Evaluation Team

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This report is the result of a project developed by the Department of Biochemistry & Molecular Biology at the University of Georgia, with funding from a Teach Quality Higher Education Program Grant Title II, Part A of Public Law 107-110, the “No Child Left Behind Act.” The contents of this publication are considered as accurate as possible at the time of publication, based on information provided. However, Cassandra Drennon & Associates is not responsible for any inadvertent errors.
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Introduction

Science, technology, engineering, and mathematics (STEM) education has become a priority for U.S. public education policy makers in recent years. A 2008 report to the U.S. Congress notes that most American high school students are not becoming proficient in STEM areas and that many of their teachers lack adequate subject matter knowledge.\(^1\) Appreciating the critical need to bring Georgia’s high school science teachers up to date in these areas, The University of Georgia (UGA) created The UGA Biotech Boot Camp. Sponsored by a Georgia Teacher Quality Higher Education Program grant, funded by the U.S. Department of Education, the five-day summer workshop offered teacher enhancement training to public high school teachers from across the state. Goals were to:

- Provide teachers the opportunity to acquire or improve content knowledge and skills in biotechnology through interaction with university scientists.
- Expose teachers to current and emerging science technologies.
- Increase the self-confidence of teachers who are teaching these skills but have had little previous hands-on experience themselves.
- Provide a forum in which teachers and scientists can work together to incorporate new techniques and ideas into the classroom curriculum.
- Promote teacher networking to share ideas and resources between teachers in different Local Education Agencies.
- Allow the teachers and university faculty to work together to develop a shared set of educational resources.

A workshop was held on the UGA campus in Tifton June 4-8, 2012, attended by 14 teachers from 12 public secondary schools in Georgia (Figure 1). Housing and meals were included, and participating teachers received a $300 stipend plus reimbursement for mileage traveled to and from the workshop site. Teachers were eligible to receive five Professional Learning Unit (PLU) credits at the completion of the workshop and submission of a finalized action plan. An additional PLU will be awarded if the teacher incorporates his or her action plan in their fall curriculum, giving six PLU credits.

The overall goal of the workshop was for Georgia high school science teachers to increase their content knowledge of science and technology. Specific content areas were: Lab skills and safety, DNA Analysis Tools, DNA and Proteins, Protein Profiling Tools, Knowledge Bases, Protein Structure, X-ray Crystallography, Crystallizing Proteins, PDB, Proteopedia, and other Web Resources.

The five-day workshop included lectures, group discussion, hands-on technology training, and evening activities to promote networking and instructional development. Opportunities for continued networking and technical support through-

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out the school year will also be provided with visits to individual schools to help teachers implement lesson plans developed in the workshop.

UGA Professors Wendy Dustman (Microbiology) and John Rose (Biochemistry & Molecular Biology) facilitated the workshop sessions. Julie Kittleson (Mathematics & Science Education) helped participants develop teaching strategies and implementation plans to incorporate the new knowledge and skills into their classroom curriculum. Participants were housed in a dormitory on campus and the workshop met nearby in the NESPAL facility. Each day had a learning focus, with lectures in the morning and laboratory work in the afternoon, interspersed with classroom activities and industry tours. Networking opportunities were provided during the day and in the evening, providing the teachers with an opportunity to work on lesson plans together. Lunch & Learn sessions each day offered time to discuss topics such as application to the teaching environment, equipment programs for high school teachers, postsecondary educational opportunities, and low cost biotech resources for the classroom. Evening activities fostered the development of a teacher network and instructional development. In addition, throughout the Fall 2012 school year, a designated Science Facilitator will travel to each high school to assist teachers with incorporating their new knowledge and skills into the classroom or to implement the lesson plan the teacher developed over the course of the workshop.

Evaluation Design & Data Collection

Cassandra Drennon & Associates, Inc. provided external evaluation of the workshop experience and learning gains made during the summer workshop. A 20-item pretest-posttest to measure these gains included close-ended multiple choice and short answer items. This instrument was administered at the beginning of the course and again on the final day. Overall responses from each group were then compared to measure participants’ knowledge gains.

To understand the knowledge gains across the nine general content areas, we asked participants to self-evaluate their knowledge gains through a retrospective pretest. Research has shown retrospective testing to be as effective as the traditional pretest and posttest to determine the impact of a professional development workshop. When asked in advance of training to assess their knowledge levels of unfamiliar content, participants are not always able to do this accurately. Once they have attended the training, however, they find out what they did or did not know, allowing them to more accurately assess their learning. We asked participants to rate their knowledge level on a 5-point scale with 0=None, 1=Little, 2=Moderate, 3=Quite a bit, and 4=Extensive. We then asked them to think back and estimate what their knowledge level had been in each content area before the workshop. To analyze the results, we compared the overall responses from both points in time.

On the last day of the workshop we also administered a Participant Evaluation Survey to learn the participants’ satisfaction with the experience and recommendations for future workshops. The survey consisted of 23 positive statements about the workshop experience and asked participants to indicate how strongly they agreed with each, using a 4-point scale: 1 = Strongly Disagree, 2 = Somewhat Disagree, 3 = Somewhat Agree, and 4 = Strongly Agree. A fifth responses category—Not Applicable/No Opinion—was provided for those who did not feel they could answer a question. These responses were not used in determining the mean. The survey was designed to capture participant levels of satisfaction in three areas—the Learning Experience, Communication, and Structure and Organization. Participants also answered

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open-ended questions about their learning experience in four areas—their most engaging experience of the week, their most distancing experience, how their learning could have been enhanced either by something they or the workshop facilitators could have done differently, and their recommendations for improving the workshop. Their responses to these questions are incorporated where relevant throughout the report.

Participants will take an additional survey pertaining to the Science Facilitator’s follow-up visit to their classroom. The 14-item survey will consist of multiple choice, short-answer, and Likert scale questions that will assess participants’s professional growth since the workshop, and their incorporation of the workshop materials throughout the Fall 2012 school year. The survey will be administered at the beginning of the Spring 2013 school year, and a separate report will be developed and disseminated based on participant responses.
Figure 1. Schools Represented by County

Key: ● High Need Local Education Agency
Source: http://teacherquality.coe.uga.edu/proposal-information/2012-2013/eligible-systems/
Findings

The 2012 Biotech Boot Camp achieved success in all six goal areas. During the five-day workshop, Georgia high school teachers had the opportunity to work with university scientists to acquire content knowledge and skills in biotechnology. The workshop structure provided a forum for teams to incorporate new techniques and ideas into classroom curriculum and to develop self-confidence as they learned. Groundwork was laid to accomplish the other goals as well -- to develop a teacher network and create an opportunity for teachers and university faculty to develop shared educational resources. The findings are discussed in two sections, The Workshop Experience and Learning Gains.

The Workshop Experience

Discussion of the teachers’ perspective on the workshop centers on data from the Participant Evaluation Survey. Table 1 shows aggregated data for participant levels of agreement with 23 positive statements. This is indicated by percentage and number of responses in each category. The findings are organized by three domains of the workshop experience - Learning Experience, Communication, and Structure and Organization. Figures 2-4 show the results with statements ranked by average score.

Learning Experience

Participants from the 2012 Biotech Boot Camp were satisfied with their overall learning experience during the workshop. The average score to the 10 positive questions in this category was 3.8 (near Strongly Agree) on a 4-point scale. There was no change in the category’s score compared to the previous year.

Finding: Group Discussions and lab exercises are key to the success of the workshop. All of the participants (100%) in the 2012 workshop strongly agreed that the group discussions and hands-on technology training sessions were effective in helping them apply what they had learned during the lectures. One participant stated that their most interesting moment of the workshop was “during all the activities in which we connected the lecture to lab procedures,” while another participant stated that “the lab activities were most engaging.” Additionally, all participants (100%) strongly agreed that UGA faculty or graduate student were effective in leading the teams through various workshop exercises. One participant stated that during the labs the instructors “allowed us to be the students and make mistakes – a much better learning experience than just listening.”

Finding: There may be more opportunities to help teachers develop lesson plans and learn how to incorporate the new materials into their classroom curriculum. Only half (50%) of the participants strongly agreed, and 36% of participants somewhat agreed, that the UGA faculty or graduate student were effective in helping participants design lesson plans throughout the workshop that they could use in their classroom. Additionally, the average score dropped from 3.9 in 2011 to 3.6 on a 4-point scale of participants leaving the workshop with a plan for incorporating their new knowledge and skills into their classroom curriculum. One participant stated that they “didn’t have a lot of time to collaborate with other teachers who teach the same thing as us, [and] some teachers seemed unwilling to share how they use the lessons/activities from both the workshop and their own classroom.” The same participants suggested, “each teacher bring one good activity/lesson to share with the group” in order to help incorporate the materials into their
curriculum. The project design for the 2012 Biotech Boot Camp has included a classroom follow-up that will be conducted by a designated Science Facilitator during the Fall 2012 school year. The Science Facilitator will travel to each high school to assist teachers with incorporating their new knowledge and skills into the classroom or to implement the lesson plan the teacher developed over the course of the workshop.

**Communication**

Since the 2011 workshop, the overall score to the five items in the communication category has increased from 3.3 to 3.5 on a 4-point scale. The 2012 score suggests participants are more satisfied with the instructors and understand the goals and objectives, as well as, the instructions better than the previous year; however, improvement remains in other areas.

**Finding: Lectures remain problematic for participants.** Only 57% of participants somewhat agreed that the presentations by instructors were pitched at their level. While this category score increased from 2.8 to 2.9 on a 4-point scale, the slight increase suggests the level of material presented during the workshop is a place for improvement. When participants were asked what the most distancing part of the workshop was, they described the lectures as being “over my head” and that “during most of the lectures the content was too in depth for what we needed.” Another participant stated, “some of the lectures were too technical, [and] I was lost a few times.”

**Finding: Workshop topics and information should be more geared to the high school students and divided by subject matter.** Forty-three percent of participants somewhat agreed that the instructors helped them connect the bio-tech information with the grades 9-12 classroom. Many of the participants made statements about the difficulty of the material and how the material should be more accessible to high school students. One participant stated that while the workshop was great, there needed to be “more information for the remedial students and maybe a different workshop for the AP teachers in different subjects.” Another participant recommended that the instructors should “try to gear the lectures to high school teachers and give us something we can take back to our high school students.” A separate participant noted “some of the lessons were geared toward more AP level courses, which was great but was hard to determine how I would integrate the concept with my general sophomore high school classes.”

**Structure and Organization**

**Finding: Participants were highly satisfied with the structure and organization of the workshop.** Overall, participants responded to the six items in this category positively with the structure and organization of the workshop receiving a score of 3.9 on a 4-point scale. Participants strongly agreed that there was adequate time provided for meals and breaks, the housing was adequate, the environment was suitable to learning, and the information provided prior to the workshop was timely. Fifty-seven percent of participants strongly agreed and 43% somewhat agreed that the length of sessions each day was about right; some participants suggested that the days could be shorter, less lectures and more labs, and that the last day could be cut in half. Participants also recommended that there should be additional industry tours added to the workshop.
Table 1. Aggregate Responses to Participant Evaluation Survey (N=14)

<table>
<thead>
<tr>
<th>The Learning Experience</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
<th>Not Applicable/ No opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Morning lectures and training sessions were effective in providing background content knowledge.</td>
<td>3 (22%)</td>
<td>10 (71%)</td>
<td>1 (7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Group discussions and hands-on technology training sessions were effective in helping me apply my learning.</td>
<td></td>
<td>14 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. UGA faculty or graduate student were effective in leading my team through various workshop exercises.</td>
<td></td>
<td>14 (100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. UGA faculty or graduate student were effective in helping me design lesson plans throughout the workshop that I’ll be able to use in my class.</td>
<td>5 (36%)</td>
<td>7 (50%)</td>
<td>2 (14%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I am leaving this workshop with a plan for incorporating new knowledge and skills into my classroom curriculum.</td>
<td>5 (36%)</td>
<td></td>
<td>9 (64%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Evening activities were effective in promoting networking and instructional development.</td>
<td>1 (7%)</td>
<td>1 (7%)</td>
<td>10 (71%)</td>
<td>2 (14%)</td>
<td></td>
</tr>
<tr>
<td>7. My group/team during the workshop consisted of teachers from nearby schools.</td>
<td>2 (14%)</td>
<td>3 (22%)</td>
<td>9 (64%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I plan to continue networking with the teachers from my group/team upon completion of this workshop.</td>
<td>2 (14%)</td>
<td>1 (7%)</td>
<td>11 (79%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. After the workshop, I plan to continue networking with participants beyond those in my group/team (other teachers, faculty).</td>
<td>3 (22%)</td>
<td></td>
<td>11 (78%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Overall, the workshop helped me develop teaching strategies for biotechnology.</td>
<td>3 (22%)</td>
<td></td>
<td>11 (78%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
<th>Not Applicable/ No opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. The goal(s) and objective(s) of the workshop were clear to me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14 (100%)</td>
</tr>
<tr>
<td>12. Instructions given prior to any activity were always clear.</td>
<td>1 (7%)</td>
<td>5 (36%)</td>
<td>8 (57%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Presentations by instructors were pitched at my level (neither too simple nor too advanced).</td>
<td>4 (15%)</td>
<td>8 (57%)</td>
<td>2 (14%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Instructors did a good job explaining difficult material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 (50%)</td>
</tr>
<tr>
<td>15. The instructors helped me connect the biotech information with the grades 9-12 classroom.</td>
<td>6 (43%)</td>
<td></td>
<td>8 (57%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structure and Organization</td>
<td>Strongly Disagree</td>
<td>Somewhat Disagree</td>
<td>Somewhat Agree</td>
<td>Strongly Agree</td>
<td>Not Applicable/No opinion</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-------------------</td>
<td>-------------------</td>
<td>---------------</td>
<td>---------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>18. The environment was suitable for learning.</td>
<td></td>
<td></td>
<td></td>
<td>1 (7%)</td>
<td>13 (93%)</td>
</tr>
<tr>
<td>19. Housing was adequate.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7 (50%)       7 (50%)</td>
</tr>
<tr>
<td>20. Information provided prior to the workshop was clear.</td>
<td></td>
<td></td>
<td>2 (14%)</td>
<td>11 (79%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>21. Information provided prior to the workshop was timely.</td>
<td></td>
<td></td>
<td>1 (7%)</td>
<td>12 (86%)</td>
<td>1 (7%)</td>
</tr>
<tr>
<td>22. Adequate time was provided for the meals and breaks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14 (100%)</td>
</tr>
<tr>
<td>23. The length of the sessions each day was about right.</td>
<td></td>
<td></td>
<td>6 (43%)</td>
<td>8 (57%)</td>
<td></td>
</tr>
</tbody>
</table>
### Figure 2. Participants Survey Results: The Learning Experience
Statements Ranked by Average Score (N=14)

<table>
<thead>
<tr>
<th>Statement</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussions and hands-on technology training sessions were effective in helping me apply my learning.</td>
<td>4.0</td>
</tr>
<tr>
<td>UGA faculty or graduate student were effective in leading my team through various workshop exercises.</td>
<td>4.0</td>
</tr>
<tr>
<td>After the workshop, I plan to continue networking with participants beyond those in my group/team (other teachers, faculty).</td>
<td>3.8</td>
</tr>
<tr>
<td>I plan to continue networking with the teachers from my group/team upon completion of this workshop.</td>
<td>3.8</td>
</tr>
<tr>
<td>Moving lectures and training sessions were effective in providing background content knowledge.</td>
<td>3.8</td>
</tr>
<tr>
<td>Overall, the workshop helped me develop teaching strategies for biotechnology.</td>
<td>3.8</td>
</tr>
<tr>
<td>Evening activities were effective in promoting networking and instructional development.</td>
<td>3.8</td>
</tr>
<tr>
<td>I am leaving this workshop with a plan for incorporating new knowledge and skills into my classroom curriculum.</td>
<td>3.6</td>
</tr>
<tr>
<td>UGA faculty or graduate student were effective in helping me design lesson plans throughout the workshop that I’ll be able to use in my class.</td>
<td>3.6</td>
</tr>
<tr>
<td>My group/team during the workshop consisted of teachers from nearby schools.</td>
<td>3.4</td>
</tr>
</tbody>
</table>

0=NA/No Opinion, 1=Strong Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly
Figure 3. Participant Survey Results: Communication
Statements Ranked by Average Score (N=14)

- The goal(s) and object(s) of the workshop were clear to me.
  - 4
- The instructors helped me connect the biotech information with the grades 9-12 classroom.
  - 3.6
- Instructors did a good job explaining difficult material.
  - 3.5
- Instructions given prior to any activity were always clear.
  - 3.5
- Presentations by instructors were pitched at my level (neither too simple nor too advanced).
  - 2.9

0=NA/No Opinion, 1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree

Figure 4. Participant Survey Results: Structure & Organization
Statements Ranked by Average Score (N=14)

- Adequate time was provided for the meals and breaks.
  - 4
- Housing was adequate.
  - 4
- The environment was suitable for learning.
  - 3.9
- Information provided prior to the workshop was timely.
  - 3.9
- Information provided prior to the workshop was clear.
  - 3.8
- The length of the sessions each day was about right.
  - 3.6

0=NA/No Opinion, 1=Strongly Disagree, 2=Somewhat Disagree, 3=Somewhat Agree, 4=Strongly Agree
Learning Gains

In this section we discuss the learning gains of participants in two sections based on the analysis of 1) a retrospective pretest, and 2) a pre-posttest multiple choice questionnaire. The workshop was structured by nine topics - Lab Skills and Safety, DNA Analysis Tools, DNA and Proteins, Protein Profiling Tools, Bioinformatics (I and II), Protein Structure, X-ray crystallography and Crystallizing Proteins. The retrospective pretest administered addressed these nine topics individually.

Retrospective Pretest

At the end of the workshop, we asked participants to self-evaluate their knowledge level in each content area and then estimate what their knowledge had been before the workshop (Table 2), according to a 4-point scale, with 0=None, 1=Little, 2=Moderate, 3=Quite a bit, 4=Extensive.

Finding: Participants increased their knowledge in all content areas covered by the workshop.

Responses reflected gains in all nine areas, the greatest areas of improvement being in Protein Profiling Tools (an increase of 1.56), X-Ray Crystallography (an increase of 1.66), Crystallizing Proteins (an increase of 1.44), and PDB, Proteopedia and other Web Resources and increase of (1.44). The area with the smallest increase was Lab Skills and Safety (0.44 increase), which is not an unpredictable result since all participants are science educators (Figure 5).

<table>
<thead>
<tr>
<th>Workshop Topic</th>
<th>Before</th>
<th>After</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Skills &amp; Safety</td>
<td>3</td>
<td>3.44</td>
<td>0.44</td>
</tr>
<tr>
<td>DNA Analysis Tools</td>
<td>1.78</td>
<td>2.89</td>
<td>1.11</td>
</tr>
<tr>
<td>DNA and Proteins</td>
<td>1.89</td>
<td>2.89</td>
<td>1</td>
</tr>
<tr>
<td>Protein Profiling Tools</td>
<td>1.11</td>
<td>2.67</td>
<td>1.56</td>
</tr>
<tr>
<td>Knowledge Bases</td>
<td>1.33</td>
<td>2.67</td>
<td>1.34</td>
</tr>
<tr>
<td>Protein Structure</td>
<td>1.33</td>
<td>2.56</td>
<td>1.23</td>
</tr>
<tr>
<td>X-Ray Crystallography</td>
<td>0.56</td>
<td>2.22</td>
<td>1.66</td>
</tr>
<tr>
<td>Crystallizing Proteins</td>
<td>0.78</td>
<td>2.22</td>
<td>1.44</td>
</tr>
<tr>
<td>PDB, Proteopedia and other Web Resources</td>
<td>0.78</td>
<td>2.22</td>
<td>1.44</td>
</tr>
</tbody>
</table>
Source: Biotech Retrospective Pretests

O=None, 1=Little, 2=Moderate, 3=Quite a bit, 4=Extensive

Figure 5. Comparison of Learning Before and After Workshop N=9

Key

<table>
<thead>
<tr>
<th></th>
<th>Lab Skills &amp; Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DNA Analysis Tools</td>
</tr>
<tr>
<td>2</td>
<td>DNA and Proteins</td>
</tr>
<tr>
<td>3</td>
<td>Protein Profiling Tools</td>
</tr>
<tr>
<td>4</td>
<td>Knowledge Bases</td>
</tr>
<tr>
<td>5</td>
<td>Protein Structure</td>
</tr>
<tr>
<td>6</td>
<td>X-Ray Crystallography</td>
</tr>
<tr>
<td>7</td>
<td>Crystallizing Proteins</td>
</tr>
<tr>
<td>8</td>
<td>PDB, Proteopedia and other Web Resources</td>
</tr>
</tbody>
</table>

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Pre- and Post-test: Multiple Choice

A quiz administered at the beginning and again at the end of the workshop contained 20 questions. The percentage of questions that each participant answered correctly on the pre- and post-tests were compared to determine learning gains. Thirteen of the fourteen participants demonstrated knowledge gains. One person’s score decreased from pre- to post-test; however, researchers noted that this particular participant had realized during the course of the workshop that the material was irrelevant to them due to the subject matter they teach. Among those who demonstrated improvement, the average knowledge increase was 28 percentage points.

Table 3. Percentage of Correct Answers on 20-item Pre-test & Post-test

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Raw Pretest Score</th>
<th>% correct</th>
<th>Raw Post-test Score</th>
<th>% correct</th>
<th>Percentage Point Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>57</td>
<td>22</td>
<td>79</td>
<td>21.4</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>43</td>
<td>17</td>
<td>61</td>
<td>17.9</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>46</td>
<td>20</td>
<td>71</td>
<td>25.0</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>21</td>
<td>23</td>
<td>82</td>
<td>60.7</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>32</td>
<td>6</td>
<td>21</td>
<td>-10.7</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>32</td>
<td>15</td>
<td>54</td>
<td>21.4</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>32</td>
<td>19</td>
<td>68</td>
<td>35.7</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>36</td>
<td>14</td>
<td>50</td>
<td>14.3</td>
</tr>
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<tr>
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<td>11.14</td>
<td>40</td>
<td>18.21</td>
<td>65</td>
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</table>
Conclusions & Recommendations

The 2012 Biotech Boot Camp met its overall goal – for high school teachers to increase their content knowledge of science and technology – and achieved success in each of its six goal areas.

❖ Provide teachers the opportunity to acquire or improve content knowledge and skills in biotechnology through interaction with university scientists.

Participants noted the positive atmosphere of professional interaction with instructors and fellow attendees, and they found the overall structure and organization of the Boot Camp conducive to learning. UGA faculty or graduate students were accessible during workshop activities for help. By the end of the week participants had increased their knowledge in all nine content areas. Participants were primarily concerned with their ability to transfer the knowledge and skills they gained from the workshop to their high school curriculums, especially for different science subjects, and for remedial versus advanced students.

❖ Expose teachers to current and emerging science technologies

Participants thought the most engaging parts of the workshop were when they were conducting lab activities using the new technologies, and during their trips to local industries where they were able to see biotechnology at work.

❖ Increase the self-confidence of teachers who are teaching these skills but have had little previous hands-on experience themselves.

Many of the participants thought that the hands-on opportunities, such as the lab exercises, truly enhanced their learning experience and their appreciation for these new technologies. Participants continued to have issues determining ways to incorporate the new information and skills into their curriculum, and many stated they would have benefited from additional help and time in developing a lesson plan that could be implemented. Participants also continued to have issues with the level of information they received, often expressing that it was over their heads and not applicable to their classroom.

❖ Provide a forum in which teachers and scientists can work together to incorporate new techniques and ideas into the classroom curriculum

Participants appreciated the time and effort taken by the UGA faculty and graduate student throughout the workshop. Participants thought instructors gave clear instructions, took adequate time to explain difficult material, and encouraged participants to fully engage in the lab exercises and take a pro-active role towards gaining new knowledge and skills. In addition to the June workshop, participants will also receive a one-time visit from an assigned Science Facilitator who will assist each participant with incorporating biotechnology into their curriculum or with implementing the lesson plan the participant developed during the workshop.
Recommendations

1. UGA faculty and staff should spend additional time with teachers to help them prepare lesson plans that incorporate the new knowledge and skills learned during the workshop. Also, as suggested by one of the participants, setting-aside time for teachers to collaborate on lesson plans for biotechnology would be efficient and helpful.

2. Provide materials before the workshop, and/or expand materials to be more relevant to different types of science subjects. Participants would benefit if the Georgia Performance Standards were taken into account as a guide to workshop lectures and materials. One participant noted that they felt as though they could not apply what they were being taught at the workshop to their classroom since it did not follow the curriculum requirements set forth by Georgia.

3. Utilize a past participant to provide insight and counsel on Georgia’s requirements to different high school science curriculums so that the workshop can better prepare materials that are engaging, practical and easy to incorporate into science curriculums.

4. Prepare lectures so that they are at a level that is easier for high school teachers to comprehend increasing their ability to gather information to take back to their classrooms.
Appendices

Pre-test
Post-test
Retrospective Pre-test
Participant Evaluation Form
Participant Open-ended Comments
BTBC12 Pre-Test

Last four digits of SS#_______________

Grade level(s) and subject I teach _______________

Total number of students I teach ________________

Name of School I teach for _________________

How would you rate your Biotech knowledge base [1-5, 1=Novice, 5=Expert]

1. Restriction enzymes are important in biotechnology because _____
   a. The diversity of restriction enzymes present within a person’s DNA produces a unique DNA fingerprint
   b. They cut DNA in specific sequences and allow new pieces of DNA to be inserted into an existing gene
   c. They help cells synthesize complex products such as biodiesel fuel
   d. They are enzymes which glow in the dark and serve as reporter molecules to measure successful bioengineering

2. Using the picture below, determine which of the following sizes of DNA fragments is NOT present in the test DNA.

   a. 3000 bp
   b. 1500 bp
   c. 500 bp
   d. 250 bp
3. What kind of chemicals would you NOT perform a BLAST analysis on?
   a. Proteins
   b. Nucleic acids
   c. Lipids
   d. All of the above

4. Looking at the picture below, if each color represents an individual protein, which of the following terms regarding protein structure would be BEST to describe the protein in the picture?
   a. Primary structure
   b. Secondary structure
   c. Tertiary structure
   d. Quarternary structure

5. In DNA gel electrophoresis, bands of DNA move through the gel and migrate from _______ to _________ charged poles of the electrophoresis chamber.
   a. Negative, positive
   b. Neutral, positive
   c. Positive, negative
   d. Neutral, negative

6. Given the following:
   (1) RNA polymerase reads DNA and produces a transcript
   (2) Amino acids are hooked to one another via peptide bonds
   (3) The ribosome moves along the mRNA to produce a polypeptide
   (4) Amino acids attached to anticodons are matched to mRNA codons.

   What is the correct order of this process?
   a. 1,2,3,4
   b. 1,4,2,3
   c. 1,3,4,2
   d. 1,3,2,4

7. The code for a protein is determined by the arrangement of what part of the DNA?
   a. Sugars
   b. Phosphates
   c. Nitrogenous bases
   d. Bonds
8. Based on the DNA fingerprints from blood evidence at the scene of a crime shown below, who can be identified as being present at the scene of the crime?

![DNA Fingerprint Diagram]

a. Only the victim  
b. Only suspect 1  
c. Only suspect 2  
d. Both the victim and suspect 1  
e. Both the victim and suspect 2  
f. All three: the victim, suspect 1 and suspect 2

9. In the diagram below list the atoms that define the peptide plane

![Peptide Diagram]

a. 3-5-6-7-8-9  
b. 8-10-11-12-13-1  
c. 1-2-3-4-5-6  
d. 5-6-7-8-9-11

10. For the figure in question 9 above, what is the amino acid sequence of this peptide?

![Amino Acid Sequence Diagram]

a. R S H Q  
b. H E L P  
c. Q K S H  
d. E R S H
11. The R group, of an amino acid determines if it is
   a. an acid or a base
   b. hydrophobic or hydrophilic
   c. polar or nonpolar
   d. charged or uncharged
   e. all of the above

12. When an organism’s gene undergoes a deletion of five nucleotides, what is the effect on the protein for which it codes?
   a. The protein’s amino acid sequence is altered beginning at the point of the mutation and extending to the end of the protein.
   b. There is no change whatsoever in the amino acid sequence of the protein.
   c. The protein will only be altered at one amino acid in the sequence, which corresponds to the site of the mutation that occurred.
   d. The number of the amino acids found in the protein will increase.

13. Alex has isolated DNA from several plant samples for his science fair project and wants to compare them using restriction enzyme digestion followed by gel electrophoresis. After preparing his agarose gel, he loads the wells successfully, then places the lid on the unit and plugs in the electrodes, letting the unit run for 45 minutes. He writes up his work in his lab notebook, including a comment that he placed the electrode with the positive charge at the end of the gel with the DNA in wells, and the electrode with a negative charge at the opposite end of the gel. Using this information, predict the results of Alex’s gel electrophoresis experiment.
   a. The DNA will move from the wells toward the bottom of the gel and restriction fragments will be sorted from heavy (nearer the wells) to light (nearer the bottom of the gel).
   b. The DNA will move from the wells toward the bottom of the gel and restriction fragments will be sorted from light (nearer the wells) to heavy (nearer the bottom of the gel).
   c. The DNA will move out of the wells and into the bugger, instead of being sorted by size in the agarose gel.
   d. The DNA will move out of the wells toward the bottom of the gel and restriction fragments which have similar weights to one another will migrate the same distance from the well as each other.

14. Which has the largest genome
   a. E. coli
   b. Ameoba
   c. Man
   d. Blue what
   e. Bakers yeast
15. Explain the key concepts behind how DNA gel electrophoresis works.

16. Briefly explain how we have been able to mass manufacture human pharmaceuticals such as insulin using bacterial fermentations.

17. Draw and label a simple diagram of the central dogma of DNA. Use the following terms in your picture: DNA, mRNA, proteins, replication, transcription, translation

18. In bacterial transformation protocols, the cells are treated with calcium chloride and heat in prior to the addition of donor DNA. What is the pre-treatment necessary?

19. In addition to forensics what other uses can DNA finger printing be used for?

20. Why do scientists want to sequence the human genome?
BTBC12 Post-Test

Last four digits of SS#________________
Grade level(s) and subject I teach ____________
Total number of students I teach ______________
Name of School I teach for _________________
How would you rate your Biotech knowledge base [1-5, 1=Novice, 5=Expert]

1. Restriction enzymes are important in biotechnology because _____
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d. 5-6-7-8-9-11

10. For the figure in question 9 above, what is the amino acid sequence of this peptide?

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19. In addition to forensics what other uses can DNA fingerprinting be used for?

20. Why do scientists want to sequence the human genome?
RETROSPECTIVE PRE-TEST
Please assess, generally, the knowledge you gained during this workshop. You can refer to the workshop agenda and other materials to refresh your memory of what was covered under each topic.

IMPORTANT: Please rate your knowledge AFTER the workshop first, and then rate your knowledge BEFORE the workshop, by circling the most appropriate response.

**My knowledge today, AFTER having completed the workshop:**

<table>
<thead>
<tr>
<th>Workshop Topic</th>
<th>None</th>
<th>Little</th>
<th>Moderate</th>
<th>Quite a bit</th>
<th>Extensive</th>
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<td>3</td>
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<td>3</td>
<td>4</td>
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<td>Protein Profiling Tools</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Crystallizing Proteins</td>
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<td>2</td>
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<tr>
<td>PDB, Proteopedia and other Web Resources</td>
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<td>1</td>
<td>2</td>
<td>3</td>
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**My knowledge today, BEFORE having completed the workshop:**

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<thead>
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<th>Extensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab skills and safety</td>
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<td>4</td>
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<tr>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>DNA and Proteins</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Protein Profiling Tools</td>
<td></td>
<td></td>
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<td>3</td>
<td>4</td>
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<tr>
<td>X-ray Crystallography</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Crystallizing Proteins</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>PDB, Proteopedia and other Web Resources</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Thank you for your participation in the workshop! We hope that this week’s experience was beneficial to you. To help us improve future workshops, please take a few moments to respond to the following questions.

Please indicate the extent to which you agree with each of the following statements.

<table>
<thead>
<tr>
<th>The Learning Experience</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Morning lectures and training sessions were effective in providing background content knowledge.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<tr>
<td>2. Group discussions and hands-on technology training sessions were effective in helping me apply my learning.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. UGA faculty or graduate student effectively led my team through various workshop exercises.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. The same faculty member or graduate student helped me design workshop-related lesson plans throughout the workshop.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I am leaving this workshop with a plan for incorporating new knowledge and skills into my classroom curriculum.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Evening activities were effective in promoting teacher-teacher networking and instructional development.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. My group consisted of teachers from nearby schools.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I plan to continue networking with the teachers from my group upon completion of this workshop.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. I plan to continue networking with teachers and faculty after the workshop.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Overall, the workshop helped me develop teaching strategies for biotechnology.</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
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</table>

<table>
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<th>Communication</th>
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<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. The goal(s) and objective(s) of the workshop were clear to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Instructions given prior to any activity were always clear.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Presentations by instructors were pitched at my level (neither too simple nor too advanced).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. Instructors did a good job explaining difficult material.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. The instructors helped me connect the biotech information with the grades 9-12 classroom.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<table>
<thead>
<tr>
<th>Structure and Organization</th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Neutral</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. The environment was suitable for learning.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. Housing was adequate.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. Information provided prior to the workshop was clear.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>21. Information provided prior to the workshop was timely.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>22. Adequate time was provided for the meals and breaks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>23. The length of the sessions each day was about right.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
1. What was the most engaging moment of the week for you? (At what moment did you feel most involved with what was happening?)

2. What was the most distancing moment of the week for you? (At what moment did you feel least involved with what was happening?)

3. We’d like you to think for a moment about yourself as a learner this week. What could you have done differently that would have improved your learning experience? (Consider whether anything got in the way of your ability to learn. Consider whether project staff could have done something differently to support your learning.)

4. What is the single best recommendation you have for improving this workshop?
## UGA Biotech Bootcamp
### Participant Open-ended Comments

1. **What was the most engaging moment of the week? (At what moment did you feel most involved with what was happening?)**

   - During all the activities in which we connected the lecture to lab procedures. Also, discussing procedures with peers for ideas for using in classrooms.
   - The lab activities were the best part of this workshop.
   - Hands-on activities, especially learning/practicing the micropipets.
   - Doing the labs! They allowed us to be the students and make mistakes - a much better learning experience than just listening.
   - The entire workshop was very engaging. However, the tour of the Miller Coors plant was the best. We actually got a chance to see biotechnology at work.
   - Micropipette lessons, pGlo labs.
   - Lab activities were very good. Field trip was Miller brewing was Very enlightening.
   - Throughout the course, I found it very interesting and engaging. The lab activities with DNA gel electrophoresis was most interesting.
   - During all the lab activities & the miller tour. The tour was very informative.
   - Learning techniques that I can take and use in my high school biology class.
   - Conducting the labs, especially the gel electrophoresis. I enjoy that. I wish/hope to find ways to incorporate it into my Chemistry class.
   - I enjoyed the field trip to Miller Coors, I felt the guide was knowledgeable and the things I learned/saw while there will translate easily into the classroom.
   - The labs activities were most engaging to me. I felt most involved when I made the connection of how I could implement the activities in my classroom.

2. **What was the most distancing moment of the week for you? (At what moment did you feel involved with what was happening?)**

   - Some of Dr. Rose’s lectures were deep, but he did a great job explaining very tedious ideas and application of proteins! His example of hemoglobin changing shape for O2 was great and I will use that in my class!
   - During most of the lectures - the content was too in depth for what we needed.
   - Late afternoon lectures
   - John’s lectures were a bit over my head - I know that I will not use the information to the depth that it was taught (for 9th graders). However, he did give us simple labs to explain the basics of the concepts.
   - The bootcamp was pretty intense and packed full of engaging activities. However, by the end of the evening I was worn out!
   - Crystallography
   - Some of the lectures were too technical. I was lost a few times.
**Dr. Rose’s lectures the last 2 days! He “lost” me and I never caught up**

Advanced lectures on protein/crystal structures because I cannot use it in my classroom.

During the Biochem lectures; and that is not a slight on John. Its more of a feeling that I’d forgotten a ton of my college Chemistry, so as a Chem teacher, it make me question what/how much Chem I actually know (and forgot); also makes me feel like I need to go back to college! If I don’t use it in my classes, I’ll lose it - or in my case I lost it :) However if there is a way to ‘simplify’ the Biochem content more, it may be more easy to digest.

Some of Dr. Rose’s lectures were way over my head, I was interested by had difficulty following along and am having difficulties seeing how I can translate the info he presented into lessons I can use with my high school students.

A couple of the lectures were really in depth. At that moment I did not know how I could relate that specific concept to my students.

3. We’d like you to think for a moment about yourself as a learner this week. What could you have done differently that would have improved your learning experience? (Consider whether anything got in the way of your ability to learn. Consider whether project staff could have done something differently to support your learning.)

I should have read through lectures/labs in the evening so I would be better prepared.

Better organization of getting reagents to groups - a couple of times, I felt I was waiting for chemicals and missed instructions for the next steps. Once or twice I missed the point of the reagents and their purpose in the experiment. Found some animations on crystallography. Find some activities about the interactions of protein shapes and their functions.

The workshop was very well organized - the only person who could not have used something from this workshop was not looking to get anything from it.

Everything was great! However some of the lectures were very lengthy to the point of boredom at times.

I think it was an excellent learning experience.

With the format of the LAB ACTIVITIES/EXPERIMENTS on the screen step by step, even though it was given in the book.

Covering the broad spectrum was difficut & I got easily distracted during lectures that did not apply to myself or my students.

Since I have forgotten most of my biochem, having something (notes, powerpoints, an intro. To biochem) in advance of the workshop would have been very helpful. Very basic, simple concepts & explanations (refreshers) on protein structures (1, 2, 3, 4 and testing methods - x-ray cryst., diffraction etc) I thoroughly enjoyed the workshop and am thankful you allowed me to participate. I’d like to explore the field of biotechnology further, to see what other areas exist, that overlap with the Chemistry content/standards I’m required to teach my students.

I would have liked to have prereading that could have been done prior to the workshop so I would be better prepared.

I am a visual learner first, then auditory. I also like discussions. Both of these were addressed this week for me. However, I felt that some of the lessons were geared toward more AP level courses, which was great but was hard to determine how I would integrate the concept with my general sophomore high school classes.

4. What is the single best recommendation you have for improving this workshop?

Keep on with activities we can do in our classes. While I probably will not do electron hoesis in my class, I will use some of the other activities. John & Wendy were wonderful! Very knowledgeable and easy to talk to and work with! They make a terrific team and have been a joy to be with!
<table>
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<tr>
<th>Suggestion</th>
<th>Details</th>
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<tr>
<td>Too much down time - there were several times where we just had to sit around and wait.</td>
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<td>More activities involving biotech technologies and labs less about protein structure and how to obtain structure</td>
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<tr>
<td>The amount of information, labs, free stuff and food was awesome this week - I highly recommend it!</td>
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<td>Shorter lectures! Add another industry tour.</td>
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<td>Classroom activities with inexperience/available resources (in public schools) for DNA gela electrophorosis, DNA fingerprinting etc.; IF POSSIBLE.</td>
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<td>Try to gear the lectures to HS teachers &amp; give us something we can take back to our HS students.</td>
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<td>It was great! More information for the remedial students &amp; maybe a different workshop for the AP teachers in different subjects.</td>
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<tr>
<td>Simplify the biochem lecture materials to a format that Chem teachers (non-bio teachers) can more easily understand the content. This would make it more applicable to my HS classroom &amp; hopefully help me find more ways/ideas for implementation.</td>
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<td>Have each teacher bring 1 good activity/lesson to share with the group. We didn’t have a lot of time to collaborate with other teachers who teach the same things as us, some teachers seemed unwilling to share how they use the lessons/activities from both the Bootcamp and their own classroom.</td>
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<td>I really enjoyed the boot camp. However, the last day of the camp probably could end at lunch even if the day before is a little longer.</td>
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