AN EVALUATION OF THE
2016 GLOBAL ENVIRONMENTAL MICROBIOLOGY (GEM)
SUMMER COURSE FOR UNDERGRADUATES

Executive Summary

Prepared for:
Center for Dark Energy Biosphere Investigations (C-DEBI)

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INTRODUCTION

The Center for Dark Energy Biosphere Investigations (C-DEBI) NSF Science and Technology Center offered a four-week summer program at USC and the Wrigley Marine Science Center on Catalina Island: the Global Environmental Microbiology (GEM) program. From early June to early July, 2016, 15 undergraduates attended lectures and lab classes, conducted hands-on research, and participated in field trips and social activities. One additional student began the program, but left for medical reasons.

Methodology

A few weeks before they arrived for the program, students completed an online pretest survey, designed in conjunction with GEM program staff; questionnaire completion took an average of 38 minutes. Questions included goals and concerns about the upcoming summer course, career plans, and familiarity with the course content, including 13 short-answer science concept questions.

At the end of the course, students completed a proctored online survey (posttest) at the Catalina facility, also designed with the GEM program staff. Questionnaire completion took an average of 58 minutes. Questions included satisfaction with the course, course impact on knowledge and career goals, knowledge of course content, and suggestions for course improvement.

Participant Demographics

All 15 participants completed both the pre- and posttest surveys, for a completion rate of 100%. Participant demographics were as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>60%</td>
</tr>
<tr>
<td>Male</td>
<td>40%</td>
</tr>
<tr>
<td>Sophomore</td>
<td>47%</td>
</tr>
<tr>
<td>Junior</td>
<td>47%</td>
</tr>
<tr>
<td>Senior</td>
<td>6%</td>
</tr>
<tr>
<td>African American</td>
<td>13%</td>
</tr>
<tr>
<td>Alaskan Native</td>
<td>--</td>
</tr>
<tr>
<td>Asian</td>
<td>7%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>53%</td>
</tr>
<tr>
<td>Native American</td>
<td>--</td>
</tr>
<tr>
<td>Native Hawaiian/Pacific Islander</td>
<td>--</td>
</tr>
<tr>
<td>White</td>
<td>20%</td>
</tr>
<tr>
<td>Other (“Chicano,” “Lebanese”)</td>
<td>13%</td>
</tr>
</tbody>
</table>

(students could choose more than one ethnicity)
Colleges and universities represented include:

- Barnard College, NY
- California State University, Fullerton
- College of the Sequoias, Visalia, CA
- Kapiolani Community College, Honolulu
- Los Angeles Valley College, CA
- Mt. San Jacinto College, Menifee, CA
- Norco College, CA
- Rio Hondo College, Whittier, CA (2)
- Santa Barbara City College, CA
- Santa Rosa Junior College, CA
- University of Pikeville, KY (2)
- Virginia Commonwealth Univ., Richmond
- Wallace Community College, Selma, AL
- Xavier University of LA, New Orleans

Most of the students (85%) had already declared an undergraduate major—all declared majors were in a STEM field, and most related to the biological sciences. Most say they probably (27%) or definitely (60%) hope to have a career in science.

This document provides a summary of the responses. Complete data for both the pre- and posttest surveys are provided in the Appendix. Participant comments were copied directly from the online survey and were lightly edited for spelling and punctuation.
SUMMARY OF FINDINGS

Overall, this sixth summer of the GEM program was again a success, with appreciative students who learned a great deal of content and skills from the course.

1. Satisfaction with the GEM program

- Students felt the course was a worthwhile experience.

- Exposure to both labwork and fieldwork was an essential component of the course. Students appreciated being able to compare the two experiences and to travel a bit as well. This is an especially salient benefit since most of the participants are from community colleges or liberal arts universities.

- A strong benefit of the course is seeing “how science really works.” Following a project from start to finish helped participants get a feel for what a career in science would entail.

Suggestions:

- Many students mentioned that the lab experiments needed more planning and explanation. Sometimes, they did not see the connection between what they were learning and the hands-on labs.

- The pre-course information needed more detail—a full schedule and itinerary, what to pack, what they were going to be doing.

2. Impact on participants’ career goals

- For many students, the program impacted their educational and career goals. Although all began the program with an interest in a scientific career, this program cemented that interest and gave them direction as to how to achieve that goal. Mentoring by the course professors and TAs, as well as others they met at Wrigley, furthered this benefit.

Suggestions:

- C-DEBI should continue to follow-up with program alumni to track their career progress and determine how the GEM program has influenced their educational and career choices.
3. Impact on knowledge of course content

- Student’s understanding of most of the relevant scientific concepts grew significantly as a result of the course.

Suggestions:

- The program should examine the content areas in which students’ posttest scores are low to see if the curriculum should be modified.

4. Inclusion and diversity

- Students appreciated the program’s focus on diversity and inclusion. A few of last year’s students had wished the program addressed issues of why minorities are underrepresented; this year’s program “discussed and celebrated” diversity.

- However, one white student felt “not as special.”

Suggestions:

- The program should continue to address the needs of underrepresented students while making white students feel at home as well.
COMPARING THE GEM PROGRAM TO STUDENTS’ EXPECTATIONS

The GEM program either met (27%) or exceeded (73%) the students’ expectations.

Several students benefitted from interactions with supportive professors and TAs.

→ “I definitely did not expect for the instructors and TAs to be as helpful as they did, they were here to teach and inform not to judge and criticize. They all really boosted up my confidence throughout the program.”

→ “It differed because when I came I didn’t expect everyone to be so open and all the people in charge of the program took the time to help you if you had any struggled with any of the material.”

→ “Apart from being heavily academically based, the GEM program was very inspirational and made me learn a lot of life lessons. The interaction we got with the professors allowed me to realize the necessity of talking to professors and to not be intimidated by them. Overall, GEM did not only help me academically, it also prepared me for life.”

Several others commented positively on the quality of their colleagues.

→ “Overall, this program was an amazing experience because I got to meet a great group of people related to my field of study.”

→ “I expected this course to not be as hands on with the instructors, as well as the diversity and the quality of my peers.”

→ “At first I felt I was going to disappoint people by not being capable of properly executing the work at hand, never have I been so wrong. I was delighted to see that my peers were willing to teach, and understand when I didn’t understand. Most times someone else had the same questions as I.”

→ “Coming in to the program, I did not expect to get really close to people. We are all a family, and I believe many of us will stay in contact for a long time.”
MOST SIGNIFICANT PART OF THE COURSE FOR STUDENTS

Students derived a variety of benefits from the GEM course.

• For some, the **fieldwork** was the most significant aspect of the course—experiencing new places and comparing fieldwork to labwork.

  → “The most significant part for me was collecting samples in the Sierra and being in the field. Not only did it affirm that I love field work, I got to see a place I otherwise would have never visited.”
  → “The trip to the Sierras had the most significant impact part of the trip for me. Not only did we have nice views, but I enjoyed the allocation to both field and lab work. I wish that more time could have been spent there in order to have a better understanding of research outside an institution and in the real world.”
  → “Doing field research, as it is simpler to develop lab research abilities because there are more opportunities to work in a lab than the field, in my opinion.”
  → “I loved being able to travel to different locations for our study sites.”
  → “Personally, I think being able to see the difference between lab work versus field work was extremely significant to me. As a freshman in college, I was extremely confused as to what I wanted to study and felt intimidated by lab research in comparison to field research. Participating in the GEM program has allowed me to see that I do like working in a lab and that I could do efficient field work as well.”
  → “The most significant part of this course was learning that I greatly enjoy doing both lab work and field work.”

• For others, the most significant part of the course was the chance to experience how science really works.

  → “The most significant part of this course was being able to do what scientists do, answering a question using different types of protocols and methods and just working in a lab for long periods of time made me really realize what type of scientist I would like to become.”
  → “The most significant part of the course was learning how to conduct research to get a little taste of what it is like to be in a lab. This was important to me because I wanted to see if this would be something I would want to do as a career.”
  → “I really enjoyed meeting all the people in the program and getting a chance to learn more about them and also I enjoyed all the lab experience because I had never been in a setting like I and it helped me realized that I enjoy doing things in the lab.”
  → “Lab work, data interpretation.”
• **Learning to work in a group** was also a benefit of the GEM course.

  → “Having to complete tasks with different groups because it allowed me to develop the ability to work efficiently and effectively with different individuals.”

  → “Also, working in a group was very significant to me. I am the type of person that likes to do everything alone, but I realize that in a real life setting this will be impossible, and so working in groups allowed me to see what a real job incorporates. It allowed me to learn how to interact with people.”

  → “Working alongside like-minded people, having an open academic, scholarly atmosphere where anybody could talk about anything in science or social affairs without hesitation and guarantee a flowing conversation enhanced by varying opinions and perspectives.”

• And, of course, students learned **new content** from GEM.

  → “I enjoyed learning about DNA, everything about it really. The code of life, how sequences have different instructions and allow for either mutations or characteristics that help the individual survive. My mind was an explosions of ideas ranging from finding cures, to re-sequencing DNA, fixing mutations that leave you prone to illnesses, and things of that sort.”

  → “The part of the course that was most significant to me was the information presented in lecture by our instructors and techniques learned that were associated with the lab portion of the course. It allowed me to better comprehend the material presented in the course and gain an overall grasp on the subject in its entirety.”
Students were quite satisfied with the educational content of the GEM program.

- Students appreciated the **research experience**, with most rating it an “8” or higher on a 10-point scale. They got to experience a “real” lab. But some students felt the experiments were disorganized.

  → “The research was great, hands on experience that was the real deal, the possibility for mistakes, frustration, confusion and all the above. The feeling of reward of getting the process down and right is priceless.”
  → “The hands-on portion of this course was phenomenal. I was able to see what a real lab environment would be like and the extensive work that comes when committing to a scientific career. I really enjoyed it and I learned so much..”
  → “I have taken lab-based classes, but this opened me up to more in depth lab processes.”
  → “What we did the lab was fun but there was too much disorganization to know what was going on, why we were doing what we were doing, and the data collected wasn't explained. We also jumped from different topics or different samples a lot which made it difficult to follow.”

- The **academic course** also received strong scores, and almost three-fourths of students rated it an “8” or higher. A few students thought there was too much information given.

  → “This course allowed me to learn so much. Being one of the few students that have not taken biology before, I feel that this program gave me enough background in biology and microbiology in order to succeed in my upcoming college courses.”
  → “I enjoyed the lectures and learning about how much collaboration there is in the field of biology and just science in general. I did not feel that the academia was rigorous and difficult to understand, but it was a good review of microbiology as a whole.”
  → “It was a fun as a month-long course on microbiology could be. It wasn't as intense as I expected but certainly not a walk in the park either.”
  → “Much of the information was very interesting but too much information was crammed making it harder to understand all of it. More short breaks are necessary to maintain the audience attentive after more than an hour of lecturing, students begin to lose focus.”
The mentoring that students received was helpful and informative. Almost all students rated it an “8” or higher.

→ “Not only are we limited to the professors and TAs, but staying at the Wrigley institute I was able to meet more scientists, undergrads, and grad students, which indirectly motivates you.”

→ “We always had someone to talk to when needed, we had unconditional support.”

→ ”Every professor and TA was willing to help if asked questions. They also gave a lot of experience and guidance tips.”

The patient and helpful program coordinators also received very positive ratings; almost all students rated them an “8” or above.

→ “I feel like they took a lot of time on planning this trip, even with the discrepancies of some alterations. They were also good about allowing us to spend free time with each other and really get to know one another through the rooming process.”

→ “Very good. Our program coordinator did a great job of making our stay throughout the duration of the course comfortable.”

→ “Good discussions were directed by the coordinators about opportunities in science as well as important issues in science (i.e., diversity).”

Students would have liked more pre-program information about logistics as well as content; only four in ten rated it an ‘8” or higher. This was the lowest-rated aspect of the program.

→ “There were many informative emails sent prior to attending the program however it would be nice if the information elaborated more on the type of work that would be conducted during the program.”

→ “The information was decent, maybe more detailed information about what to pack or how much to pack.”

→ “I thought that the information before the program was a little vague in terms of what we were doing and when we were going to do it, but many of the readings and projects did help get a basic overview of what we were going to study.”

→ I just received an outline of the lab, but I had no idea what anything on that sheet meant, and maybe a full itinerary of the course so I wouldn't be completely unaware of what was to come.”
PROGRAM RATINGS: SOCIAL/EXTRACURRICULAR ACTIVITIES AND OVERALL

<table>
<thead>
<tr>
<th></th>
<th>Mean (0-10)</th>
<th>% 8,9, or 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social/Extracurricular activities</td>
<td>9.2</td>
<td>93%</td>
</tr>
<tr>
<td>Overall Program</td>
<td>8.6</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Students were very pleased with the social/extracurricular activities in the program. Almost all students rated them an “8” or higher.
  - “We went to all sorts of great, fun places that we did not have to! Taking time out of their schedules, driving and showing us around, teaching us about the wonders of the planet was amazing.”
  - “I got to see snow for the first time in my life, and swim with some sharks. It might not sound like much it can be life changing in certain individuals.”
  - “Good balance of learning, applying material to lab, and experiencing what Sierras/Catalina had to offer. Especially for out of state students, they’re in California and wanted to experience it.”
  - “The social activities were so essential to this course. I got to meet and learn about so many people within just one month. I do feel that maybe more time for certain excursions are necessary for the group to bond and the number of non academically related excursions we got were small.”

- The program overall scored extremely well—all students rated it an “8” or higher. It was a valuable and fun experience.
  - “The GEM program was very enlightening and excited me about the variety of different opportunities. GEM was also really fun and it will be recommended to many people interested in this field of study.”
  - “I met amazing people which made my experience valuable and I learned more about my own interests in the field as well as learned about more research opportunities.”
  - “It was a great experience, everything was a lot of fun and there were a lot of unforgettable moments in this course both academically and socially.”
  - “It exceeded my expectations, gave me confidence in lab, and helped me have better communication among peers and staff.”
  - “Overall the GEM program was a great experience and I would recommend the program. I learned a lot and was able to do things that I wouldn't have been able to back at home. It was an opportunity that a lot of minority students don't come across or isn't privileged to participate in.”
ATTITUDES TOWARD THE PROGRAM

<table>
<thead>
<tr>
<th></th>
<th>Mean (1-5)</th>
<th>% Agree</th>
<th>% Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worthwhile way to spend summer</td>
<td>4.9</td>
<td>13%</td>
<td>87%</td>
</tr>
<tr>
<td>Would recommend to others</td>
<td>4.8</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>Help me get ahead in my career</td>
<td>4.6</td>
<td>27%</td>
<td>67%</td>
</tr>
<tr>
<td>Introduced me to new career options</td>
<td>4.5</td>
<td>33%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Students’ attitudes toward the program were very positive.

- All students agreed (most of them, strongly) that the GEM program was a worthwhile way to spend their summer.
- All students would recommend the program (most of them, strongly) to other students at their university.
- Most students agreed that the GEM program would help their future career. One student was “neutral” as to whether or not the program would help their career.
- Most students agreed that the program introduced them to new career options. Only one student was “neutral” on this item.
Students showed a more sophisticated understanding of targeted science concepts after completing the course.

- Students came to the course with little exposure to course material, with the exception that about one-half of students knew some microbiology basics (DNA/RNA structure & function, diversity vs. abundance, bacterial growth, the difference between viruses and bacteria, and prokaryotic vs. eukaryotic cells). While students showed improvement in all these basic areas, change was statistically significant only for diversity vs. abundance and bacterial growth.

- Students demonstrated statistically significant learning of all other course concepts. Knowledge gain was largest for content for which most students had no previous exposure: bioluminescence and quorum sensing, a protocol to define microbial diversity, dissecting vs. epifluorescent microscopes, and nitrogen cycling. Note, however, that for some of these content areas, only about half the students show a strong understanding at the end of the course.
• For **oxygen effects on microbial communities**, even though there was a significant increase in students’ understanding, only about one-third of the students had mastered the concept by the end of the course.
**PROGRAM IMPACT ON EDUCATIONAL/CAREER STEPS**

<table>
<thead>
<tr>
<th>Question</th>
<th>Pretest %</th>
<th>Posttest %</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Probably</td>
<td>% Definitely</td>
<td>% Probably</td>
</tr>
<tr>
<td>Take more science classes in college</td>
<td>8%</td>
<td>100%</td>
</tr>
<tr>
<td>Major in science at a 4-year college</td>
<td>9%</td>
<td>82%</td>
</tr>
<tr>
<td>Apply to a 4-year college</td>
<td>13%</td>
<td>73%</td>
</tr>
<tr>
<td>Work in a professor’s lab for credit or pay</td>
<td>27%</td>
<td>60%</td>
</tr>
<tr>
<td>Have a career in science*</td>
<td>27%</td>
<td>60%</td>
</tr>
<tr>
<td>Conduct scientific research in the field</td>
<td>27%</td>
<td>47%</td>
</tr>
<tr>
<td>Conduct scientific research in a lab</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Teach science</td>
<td>8%</td>
<td>8%</td>
</tr>
</tbody>
</table>

See the Appendix for complete question wording and response distribution.

*Pre-post change significant at p < 0.05.

Even before entering the program, most or all of the GEM students had planned to continue with their science education. All planned to take more science classes in college, and almost all planned to major in science at a 4-year college. This did not change significantly as a result of the GEM program.

- After the GEM program, students were significantly more likely to say they definitely hope to have a career in science (80% vs. 60% before GEM).

- More students say they definitely hope to pursue a science education beyond a 4-year college (87% vs. 73% before GEM), although this different is not statistically significant.

- Both before and after the program, about two-thirds say they hope to conduct scientific research in the field, and about half say they hope to conduct scientific research in the lab.
IMPACT ON EDUCATIONAL GOALS

“How much has this program influenced your educational goals?” (posttest)
0-100, 0=“none”, 90=“new goal”

<table>
<thead>
<tr>
<th>Score Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>--</td>
</tr>
<tr>
<td>71-99 (90=“New goal”)</td>
<td>33%</td>
</tr>
<tr>
<td>51-70 (70=“Significant changes”)</td>
<td>53%</td>
</tr>
<tr>
<td>31-50 (50=”Some changes”)</td>
<td>13%</td>
</tr>
<tr>
<td>&lt; 30 (30=“Very little”)</td>
<td>--</td>
</tr>
</tbody>
</table>

(Mean impact score = 71, “significant changes”)

All students felt that the GEM program impacted their educational goals at least somewhat. For most, the program confirmed that scientific research is a strong option for their careers. Students’ educational impact ratings are indicated in parentheses after their direct quote below.

“New Goal”:

→ “This program has allowed me to see new forms of reaching my career goals. I was extremely surprised when I found out that one can pursue a PhD right after finishing a bachelor’s degree. I am sure of what I want to do now and will continue to look for different opportunities that will help me figure out the right career path within my major. Before this program I was not sure whether I really wanted to pursue a scientific career but after going over the material, talking to the professors and advisors, I realized that this is the pathway for me. Overall, this program has been extremely influential and impacting on me. I definitely see myself in a scientific career now.” (95)

→ “I wouldn't not say that it has set a completely new goal. What I can say is that this opportunity has made me realize that what I once thought to be out of the question for me, the science field, is now at my fingertips. All I need to do is keep going.” (90)

→ “Participating in this program has enlightened me to stick to my goals in the scientific field and pursue an even higher education in the future. It has showed me the life of a scientist, and more importantly what research consists of and if I wanted to do that or not.” (80)

“Significant Changes”:

→ “I discovered that I am not a fan of field research but I do enjoy lab research.” (75)

→ “Was iffy about grad school before but am now certain. Still attempting to decide between earning a Masters or Ph.D.” (70)
→ “It has made me sure that I want to do research in the future.” (70)

→ “Re-motivated me to try and do well in classes that I don't have much interest in so that I can achieve further goals.” (70)

→ “More open to possibility of career in research.” (68)

→ “The program opened my eyes to different opportunities available in microbiology and in biology in general. Since my career goals are still under the works the GEM program really offered many ideas to the surrounding work developing in fields in or related to biology.” (60)

→ “It has opened up my eyes of the different areas of science I could get in. It has also allowed me to see what it is like to be in a lab, how to do scientific talks, and how to collect data and conduct research. Because what this program has showed me and how it emphasized the importance of finding what you love to do I have know looked deeper into what I want for a career choice that fits what I love to do.” (60)

“Some Changes”:

→ “When I first began this program I was not sure if I wanted to work in the lab doing marine science, after participating, I am sure I would like to pursue more environmental/forestry work in the field.” (50)

→ “This program has made me think about other careers available in the sciences. I plan on looking into more of the different areas.” (50)
## SENSE OF DIVERSITY/INCLUSION

<table>
<thead>
<tr>
<th>Responses range from Strongly Disagree (1) to Strongly Agree (5)</th>
<th>At my home institution… (pretest)</th>
<th>The GEM program… (posttest)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (1-5)</td>
<td>% 4 or 5</td>
</tr>
<tr>
<td>…there is an appreciation of cultural differences.</td>
<td>4.5</td>
<td>100%</td>
</tr>
<tr>
<td>…others believe in my potential to succeed.</td>
<td>4.4</td>
<td>93%</td>
</tr>
<tr>
<td>…I am encouraged to participate in discussions and ask questions.</td>
<td>4.5</td>
<td>93%</td>
</tr>
<tr>
<td>…I have to work hard to be perceived as a good student.*</td>
<td>4.3</td>
<td>93%</td>
</tr>
<tr>
<td>…there is a commitment to diversity.</td>
<td>4.1</td>
<td>93%</td>
</tr>
<tr>
<td>…all students are treated as capable learners.</td>
<td>4.2</td>
<td>87%</td>
</tr>
<tr>
<td>…I can speak openly about diversity issues.</td>
<td>4.0</td>
<td>87%</td>
</tr>
<tr>
<td>…I feel a sense of belonging.</td>
<td>4.0</td>
<td>80%</td>
</tr>
<tr>
<td>…people are willing to talk about equity, injustice, and group differences.</td>
<td>4.0</td>
<td>80%</td>
</tr>
<tr>
<td>…my contributions are valued.</td>
<td>3.9</td>
<td>80%</td>
</tr>
<tr>
<td>…the instructors are sensitive to the ability levels of all students.</td>
<td>3.9</td>
<td>73%</td>
</tr>
<tr>
<td>…I am often asked to speak on behalf of members of my social identity.</td>
<td>2.9</td>
<td>21%</td>
</tr>
<tr>
<td>…I feel silenced or invisible.</td>
<td>1.9</td>
<td>--</td>
</tr>
</tbody>
</table>

See the Appendix for complete question wording and response distribution.

*Home institution vs. GEM comparison significant at p≤.10.

Almost all these students feel that their home institutions have a commitment to diversity.

The GEM program gets slightly higher marks for diversity and inclusion than do the students’ home institutions. These differences are not statistically significant with the exception of having to “work hard to be perceived as a good student”; this difference is statistically significant, albeit at a less stringent standard, acceptable with smaller sample sizes as in this study.

Students’ comments suggest that they noticed and appreciated GEM’s focus on diversity:

→ “I feel that both my home institution and the GEM program are similar in the way that they have several support systems for underrepresented minorities. The GEM program being a much smaller tight knit group can reach out to everybody quicker and help everyone, while my college is not always capable of doing so. This program really allows for everyone to be equally informed.”

→ “There is in a sense equal representation between the both, although within the GEM course we were all allowed to actually hangout together, not just as a
different race, but as a family; regardless of our ethical and cultural background. At our schools, we would just be almost segregated as a whole considering our race.”

→ “Well it is very difficult to compare an institution of 20,000 students to a course of 15. Though the diversity level in the GEM course is really accepting. Given that at my home institution the more advance math, and science classes are predominantly Caucasian. This GEM course really helped me understand that we are just PEOPLE, not white, not green, not purple, but people. We are just people who love science.”

→ “I have never been involved in a program where diversity was discussed and celebrated this much, I think it is extremely important for these topics to be discussed in all environments with all people.”

→ “I noticed that the program is open to talking about the issues that we face and help us work through it and the GEM program makes sure everyone is included in all the projects.”

→ “I feel that there is a great difference on the topic of diversity between my home institution and the GEM program. Given that there is a lot more diversity within the GEM program, I felt extremely comfortable talking about diversity and the barriers and challenges one goes through because of this difference in comparison to a person of a higher socioeconomic status. On the other hand, in my home institution, which is predominantly white, I sometimes feel excluded and feel that I cannot discuss such topics unless it is with people who have shared the same experience as me. I think it is extremely essential to talk about diversity because it allows for people to understand the differences better and ultimately leads to a union of different backgrounds. The GEM program did a great job in choosing an extremely diverse group of people, and that allowed us to learn about the harm prejudice can do, and about the necessity of diversity not only within a scientific career, but also within the world.”

All students said they did not experience any racial tension or discrimination during the GEM course. However, one white student made the following comment:

→ “But since I am of Caucasian decent, I felt in a way that "I am not as special" as some people. Or there are double standards on the respect aspect of these topics. For example, it is socially unacceptable to make jokes, etc., about certain races or religions, but if someone says something about a white person it is "okay". The majority of the time it is not a big deal, but it is still a double standard that humans need to end.”
ADDITIONAL CONTENT STUDENTS WOULD HAVE LIKED IN THE COURSE

Students were asked if there was anything else they would have liked to learn as part of the GEM course.

• Some students requested more information about specific topics within the field, especially virology and how what they were learning affects people.

  → “I would like to learn a bit more about virology.”

  → “More about viruses and pathogens.”

  → “I would have liked to learn a bit more about field work, as well as other aspects on how microbes affect our terrestrial lives, not strictly upon our oceans.”

  → “A greater understanding of how these microbial processes affect humanity.”

  → Since I am an environmental science major, I wish we would have tied current issues into more of what we learned.

  → A little bit more about the origins of life.

  → “I would have enjoyed learning more about genomics, I found it really interesting and important to study.”

• Two students would have wanted more information about science processes or diversity.

  → “More information on why some protocols were done in order to have a better understanding and analysis of results.”

  → “I would have liked to learn more about the diversity in the sciences.”
STUDENTS’ SUGGESTIONS FOR IMPROVING THE GEM COURSE

Several students mentioned wanting more explanation of lab content and procedures.

→ “More organization in the lab component of the course because many times it was not properly explained and many students performed the procedures blindly.”

→ “I would propose that the instructors took some more time on a subject and the labs being more coordinated and thoroughly explained. Along with maybe another TA inside the labs to attend all the questions we have.”

→ “In the lab the instructions were clear but I didn't know why I was doing what I was doing or why I used this because I didn't know its purpose. There should be more time to explain what we are looking for, why we are looking for it, and how does this procedure work. I think it would help if you did a small lecture before the lab to explain what exactly we are doing in the lab, explain any major key concepts to students about the procedures and the importance of our research.”

→ “I think overall the course was constructed well, the only thing would be for the advisors/TA to more organized before lab and to thoroughly explain or give protocols to students because for all of other people, it was their first lab experience so many procedures were foreign to them.”

→ “I feel that something that there could be improvement on is the level of organization there is within the lab work. Sometimes, I felt myself just following procedures rather than really knowing what I was doing in lab. There was a lot of mix up within our samples and our data was not coherent. This was due to a lack of organization.”

→ “More organized labwork. Have each team collect their own samples, label them CLEARLY with group name, date, site (name agreed on and noted by whole class). Then have each team work on their OWN samples (filtration, extraction, gel, etc). When doing work on other people's samples, the whole process seems random and unplanned, there is less attachment to the work.”

→ “Sometimes I was very confused in lab because I would forget verbal instructions. Not being the only one, I know some of the mistakes (with like PCR) were due to that, and probably wasted our time a little. Having reliable lab procedures is essential so none of this miscommunication happens and I didn’t exactly feel that.”
A few students suggested **more organization** for the course overall.

→ “Changes for next years course would be to have a better set schedule. At times, I felt like we did not really have anything planned and it would have been nice to know what we were doing as opposed to going on a whim.”

→ “Also to have a more concrete schedule of the trip.”

→ “Give more information before the class starts; I felt like didn't know what was going on at all until the final week before we left.”