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The Phage Genomics Research Program -Authentic Research for First Year Students

Aaron Best Hope College, best@hope.edu

Joseph Stukey Hope College

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The Phage Genomics Research Program – Authentic Research for First Year Students

Dr. Aaron A. Best and Dr. Joseph Stukey Department of Biology, Hope College

I. Abstract

The Hope College Department of Biology is entering its 6th year of the Phage Genomics Research Honors Laboratory course offered to first-year college students as an alternative to the standard Hope College Introductory Biology lab. This course is part of a national experiment to improve education in the sciences led by the Howard Hughes Medical Institute: Hope College was selected as one of 12 institutions nationwide to pilot this program. Students for the honors laboratory course at Hope College were selected from a restricted pool of applicants earning high scores on the ACT and/or SAT college entrance exams and showing an interest in science. Lab sessions ran twice a week for a total of 5 hours in the fall (phage/DNA isolation semester) and 4 hours in the spring (bioinformatics work). 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 three or four, analyzed the sequenced genome, and highlighted their findings in student-driven journal article discussions and group oral presentations. During the first 5 years of the program, 98 of 99 students successfully isolated novel mycobacteriophage from the Holland area and 11 of the phage genomes have been sequenced. The HHMI course outline has been supplemented with additional laboratory and analysis skills during the fall semester based on subject material covered in the standard Hope College Introductory Biology core course. This included statistical analysis (phage plaque size) and microscopy (differential staining of the host strain, M. smegmatis). During the spring semester students have been introduced to computer programming and bioinformatic databases through a series of individual and group assignments. The phage program has been highly successful for recruitment and retention of high quality students to Hope College, the Division of Natural and Applied Sciences, and the Department of Biology.

II. Introduction

A. HHMI Science Education Alliance

- · Enhance undergraduate education in sciences
- · Target incoming first-year students
- · Immerse students in year-long authentic research experience · Hope College one of original 12 institutions selected to participate from across the nation, now expanded to ~80 institutions
- · Applicants with ACT Science Subject Score ≥30 and Indicating some interest in science (any discipline) invited to apply to the Hope College Phage Program

B. Mycobacteriophage Biology and Genomics

- · Mycobacteria species cause tuberculosis, affecting 1/3 of people worldwide
- · Bacteria are infected by viruses called phage
- · Phage allow for study of mycobacteria through enhanced genetics. understanding of how phage contribute to bacterial biological processes
- · Full genome sequences of phage reveal novel functions, genes, and evolution of mycobacterial phage and hosts

2008-2009



manda Barber	Phantom	Courtney Long	Clslowpoke
ebekah Chew	Caviar	Christine Murray	Paige
effrey Corajod	JamesB007	Caitlin Peirce	Pumpkin
nne Georges	Scout	Luke Peterson	JimmyP
atherine Harmon	Scallywag	Andrew Rose	Dutchmen
rin Hildebrandt	Somtia	Dale Schipper	Langerak
rica Jansen	Cheerio	Jessica Simmons	Chumley
ustin Knutter	Roxas	Robert Sjoholm	Lars
ruce Kraay	Nemo2	Ingrid Slette	Varg
ennifer LaRoche	RuthieJr	Angelica Willis	Kellix

III. Phage Genomics Research Course Overview

Goals for the Program

2009-2010

Casey Baxte

ward Dobb

Anthony Gasparot

abeth Ge

Create unique laboratory based experience for first year students conducting authentic research Create cohorts of high quality students within Department and Division

Increase recruitment and retention of students into Biology and STEM fields



Vignette: GRAND CHALLENGE - How do you focus sequencing efforts on finding truly novel phage? PhIND: Phage Identification of New Digests

Jassica Kozac

Leah LaBarge

laceica La

Megan Ludwig

Marshall Willer

Timothy

Ender

erseid

JoeDirt

Caracal

A Java program was written to autonomously give list of possible clusters for newly isolated phage (Carl Deeg, 2012) tum with Known Mycobacteriopha ationships of 60 sequence ted from Hatfull G.E. et al. J. Mol. Biol. 201



Alexandra Benson	Lynx	Taylor Mann	Optimus
David Blystra	Nuria	Danielle Mila	Gremlin
Rachel Butts	Aurora	Shayla Patton	TheCube14
Catherine Calyore	Redrum	Caitlin Ploch	Creed
Christopher Davis	Auriole	Matthew Ringel	Goosebump
Guillermo Flores	Raskolnikov	Austin Roblyer	Kroo
Lauren Janness	Cowboy	Daniel Schreimer	BigPoppa
Kelsey Jeletz	Quin	Jonathan Turkus	Speck2x
Joshua Kammaraad	Casalina	Holly Vander Stel	Tube

IV. Outcomes of Hope College Phage Program



Hope College Student Retention* and Phage Program

	Cohort	Hope College All Students	Hope College Students with Science ACT ≥30	Phage Program Students
	2008	79%	85%	95%
	2009	78%	84%	89%
*Calculated based on four year fall enrollment rates				

Phage Program Students Declare STEM Majors

Cohort	Biology 240 Students in Biology and BMB	Phage Program Students in Biology and BMB	Phage Program Students in All STEM Fields
2008	16%	50%	80%
2009*	20%	42%	63%

*Declared majors for cohort's 3rd year - not all students may have declared

Impacting Students

Students do science

Propels students toward leadership in the division

Inspires early and sustained participation in research programs

Forges lasting relationships among students cohort building

Students achieve national recognition

2012-2013



 Beckman Research Scholar Awards · ASM Undergraduate Research

Fellowship

Student Achievements

Publications: 3 in peer-reviewed

Presentations: Numerous student

presentations at local, regional and

national scientific meetings - oral and

journals from phage program

poster

Awards:

 HHMI EXROP Award · Multiple external Summer Research

Program awards Conference presentation awards for

best posters/oral presentations

2011-2012



laria Eguiluz	MiniMe	Nicholas North	Grub
itchell Gage	DrMcNinja	Heather O'Connell	Phoebe
ric Hederstedt	Phineas	Amanda Porter	AdialP
rista Hoevemeyer	Echo	Amber Prins	Phantasmic
ameron Holder	Pherb	Shaylyn Pritchard	SquishE59
ze Loubser	Confuzzles	Peter Schemper	Bland
ndrea Matthew	Ringer	Ashley Tiemeyer	Boe26
sa McClellan	Glen	Andrew Valesano	Patronus
eth Menzer	Pest	Amy VanderStoep	Phil
opiallo Meuror	ObStandar	Joohug Malash	Resetes

Impacting Hope College

Creates new learning communities at Hope Strengthens national reputation as a leader in science education

Attracts high quality students to Hope College

Enhances retention of high quality students at Hope College

Extends beyond the discipline of Biology to all STEM fields

Yields new research, collaboration, and funding opportunities

Encourages development of phage-like research courses throughout the division

Provides a model for extending authentic research experiences to a broader student population

Acknowledgements

Five years of students willing to try something different University of Pittsburgh Hatfull Lab Howard Hughes Medical Institute SEA-PHAGES Program Hope College Department of Biology Faculty Dr. Rob Eversole, Western Michigan University



homas D'Addario	Reepicheep	Julia Schuman	BroFist
Jlie Day	TweedleDee	Mark Stukel	Seer
arl Deeg	Revan	Lucas Tans	Chaser
ustin Hiemstra	Turbo	Miriam Thomas	Walter
aura Johnson	Juliette	Miranda Ulmer	Rafikki
fatt Karrsen	Inventum	Hana VanderVeen	Lyndzie
elsey King	Thing1	Cassie VanWynen	Mahalo
Irittany Leonard	Meeko	Danny Vessels	Nocturnal
Vrake Neilands	Kaladin	Tori Viveen	Scamp
lick Owens	Hoosier	Matt Weiss	Nutello



