and analysis skills consistent with the Hope College Biology core course sequence subject matter. About 80% of the students have enrolled in the final course of the Biology core sequence, historically an indicator that students will declare Biology as their major field of study.

II. Student Recruitment, Statistics

A. Course announcement, Student selection

- New course announcement and application instructions sent to select HS graduates considering Hope College
- Applications reviewed by course instructors plus department chair
- Application requirements included written responses to questions designed to evaluate applicant preparedness, interest in science and research, and career objectives
- 71% of applicants receiving course offer accepted

B. Student statistics

- 20 first-year students
- 7 males, 13 females, 2 minorities
- 3.98 average high school GPA (n = 20)
- 32.2 average composite ACT score (n = 16)
- 1418 average composite SAT score (n = 9)

Acknowledgements

•Howard Hughes Medical Institute and the Science Education Alliance
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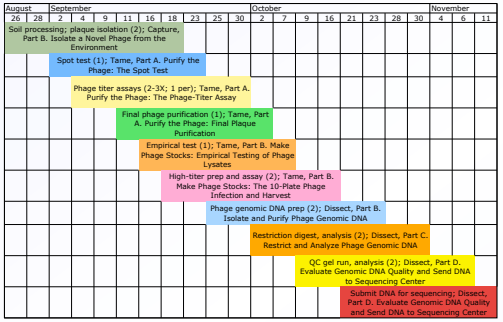
•Paul van Allsburg, Hope College

III. Course Implementation, Logistics

A. Course implementation strategy

- Students met for two scheduled laboratory sessions per week
  - Fall semester - Tues. 3 hour lab, Thurs. 2 hour lab
  - Spring semester - Tues. and Thurs. both 1.5 hour sessions
- Phage/DNA isolation work conducted in college teaching laboratory; bioinformatics work performed in computer teaching laboratory
- Established flexible target dates for completion of defined research program goals
- Flexible schedule (see example below) provided opportunities for enhanced coverage of some topics based on time availability



Fall 2008 experiment schedule

B. Course logistics

- Two student TAs assisted in lab preparations
- Fresh 1X top agar prepared on Monday for use that week or up to 10 days
- Agar base plates dried at room temperature minimum of 3 days prior to use (eliminated problem of incompletely solidified top agar)
- One P1FF *M. smegmatis* stock used to seed all P2FF cultures during semester; each P2FF culture used for up to 2 weeks (fresh cultures may have yielded higher titer counts)
- Materials supplied ready-to-use to students:
  - Phage buffer
  - 1X top agar
  - Agarose gels
  - DNA size standards for gel electrophoresis work
  - Phage D29 stock
  - Base agar plates
  - Bacterial cultures (proper volume)

IV. Pedagogy

A. Supplementary course content

- Topics of interdisciplinary coverage
  - chemistry of DNA polymerization and sequencing reactions; DNA sequencer operation
  - chemical specificity of nucleases and restriction enzymes
  - physics of phage DNA packaging
- Additional laboratory methods covered
  - students contributed finishing data on Pumpkin genomic DNA sequence
- Skills covered to prepare students for subsequent core courses
  - statistical analysis and graphic representation of plaque size data
- Student-directed journal discussion topics relevant to Pumpkin genome findings
  - Pnkp and RNA repair; Zhu et al., J. Biol. Chem. 279:26358 (2004)
  - Lsr2 and bacterial growth, lysogen stability; Arora et al., J. Bact. 190:4291 (2008)
  - Tmp domain motif and infection; Piuri and Hatfull, Mol. Micro. 62:1569 (2006)
  - Phamily 62 nuclease and phage DNA replication; Giri et al., J. Bact. 191:959 (2009)
- Things we would like to try in the future
  - include a cell staining and microscopy lab, examine *M. smegmatis* host strain
  - cover bioinformatic algorithm principles in greater detail
  - introduce students to basic programming

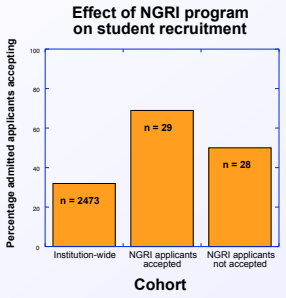
B. Classroom dynamics

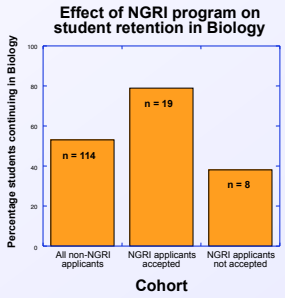
- Fall - students worked independently to isolate phage and analyze phage genomic DNAs
- Spring - 4 teams of 5 students, each analyzed ≈25% of the Pumpkin genomic DNA sequence

C. Student assessment

- Fall - emphasized written presentation with laboratory notebook and journal article-style final report
- Spring - emphasized oral presentations with group journal discussions and final seminar-style report

V. Student Recruitment and Retention Outcomes





2008/09 PGR Course - The Year in Review