

# 2014

# Project Biotech

## Summer Camp Report



### *PROJECT BIOTECH Team:*

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## 2014 PROJECT BIOTECH Summer Camp: Year 1 Report

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*Program Coordinator: Reitha Weeks, PhD*

*Program Advisor: Guy Hamilton, PhD*

### Overview

The Shoreline Community College (SCC) Biotech Program and the Amgen Biotech Experience (ABE) program partnered with the Institute for Systems Biology (ISB) to develop a one-week summer camp for high school students called **PROJECT BIOTECH**, held at SCC July 7-11, 2014, from 9:00AM to 4:00PM daily. While the Puget Sound region is home to many diverse summer camp experiences for teenagers, few focus exclusively on the life sciences (i.e., biology and biotechnology). **PROJECT BIOTECH** is designed to provide an immersive science experience for up to 24 campers, including biotechnology curricula from the ABE program and bioinformatics curricula from the Northwest Association for Biomedical Research (NWABR) and Digital World Biology (DWB). The camp also includes science, technology, engineering and mathematics (STEM) career exploration activities, such as panel discussions with local STEM professionals. **PROJECT BIOTECH** is administered by ABE Program Manager Adrienne Houck, ISB Project Manager Dr. Dina Kovarik, and **PROJECT BIOTECH** Program Coordinator Dr. Reitha Weeks, in consultation with Dr. Guy Hamilton, Biology/Biotechnology Program Chair at SCC.

### Camp Goals

The goal of **PROJECT BIOTECH** is to provide high school students:

- Hands-on, authentic biotechnology laboratory experiences
- An understanding of bioinformatics – how computers are used to organize and analyze biological information
- Exploration of STEM-related careers, educational opportunities at SCC, and career opportunities in the Puget Sound biotechnology community

### Financial Support

The camp was made possible by a \$12,000 seed grant from SCC's Innovation Fund and sponsorships for financial-need camp participants provided by local biotechnology companies Novo Nordisk, Dendreon Corp., Illumina, Inc., and Amnis/EMD Millipore. A sponsorship was also provided by Travelmore / Travel Leaders. Student registration fees collected in Year 1 will fund another camp in Year 2, with additional grant funds and sponsorships providing camp opportunities to students who would be precluded from participating for financial reasons.



## Data Collection

All campers were asked to complete anonymous, numerically-matched pre- and post-camp surveys to evaluate their perceptions of their awareness, skills and knowledge of life sciences and related STEM careers. The pre-camp surveys also included questions about camper demographics. The post-camp surveys included retrospective questions which asked campers to rate their perceptions “before” participating in this camp and “now” (i.e., post-camp). Inclusion of retrospective survey questions in addition to traditional pre/post questions is helpful when participants may over or underestimate their pre-program knowledge or perceptions related to terms or procedures of which they have little prior knowledge (such as specific STEM-related terminology). The breadth and depth of their knowledge may only become evident to themselves after workshop completion. Surveys were administered on paper, and were designed to take no more than 10 minutes each. Optional open-ended responses regarding the workshop and suggestions for improvement were collected at the end of each day on “Stars & Wishes” evaluation forms, in which campers were asked what they enjoyed or found most useful about that day (i.e., “Stars”), and what they would like done differently or their remaining unanswered questions (“Wishes”). Statistical analyses were performed with GraphPad Prism 5 for Windows. Pre-/post- and before/now responses were analyzed with nonparametric t-tests (Wilcoxon matched-pairs signed rank test).

## Characteristics of Participants

Recruitment of campers began in April, when SCC Innovation Funds were awarded. While this was a late start for recruitment for a summer program, the camp quickly filled with 24 registrants plus eight students on the waiting list. Students were recruited through SCC’s Running Start school coordinators, existing ABE and ISB teacher networks, especially prior ABE professional development teacher workshop participants and high school students who applied for, but did not receive, ISB summer internship positions. Of the 24 campers who registered for the workshop, 23 attended (Table 1).

Campers came from 13 schools in nine school districts. Almost half (48%) of the participants were female (Table 1). Seven campers received financial need-based scholarships. Two of these campers qualified for free or reduced price meals during the previous academic year, and five were from families experiencing temporary financial hardships (i.e., illness or long-term unemployment of one or both parents). Campers ranged in age from 13 to 18 years old (mean = 15.6), and were predominantly white, non-Hispanic/Latino, Asian, or multi-racial. Most (87%) indicated on the pre-camp survey that they planned to attend college, and this rate remained unchanged on the post-camp survey. Interestingly, approximately half (57%) of students had at least one parent who worked in a STEM-related field. Some studies suggest that students are more likely to major in a STEM field if at least one of their parents is occupied in a STEM-related career (Leslie, McClure, Oaxaca, 1998; Harwell, 2012). Recruiting young people to PROJECT BIOTECH whose parents are not employed in STEM, or who might otherwise lack STEM role models, is an important goal of the PROJECT BIOTECH program.

**Table 1. Characteristics of 2014 PROJECT BIOTECH Camp Participants.<sup>a</sup>**

<b>Camp Participants (N=23)</b>	
<b>Mean Age (Range)</b>	15.6 (14-18)
<b>Grade in School</b>	22% Rising High School Freshman (5) 26% Rising High School Sophomore (6) 30% Rising High School Junior (7) 17% Rising High School Senior (4) 4% Rising College Freshman (1)
<b>Gender</b>	48% Female (11) 52% Male (12)
<b>Ethnicity</b>	87% Non-Hispanic White (20) 4% Hispanic (1) 9% unknown (2)
<b>Race</b>	78% White (18) 0% Black/African American (0) 13% Asian/SE Asian (3) 4% American Indian (1) 4% Alaska Native (1) 0% Native Hawaiian (0) 4% Pacific Islander (1) 22% Two or More Races (5) 4% Other: Middle Eastern (1) 4% Unknown (1)
<b>Scholarship Recipients</b>	9% Free & Reduced Price Lunch Recipient (2) 22% Family Need (5)
<b>Plan to Attend College</b>	87% Yes (20) 0% No (0) 4% Unsure (1) 9% Unknown (2)
<b>Parents or Guardians work in STEM</b>	57% Yes (13) 35% No (8) 9% Unknown (2)
<b>School Districts Represented by Campers</b>	4% Bellevue (1) 35% Edmonds (8) 4% Kent (1) 9% Monroe (2) 9% Mukilteo (2) 22% Northshore (5) 9% Seattle (2) 4% Shoreline (1) 4% Snohomish (1)

<sup>a</sup> Percentages of individual items might not equal 100% because of missing responses, rounding, or classification of individuals into multiple categories.



## Camp Content

### BIOTECHNOLOGY

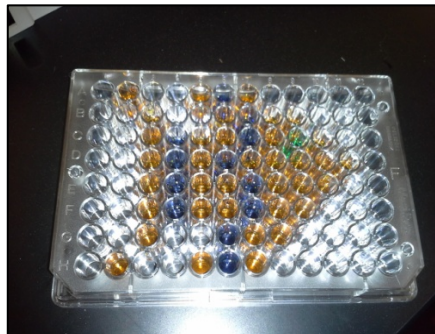
This one-week camp introduced campers to common biotechnology and molecular biology techniques using DNA cloning of red fluorescent protein (RFP) and DNA barcoding as models.



With ages ranging from 13 to 18 years old, campers learned the importance of collaboration by working together with lab partners throughout the week.



Students began the week by practicing their micropipetting skills making “suncatchers” with food coloring and 96-well plates (bottom, right) and purifying DNA from their cheek cells (far right).





By the end of Day 1, campers had also learned about plasmid DNA, restriction digestion, gel extraction, and agarose gel electrophoresis.



Campers worked through the laboratory activities and hands-on training with the following Amgen Biotech Experience activities:

- *Laboratory 2: Restriction Analysis of pARA and pKAN-R;*
- *Laboratory 3: Ligation of pARA/pKAN-R Restriction Fragments: Producing a Recombinant Plasmid, pARA-R;*
- *Laboratory 4: Confirmation of Restriction & Ligation Using Agarose Gel Electrophoresis; Transforming Escherichia coli with a Recombinant Plasmid; and*
- *Laboratory 6: Overnight Culture of Escherichia coli.*

Campers also trialed an adaptation of the ABE curriculum – gel extraction of the digested RFP “insert” and cloning vector using the Quantum Prep™ “Freeze N’ Squeeze Gel Extraction” protocol.



Throughout the camp, everyone was encouraged to document their work by taking pictures. The photo on the left shows campers taking pictures of their agarose gels, made possible by the cutting-edge GelRed™ Nucleic Acid Gel Stain from Biotium, which illuminates DNA when exposed to an LED light.



Campers, parents, sponsors and other members of the community are encouraged to follow Project Biotech on Twitter **@ProjectBiotech**. Check out the 2014 feed using **#PBT2014!**



## BIOINFORMATICS

Campers also learned about “bioinformatics,” the application of computers in the biological sciences to organize and analyze biological data, using DNA barcoding as a model.

**DNA barcoding** is a taxonomic method that uses a short segment of an organism's DNA to identify it as belonging to a particular species (Folmer *et al.*, 1994; Herbet *et al.*, 2003). For animals, the mitochondrial-encoded cytochrome c oxidase subunit 1 (*COI*) gene is used (Folmer *et al.*, 1994). Barcoding can be used to catalog and confirm the discovery of a new species, or to identify the species of an unknown sample.

Using the NWABR and DWB advanced bioinformatics curriculum, *Using Bioinformatics: Genetic Research*, campers explored DNA barcoding of animal and insect specimens of their choice with wet lab experiments including DNA purification, polymerase chain reaction (PCR), and agarose gel electrophoresis. Campers generated their own DNA sequence data, which they learned to analyze with the bioinformatics programs BLAST (Basic Local Alignment Search Tool) and FinchTV.



They also used the molecular visualization programs Cn3D (available through the National Center for Biotechnology Information (NCBI)) and Molecule World™ (a new iPad app developed by Digital World Biology) to visually explore the three-dimensional structures of DNA and various fluorescent proteins, including RFP and green fluorescent protein (GFP).



## STEM CAREER EXPLORATION

To increase campers' awareness of, and interest in, STEM-related careers, a series of activities provided an overview of the process of drug discovery -- from initial laboratory experiments through clinical trials and marketing. This provided background for the seven visiting STEM professionals who participated in two career panels on Days 3 & 4 of the camp. These panelists included:

- **Kaytlyn Beres**, a graduate student in the University of Washington Department of Bioengineering. Ms. Beres works on the development of cardiomyocytes (cardiac cells) that are derived from human stem cells for regenerative medicine and disease modeling.
- **Phil Kong, PhD**, a Research Scientist at Novo Nordisk. Dr. Kong is responsible for developing new ideas and targets for the treatment of autoimmune diseases such as rheumatoid arthritis, lupus and inflammatory bowel disease.
- **Cindy Pekow, DVM**, Chief of the Veterinary Medical Unit at the Veterans Administration and Clinical Associate Professor in the Department of Comparative Medicine at the University of Washington. Dr. Pekow is a veterinarian, specializing in research animal care, working with researchers, animal care staff, and animals (mostly mice and rats, some other species including rabbits, dogs, and pigs). She advises and trains on care, research techniques, and prevention of pain or distress in animals.
- **Theresa Proctor**, Senior Manager of Facilities & Sourcing at Novo Nordisk. Her responsibilities include design, space use, build-outs and facility projects, management of supplier relations, and vendor & consultant contracts and agreements, as well as supervision of laboratory operations.
- **Kristin Rand, JD, MA**, Executive Director of Compliance at Seattle Genetics. Ms. Rand oversees the company's Compliance Program and commercial legal matters.
- **James Trager, PhD**, Vice President of Research & Product Development at Dendreon. Dr. Trager works primarily on targeted cancer therapeutics, including Provenge, the first approved cellular immunotherapy for cancer.
- **Sam Tran, MT**, a Senior Associate Scientist in the Pathology Department at Amgen, Inc. Mr. Tran works in the field of laboratory automation, using the Agilent VWorks software to build protocols that the DDR robot executes.

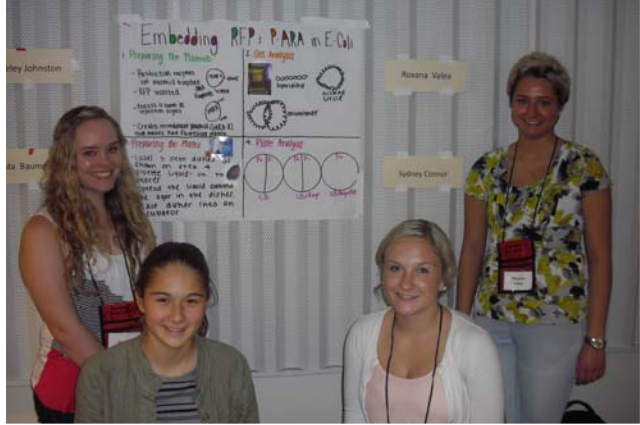


STEM professionals shared their educational pathways, experiences and advice. Left to right, Kaytlyn Beres, Dr. Phil Kong, Kristin Rand, Sam Tran, Dr. Cindy Pekow, Dr. James Trager, Theresa Proctor.



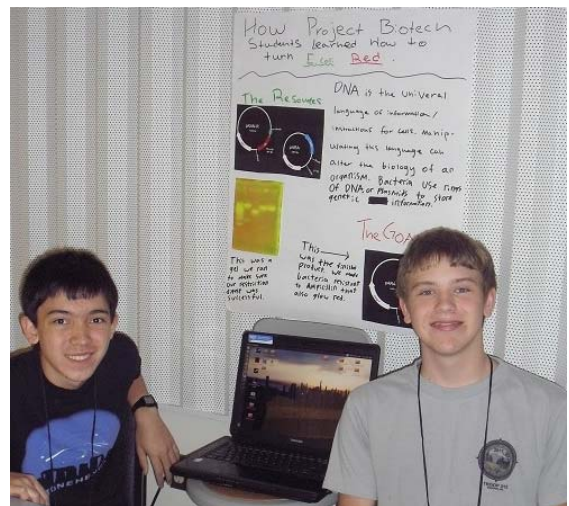
## SHOWCASE OF LEARNING

On the final day of the camp, parents, teachers, friends, staff, and members of the education, political, and biotechnology communities came together to learn from campers about the highlights of the week – what they learned and what they enjoyed the most.



**At the Showcase of Learning, campers shared what they enjoyed most during PROJECT BIOTECH.**

Clockwise from upper left: demonstration of how to visualize transformed *E. coli* expressing RFP; two groups of campers explain the steps involved in cloning RFP; a camper talks about his experiences with agarose gel electrophoresis and his experiences as an Iraqi refugee; a hands-on demonstration of micropipetting; detailed instructions of micropipetting; and an explanation of DNA sequencing.



All campers were encouraged to make a poster that included the name(s) of their selected experiment(s) and/or activity. Some campers chose to demonstrate laboratory techniques such as micropipetting or agarose gel electrophoresis; some campers worked alone, while others worked in pairs or small groups. Many campers included a tour of the SCC Biotechnology lab in their presentations, and some encouraged Showcase attendees to use the laboratory equipment and reagents.

To view video highlights from the 2014 **PROJECT BIOTECH** summer camp visit:

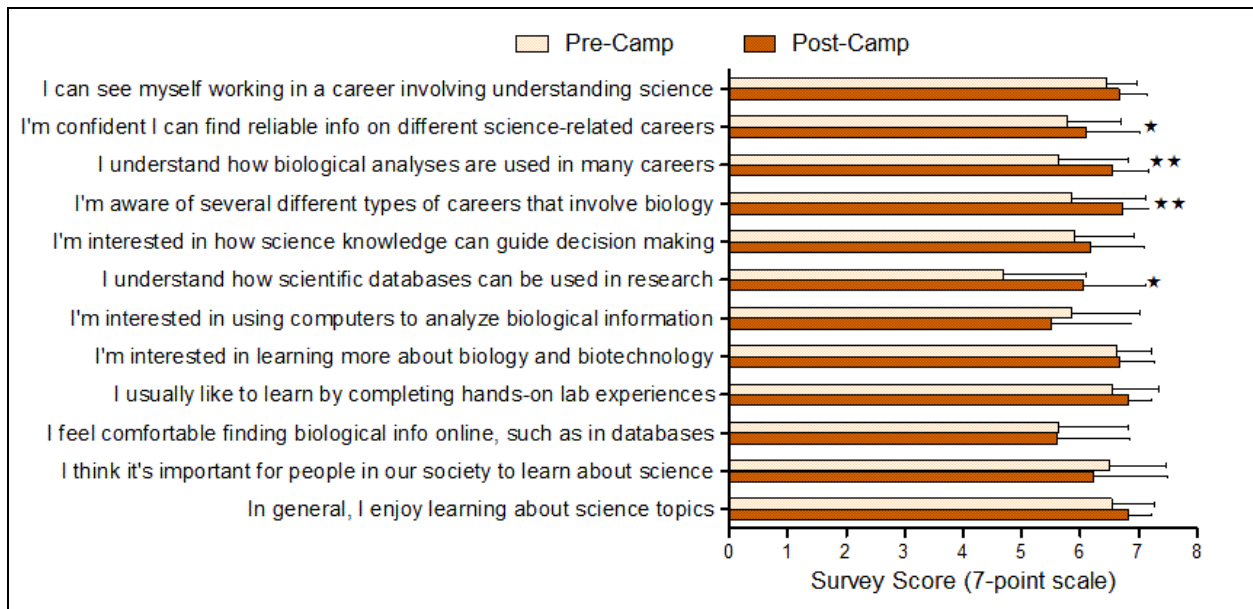
<http://bit.ly/PBT2014>

## Camp Evaluation Results

Among campers who completed pre-camp (N=22) and post-camp (N=18) surveys, post-camp gains were made in almost all areas surveyed (Figure 1). Significant self-reported pre/post-camp gains were observed in the following areas:

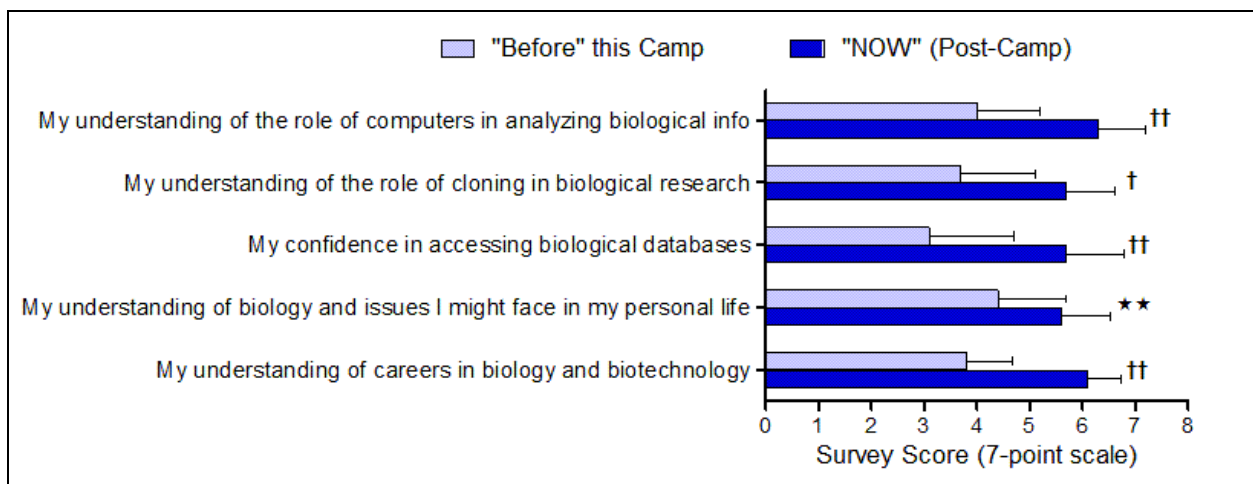
- Understanding how databases that store biological information can be used in research
- Awareness of different types of careers that involve biology
- Understanding how the analysis of biological information can be used in different careers
- Confidence in the ability to find reliable resources on the use of science in different careers

Prior to the camp, campers indicated a high level of interest in learning more about biotechnology and biology (mean = 6.64 on a 7-point scale), enjoyment in learning about science (mean = 6.55), and enjoyment in learning by completing hands-on activities (mean = 6.55). Post-camp scores on these questions were similarly high (means = 6.68, 6.83 and 6.83, respectively). There was a modest, though non-significant decrease in campers' interest in using computers to analyze biological data (pre-camp mean = 5.86 versus post-camp mean = 5.50). This could be due to the numerous technological issues experienced during these activities, including intermittent internet connection problems, uncharged laptop batteries, a shortage of laptops and power cords, and the unfamiliarity and/or unpopularity of Apple computers among many camp participants.



**Figure 1: Pre- and Post-Camp Survey Responses among 2014 PROJECT BIOTECH Summer Camp Participants.** Responses represent sample means and standard deviations. P-values are reported as \*  $p \leq 0.05$  and \*\*  $p \leq 0.01$ .

Retrospective questions on the post-camp survey asked participants to rate themselves “before” the camp (retrospectively) and “now” (at the end of the camp). Campers demonstrated statistically significant gains of 1.2 to 2.7 points on all retrospective survey items following the one-week camp (Figure 2). The largest reported gains were on questions measuring campers’ understanding of careers in biology and biotechnology (mean 2.7 point gain), confidence in accessing biological databases (mean 2.6 point gain), and understanding of the role of computers in analyzing biological information (mean 2.3 point gain).



**Figure 2: Post-Workshop Retrospective Survey Responses 2014 PROJECT BIOTECH Summer Camp Participants.** Responses represent sample means and standard deviations. P-values are reported as \*\*  $p \leq 0.01$ , †  $p \leq 0.001$  and ‡  $p \leq 0.0001$ .



**STARS & WISHES** daily program evaluation forms were the primary method for open-ended camp feedback from participants. Selections of campers' quotes are listed below.

*"[I] Did more experiments than the entire last school year."*

*"I like how there are so many labs & hands-on experiences!"*

*"Interesting labs. Advanced! I learned a lot."*

*"I really enjoyed all of the labs and explanation was good. I was happy we got to do things I was passionate about."*

*"This camp is an amazing experience!"*

*"I thought everything was run really well and I enjoyed it a lot."*

*"I really enjoyed our labs and being able to walk around campus. It was nice to have explanation because I didn't know some of the stuff."*

*"I really enjoyed the lab today. DNA barcoding should be done every year."*

*"Learning about the different jobs in the biotech industry was cool. (I liked the panel.)"*

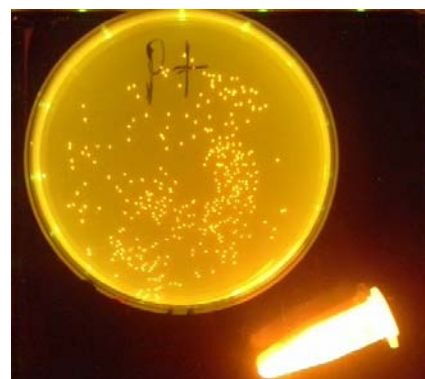
*"I enjoyed finishing up the lab and being able to use the database. Also, I am really enjoying working with my partner."*

*"Thank you so much for letting us redo experiments to see different results. I love seeing why and how results change. Also, I loved all of the cool resources and tools you introduced to us. I can't wait to explore them more."*

*"I really liked that you wanted us to do the transformation again. It was nice that you cared about us to do it again."*

*"Getting to see the RFP under the light."*

*"I really enjoyed being able to work on an individual project that we didn't have a set procedure for."*



Giving campers the opportunity to repeat failed experiments ensured that everyone was able "to see the RFP under the light."



*"No grades! Yay!"*

*"How much time we were given for presentations. Thanks for all the help explaining processes."*

*"Seeing structures on the computers and especially iPads were really cool. Liked having time to prepare for Showcase."*

*"It is kinda upsetting that we might not be able to do something like this maybe till college again!"*



*"I wish it was longer than one week."*

*"I wish that you explained the DNA more specifically for me because I was not coming at a scientific background. So I kinda got side tracked, and lost focus."*

*"More instruction given to people during labs because some people may not know exactly what is happening and unfortunately do not correctly read the procedure messing up their experiment for them as well as their partner."*

*"I wouldn't change anything. I just wish our computers would have worked!"*

*"Have the computers more prepared. It would have gone much smoother if the computers were charged or we had enough cables."*

*"I think it would be really cool to have a time where we could each pick an experiment to either try or redo and then work on that experiment on our own."*

*"Also focus not only on biotech, but also biochem and other sections of science, but still involving biology."*

## Future Directions

Feedback from campers, parents, PROJECT BIOTECH staff, teachers and community members has led to a number of suggestions for improvement during Year 2 of PROJECT BIOTECH.

### **1. Offer different camps for younger versus older campers.**

The wide range in campers' ages and experiences led to a number of opportunities for pairs of students with more or less laboratory experience to work together and learn from each other. However, the knowledge gap between rising freshman / sophomores and rising juniors / seniors was an impediment to learning and participation for some campers. As one camper noted on his/her "Stars & Wishes":

*"IMPORTANT NOTICE: Can we have 2 camps because for incoming 9<sup>th</sup> graders, this camp right now is difficult because I don't have a year of biology curriculum that all the other students have. I feel lost at times and sometimes don't know what the discussion is about. One completely introductory class, and the levels after that."*

Creating at least two camps – one for campers with no laboratory experience and one for campers with some laboratory experience – was suggested by at least two campers and all PROJECT BIOTECH staff. The 'introductory' camp should be designed to prepare campers for participation in subsequent 'advanced' camps. Other campers noted that information about STEM career options may not be as relevant or engaging for younger campers, but is of the upmost priority for older campers applying for or ready to attend college. Therefore, 'advanced' camp(s) should also offer opportunities for deeper STEM career explorations, including additional career panels and tours of local research institutions.

### **2. Provide more opportunities to repeat failed experiments.**

Many campers learned that 'failure' is an integral part of science. Experiments rarely work the first time that they are attempted, and many campers expressed the desire to repeat experiments and learn from their mistakes. While this was possible for some experiments during Year 1 of PROJECT BIOTECH, explicitly planning for this in future camps will more accurately model the realities of scientific practice.

### **3. Offer additional camps each summer.**

Most campers were eager and ready to participate in additional camps as soon as they are available. Anticipating that this may be the case, campers were asked for suggestions of future camp topics or themes (Table 2). Based on the expertise of PROJECT BIOTECH staff and participating partners (such as Amgen, ISB and Novo Nordisk), a top candidate for an advanced Year 2 camp is "Biotechnology & Human Health," which could include laboratory and bioinformatics activities related to infectious diseases, personalized medicine (genetic testing), and cancer.

**Table 2. Topics for Future Summer Camps Suggested by 2014 Camp Participants.<sup>a</sup>**

	Student Votes (N=18)	Mean Rating	Range of Ratings
<b>Global Health and Infectious Disease</b> (such as HIV and malaria)	17	5.941	4-7
<b>Understanding Human Health</b> (such as diabetes, cancer, and genetic testing)	18	6.056	4-7
<b>Evolution and Species Diversity</b> (such as DNA barcoding)	15	5.600	4-7
<b>The Process of Drug Discovery</b> (including lab experiments involved in making treatments for human diseases)	17	5.706	3-7
<b>Write-In Topics</b>			
<ul style="list-style-type: none"> <li>• “Brain functioning”</li> <li>• “What problems can viruses cause.”</li> <li>• “General topics about deadly diseases that affect our population”</li> <li>• “Biodiesel &amp; other biofuels”</li> <li>• “Clinical effectiveness, Biochem”</li> </ul>	1 each	Each was rated “7”	n/a

<sup>a</sup> Percentages of individual items might not equal 100% because of missing responses, rounding, or classification of individuals into multiple categories.

#### **4. Optimize program logistics.**

Minor adjustments to the camp program could ensure greater camper engagement and attainment of program goals. In addition to the suggestions above, these adjustments include:

- Hosting career panels in classrooms, not in the Biotechnology Lab, where ambient noise levels are lower.
- Hosting computer activities in a dedicated computer lab, and/or encourage students to bring and use their personal computers, to reduce the incidence of IT-related issues.
- Begin recruitment of campers earlier in the school year, with specific emphasis on low-income/high-need schools and districts.
- Increase camp funding via sponsorships, grants, and on-going institutional support to provide additional need-based scholarships and to fully pay PROJECT BIOTECH staff for time spent in preparation and execution of the summer camp.
- Expand the PROJECT BIOTECH web presence to facilitate recruitment, funding, and sharing of camp activities.
- Require a letter of recommendation from a teacher for scholarship recipients.

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## The 2014 PROJECT BIOTECH Team

