Assessment of Honors Collegium 70A and AL:
Genetic Engineering in Medicine, Agriculture, and Law
and
Gene Discovery Lab

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Executive Summary

The Center for Educational Assessment at the University of California, Los Angeles was commissioned by Dr. Robert Goldberg to evaluate a two-course honors collegium series, Honors Collegium 70A: Genetic Engineering in Medicine, Agriculture and Law (HC70A) and Honors Collegium 70AL: Gene Discovery Lab (HC70AL). The purpose of this evaluation was to document students’ perspectives on their experiences in HC70A and AL and to assess the impact of the courses on student learning outcomes. Qualitative research methods were applied to three data sources: (a) open-ended feedback students provided in official university course evaluations for the lecture and lab courses, (b) course exit questionnaires, and (c) interviews conducted with former HC70A and AL students who also served as Teaching Fellows (TF) in HC70A and Peer Research Mentors (PRM) in HC70AL. While qualitative data from course evaluations and exit questionnaires collected over the past six years provided insight into student experiences, the interview data captured the experiences of the TFs and PRMs. Overall, the results revealed that the honors collegium series had a significant impact on student learning.

Across the years, a total of 216 students completed course evaluations for HC70A and 52 for HC70AL. In addition, 56 students who completed both courses in the series also filled out exit questionnaires designed to assess course impact and learning outcomes. Lastly, four previous HC70A and AL students who became undergraduate teaching assistants were interviewed about their peer-teaching experiences in HC70A and AL. In line with rigorous qualitative data analysis methods outlined by Creswell (2009), open-ended responses from the course evaluations, exit questionnaires, and interviews were reviewed; themes were identified; and responses were coded by theme.

In both the lecture and lab course evaluations, students frequently commented on the numerous strengths of the course and instructor. They noted how outstanding the courses were and praised the instructor’s use of the Socratic Method to actively engage students in the course content. A small minority, however, found this instructional technique to be intimidating. Students claimed that while the courses were extremely challenging, they were also academically and personally rewarding.

Analysis of the exit questionnaires revealed that HC70A and AL series had a significant positive impact on students’ proximal and distal learning outcomes. Students gained confidence in their science ability, learned to think like scientists, and mastered complex research concepts and techniques. They learned about genes, gene activity processes, and the various applications of genetic research by working intensively with genes throughout both courses. As a result of this first-hand experience, students attained a greater appreciation for the large amount of time, effort, and discipline required to carry out complex scientific research. HC70A and AL also impacted students’ academic paths and post-graduate plans. A majority of the students expressed interest in taking additional science courses and pursuing lab work or research after taking HC70A and AL. A few students even hoped to change their major to pursue a science degree or to attend graduate school in the sciences. Students unanimously declared that they would highly recommend this series to fellow undergraduates.

Interview data corroborated findings from analyses of course surveys and exit questionnaires and suggested numerous positive impacts on not only HC70A and AL students but also its student leaders. Former student TFs and PRMs shared that their involvement in the course series motivated them to persist in science throughout their undergraduate careers and beyond. The course and teaching experience substantially contributed to their current paths in graduate and professional school. It also led to mastery of scientific knowledge, both conceptual and topical; gains in teaching, presentation and verbal communication skills; increased confidence; and an awareness of the relationship between science and society.
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Assessment of Honors Collegium 70A and AL: Genetic Engineering in Medicine, Agriculture, and Law and Gene Discovery Lab

The Honors Collegia at the University of California, Los Angeles, are interdisciplinary seminars taught by distinguished faculty and emphasize discussion based learning and scholarly exchange across disciplines. First offered in 2003, Honors Collegium 70A: Genetic Engineering in Medicine, Agriculture, and Law (HC70A) is designed to provide non-science majors and entering life science students with a foundation in molecular biology and genetics as it applies to genetic engineering, and addresses the social, legal, and ethical issues that arise from emerging new genetic technologies in medicine, agriculture, and law. This course is followed by Honors Collegium 70AL: Gene Discovery Lab (HC70AL), where students apply experimentally the concepts and techniques learned in HC 70A and conduct genomic research in a laboratory setting. (http://www.mcdb.ucla.edu/research/goldberg/HHMI_Program/hc70a.html)

The Center for Educational Assessment at UCLA was commissioned by Dr. Robert Goldberg, the instructor of the course, to evaluate the honors collegium series. The purpose of this evaluation was to document students’ perspectives on their experiences in HC70A and AL and to assess the impact of the courses on student learning outcomes. The current report details the methods, describes student experiences, and discusses the course impact on student learning.

Methods

In order to assess the impact of HC70A and AL on student learning, several qualitative data sources were examined: course evaluations, questionnaires, and interviews. Students’ open-ended comments from the course and lab evaluations and responses to exit questionnaires from 2003 to 2006, 2008, and 2009 were analyzed. Across the years, a total of 216 students completed course evaluations for HC70A and 52 students completed lab evaluations for HC70AL. In addition, 56 students who finished the HC70A and AL series completed exit questionnaires designed to assess the course impact on learning outcomes. Lastly, four former HC70A and AL students turned undergraduate Teaching Fellows (TFs) for HC70A and Peer Research Mentors (PRMs) for HC70AL were interviewed about their teaching experiences. Please note that students often referred to the TFs and PRMs as Teaching Assistants (TA).

Qualitative research methods were applied to the three data sources. While qualitative data from course evaluations and exit questionnaires provided insight into student experiences, the interview data captured the experiences of former students who also served as undergraduate teaching assistants in HC70A and AL. In line with rigorous qualitative data analysis methods outlined by Creswell¹, open-ended responses from the course evaluations, exit questionnaires, and interviews were reviewed, themes were identified, and responses were then coded by theme. All data were analyzed for content by identifying themes and then creating subcodes. It is important to note that individual student responses often contained multiple codes. Therefore, samples sizes (N) throughout this report often refer to the number of coded responses rather than the number of students because a single student response would contain multiple codes.

While a total of 216 course evaluations were completed for HC70A, 199 students (92%) provided open-ended feedback on the strengths and weaknesses of the instructor and lecture course. Likewise, 48 out of 52 students (92%) provided open-ended comments about the lab, HC70AL. Exit questionnaire items varied by year and items were selected for analysis based on their relevance to determining the impact of HC70A and AL on specific learning outcomes. The following items were selected for analysis: (a) What students learned about how science is carried out, (b) Student views of scientists and scientific discovery, (c) How HC70A and AL impacted students’ knowledge of genes and gene activity processes, (d) Student

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interest in pursuing future lab work and research, (e) Student plans for pursuing future courses and graduate programs, and (f) Whether students would recommend HC70A and AL to fellow undergraduates. Lastly, four Teaching Fellows and Peer Research Mentors were interviewed about their experiences, both as former students and as undergraduate teaching assistants in HC70A and AL.

Results

This section presents findings from the three major assessment components: (1) Course Evaluations and Lab Course Evaluations both asking about the strengths and weaknesses of the instructor and course, (2) Exit Questionnaires: (a) What students learned about how science is carried out, (b) Student views of scientists and scientific discovery, (c) How HC70A and AL impacted students’ knowledge of genes and gene activity processes, (d) Student interest in pursuing future lab work and research, (e) Student plans for pursuing future courses and graduate programs, and (f) Whether students would recommend HC70A and AL to fellow undergraduates, as well as (3) Teaching Fellow and Peer Research Mentor interviews.

1. Course Evaluations

HC70A Lecture Course Evaluations
Comments on strengths and weaknesses of instructor and course

The course evaluations provided information on what students perceived to be the strengths and weaknesses of the instructor and course. A total of 216 course evaluations were completed, with 199 students (92%) providing open-ended feedback, while 17 students did not. Qualitative analysis of open-ended feedback yielded a total of 579 coded responses. Figure 1 displays the percentage of major codes identified in the student responses. The majority of responses (86.4%) noted the strengths of the course citing it was an outstanding course and professor (47%), they gained interest, engagement, and learning in science (22.6%), and it was a one-of-a-kind experience in college (16.8%). In contrast, a small number of responses (13.6%) reflected challenges to the course and professor.

Figure 1. Course Evaluations of HC70A (N=579)
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Figure 2 presents the percentage of subcodes for “Outstanding course/professor.” All 272 coded responses revealed that HC70A was an outstanding course and praised the professor, citing it was the best course, an amazing experience, where they learned a lot (46%) and had the best, exemplary professor (20%).

**Figure 2. Course Evaluations of HC70A: Outstanding course/professor (N=272)**

As shown in Figure 3, all 131 coded responses revealed that students in HC70A experienced increased interest, engagement, and learning in science. Reasons given were that it was a challenging and intense course and workload but worthwhile (39%), and students enjoyed the interactive discussions and group work (28%).

**Figure 3. Course Evaluations of HC70A: Interest/engagement/learning in science (N=131)**
Assessment of HC70A and AL.

Figure 4 displays the percentage of subcodes for “One-of-a-kind experience.” All 97 coded responses revealed that students in HC70A experienced a one-of-a-kind experience because it offered a unique, novel, revolutionary, teaching method (53%) and the professor showed care and concern for students and valued their learning (34%).

**Figure 4. Course Evaluations of HC70A: One-of-a-kind experience (N=97)**

![Pie chart showing the percentage of subcodes for One-of-a-kind experience.]

As seen in Figure 5, all 79 coded responses revealed that students in HC70A experienced challenges with the course and professor because it was intimidating (38%) and the workload was heavy and course too fast paced (23%).

**Figure 5. Course Evaluations of HC70A: Challenges with course/professor (N=79)**

![Pie chart showing the percentage of subcodes for Challenges with course/professor.]

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Quotes were selected from student responses detailing their experiences related to the course, engagement in science, and participating in a one-of-a-kind experience. The following quotes represent almost half of the responses, describing both the course and professor as outstanding.

This has been a class that could possibly make my whole UCLA career. It has been an experience that I couldn't trade or regret. The professor inspires you to put everything you can into the work. Hard work, but well worth it. The most respected professor, to me, and well earned.

Excellently done! This is by far the most unique class I have taken at UCLA. As a graduating senior I can say I am glad to have taken this class while I was here. I only wish I had taken this class earlier in my career. Hats off to all who helped produce this class! It was phenomenal.

No amount of words can sum up my appreciation and huge respect for this course and Dr. Goldberg. Not only has he sparked an interest in a field I detested, he has pushed me to realize my true academic potential. UCLA is tremendously lucky for having him on their staff and should be eternally grateful for his continual hard work. To be concise, the best academic experience of my life.

The next two quotes represent close to a quarter of the responses which reflected an increase in interest, engagement, and learning in science.

Professor Goldberg will remain in my mind as the best professor who is extremely passionate, caring, and brilliant, and whose devotion to science and students' education shows through in every aspect of the class from its organization to the way that each of the lectures were conducted. I wish that there are more classes at UCLA that offer such an eye-opening learning experience which use novel method and encourages students' active engagement with the course material, fellow classmates, faculty, and the professor. I feel that I have learned so much and also been extremely inspired by both the class itself and Dr. Goldberg himself.

The last quote below captures student comments which described the course as a one-of-a-kind experience in college.

HC70A has met and exceeded all of my expectations. I know that there will never be another class in my entire student career quite like it. This class had too much reading, too much work, and too much information to absorb. But that is exactly what makes it so exceptional. I have never had to work as hard for any other class but then again, I have never reaped bigger rewards. Professor Goldberg's class really is one of a kind and what makes it so unique is that he really cares about his students, what he's teaching them, and what they are learning. We put in our all because he does the exact same and this symbiotic relationship is what makes the class so dynamic. This is the best class ever. Never ever cancel it!
**HC70AL Lab Course Evaluations**

*Comments on strengths and weaknesses of instructor and lab course*

The laboratory course evaluations provided information on what students perceived to be the strengths and weaknesses of the instructor and lab course. A total of 52 lab course evaluations were completed, with 48 students (92%) providing open-ended feedback. Qualitative analysis of open-ended feedback yielded a total of 161 coded responses. Figure 6 displays the percentage of major codes identified in the student responses. All students praised the lab course: Outstanding course, professor, and TAs (47.8%), Interest, engagement, learning in science (44.1%), and One-of-a-kind experience in college (8.1%).

**Figure 6. Lab Course Evaluations of HC70AL (N=161)**

Figure 7 displays the percentage of subcodes for “Outstanding course/professor/TAs.” All 77 coded responses revealed that HC70AL was an outstanding course, praised the professor, and TAs, stating it was the best course taken, a phenomenal course, an invaluable and amazing experience (40%) and that the professor had an exemplary teaching style (29%).
Figure 7. Lab Course Evaluations of HC70AL: Outstanding course/professor/TAs (N=77)

Exemplary teaching style
- Outstanding course/professor/TAs: 29%
- Best course taken, phenomenal course, invaluable or amazing experience: 40%
- Emphasis on critical thinking/student learning: 16%
- Dedicated/enthusiastic/passionate instruction: 6%
- Collaborative/interactive environment: 4%
- Personal support or attention/mentoring: 5%
- Collaborative/interactive environment: 4%

As shown in Figure 8, all 71 coded responses revealed that students in HC70AL experienced increased interest, engagement, and learning in science. They cited that there was an unmatched level of learning and mastery of research concepts (28%) and while it was challenging, intense, and a high-level workload, it was also rewarding and worthwhile (20%).

Figure 8. Lab Course Evaluations of HC70AL: Interest/engagement/learning in science (N=71)

- High, very high, or unmatched level of learning, mastery of research concepts/techniques: 28%
- Challenging, intense, high-level, or time consuming workload, but rewarding/worthwhile: 20%
- Intellectual stimulation/inspiration/personal rewards: 10%
- Passion, excitement, enthusiasm toward science, scientific research: 10%
- Immersion in science or engagement in (advanced-level) research: 8%
- Appreciation for interest in science, its practical applications and importance: 8%
- Non-science major - contributing to original research, discovering interest in science, and/or achieving high level or science learning: 8%
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Presented in Figure 9 are the percentage of subcodes for “One-of-a-kind experience.” All 13 coded responses revealed that HC70A was a one-of-a-kind experience because it was a unique, novel, and special experience (84%).

**Figure 9. Lab Course Evaluations of HC70AL: One-of-a-kind experience (N=13)**

Almost half of the open-ended responses, described the course, professor, and TAs as outstanding.

This course, coupled with HC70A is by far the finest, most intense, and most inspiring educational experience I have ever taken part in. I feel blessed to have had the opportunity to work in a world class laboratory and interact daily with the finest available equipment & instructors. This is a class that changes lives and plants inspiration within its students that will last forever.

This course along with HC70A have been the best courses I have taken at UCLA. The TA's were passionate about their teaching roles and always gave 110%. Prof. Goldberg's teaching method encourages critical thinking and learning, and not memorization or regurgitation. During the duration of the course non-science majors gain mastery of the material beyond what most science majors attain. The past 2 quarters have been an illuminating experience.

By far the best experience I have had and will probably ever have. This course is above and beyond any other science class I have taken or have ever heard of. I fell in love with laboratory work thanks to this class. Strengths: making us critically think, hands-on experience! No weaknesses!

As shown below, close to half of the responses reflected an increase in interest, engagement, and learning in science.

The fact that he was able to take 7 students with no scientific background and have us doing graduate-level work speaks for itself.

The lab was definitely something that changed my outlook on science and how I think. Professor Goldberg's method of teaching is revolutionary and helps me retain way more information than another professor's lecture style would. I would definitely recommend this class for anyone who is even remotely interested in science.

A final quote represented responses from a small number of students who described the course as a one-of-a-kind experience in college.
This has been one of the most unique and amazing learning experiences I have ever had the chance to participate in. I tell everyone I can about this class. It is what has made my UCLA experience thus far. Best course ever.

2. HC70A and AL Exit Questionnaires

Exit questionnaires varied by year and therefore six specific items were selected for analysis based on their relevance to determining the impact of HC70A and AL on specific learning outcomes: (a) What students learned about how science is carried out, (b) Student views of scientists and scientific discovery, (c) How HC70A and AL impacted students’ knowledge of genes and gene activity processes, (d) Student interest in pursuing future lab work and research, (e) Student plans for pursuing future courses and graduate programs, and (f) Whether students would recommend HC70A and AL to fellow undergraduates. The questionnaires provided information on a range of course and lab experiences based on student feedback.

(A) What Students Learned About How Science is Carried Out

This questionnaire item asked “What students learned about how science is carried out.” Data are from 2003, 2006, 2008, and 2009 questionnaires. A total of 33 questionnaires were analyzed, which yielded 45 coded responses, and are displayed in Figure 10. All students stated they gained insight on how science is carried out. The main reasons students provided were: science requires a lot of time, effort, and discipline, it is a very challenging, and extremely complex process (60%); science is more than hypothesis testing, it is important to be flexible and examine all possibilities, and fully analyze results (13.3%); and it is exciting to answer questions and make novel discoveries (11.1%).

Figure 10. What students learned about how science is carried out (N=45)

Overall, students gained insight on how science is carried out. For example, one student discovered that scientific discovery is an intense process driven by a network of teamwork.
The scientific community that exists is quite fascinating. The drivers of scientific success are not only the individual efforts of researchers, but the compilation and network of these results that arise from teamwork. Science is also a thinking-intensive process that requires logical progression from one step to the next. Research also requires many tries; trouble-shooting is an extremely large part of the scientific process, and it is not as simple as just translating protocol into results.

(B) Student Views of Scientists and Scientific Discovery

This questionnaire item asked about “Student views of scientists and scientific discovery.” Data are from 2006, 2008, and 2009 questionnaires. A total of 25 questionnaires were analyzed, which yielded 35 coded responses. Figure 11 displays the percentage of coded responses. All students stated their views of scientists and scientific discovery were enhanced after completing the laboratory experience. The main reasons students provided were: they gained lots of admiration and respect for the hard work, passion, curiosity of scientists and their dedication to scientific discovery (57.1%); scientific discovery helps change the world and better our lives (17.1%); and it requires knowledge, critical thinking, patience, and attention to details to be scientist (14.3%).

Figure 11. Student views of scientists and scientific discovery (N=35)

Students stated their views of scientists and scientific discovery were enhanced after completing the series. For example, one student described the experience as,

EYE OPENING. I have such a profound appreciation for scientists in general, professors, and my friends who are science majors. Major discoveries are not easy to come by—and I realize that for every scientist that I have read about, there are thousands who put in similar hard work and thought to solving the same problem, or advancing knowledge to the point that the discovery to be made. It was also great to get a peek into how labs operate. It really humanized science for me... before I thought it was sort of sanitary and heartless. And while it's incredibly hard work my eyes were open to the amount of collaboration and communication required to move forward with research and learning.
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(C) How HC 70A and 70AL Impacted Students’ Knowledge of Genes and Gene Activity Processes

This questionnaire item asked “How HC70A and AL impacted students’ knowledge of genes and gene activity processes.” Data are from 2004 and 2005 questionnaires. A total of 24 questionnaires were analyzed, yielding 24 coded responses. The percentage of coded responses is presented in Figure 12. All students stated that HC70A and AL positively impacted their knowledge of genes and gene activity processes. The main reasons students provided were: built a solid foundation/base for further learning about genes, gained confidence in science (29.2%); first-hand experience working intensively with genes, broadened understanding and application of genetic research (25%); and learned more about genes and gene activity in this course than other Life Science courses (20.8%).

Figure 12. Impact of HC70A and AL on students’ knowledge of genes and gene activity processes (N=24)

Students were shaped by participation in HC70A and AL and increased their knowledge of genes and genes activity processes. As described by a student,

Taking this course has definitely enhanced my knowledge of genes and gene activity processes. Before taking HC7A0 and HC70AL, I wouldn't be able to recall what genes were. However, after taking these two courses, I discovered that genes play a larger role than I ever could have imagined. While I don't need to go into any specifics (i.e. Genes direct the production of certain proteins and reside on a DNA chromosome...), you can very well see that our knowledge of genes is critical to understanding what genes play a role in the development of seeds and what genes direct the production of proteins that may cause embryo lethal.

(D) Student Interest in Pursuing Future Lab Work and Research

This questionnaire item asked about “Student interest in pursuing future lab work and research.” Data are from 2003, 2004, 2005, and 2009 questionnaires. A total of 39 questionnaires were analyzed which identified three different groups: students who expressed interest in pursuing future lab work/research (N=24, 62%), those who did not (N=13, 33%), and two students (5%) who were undecided. For the 24 students who expressed interest in pursuing future lab work and/or research, analysis yielded 36 coded responses. The main reasons students provided were: discovered enjoyment, interest, and
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passion for research/science (27.8%), unspecified interest (25%), and plan to take more science courses, change major, and/or continue with lab work (16.7%). Figure 13 shows the percentage of coded responses.

**Figure 13. Student interest in pursuing future lab work and research (N=36)**

- Discovered enjoyment, interest, or passion for research/science: 27%
- Unspecified interest: 25%
- Plan to take more science courses, change major, and/or continue with lab work: 17%
- Gained awareness into research, graduate-level work, and/or future options in science: 14%
- Realized capacity to do research, gained skills/confidence: 8%
- Enjoyed challenge of research: 6%
- Contributed to scientific/academic community through original research: 3%
- Enjoyed challenge of research: 6%
- Contributed to scientific/academic community through original research: 3%

Well over half of the students expressed interest in pursuing future lab work and research. For example, one student replied:

HC70AL made [the] commitment worthwhile. I had no reservation staying late and coming into the lab to work because whatever I conclude in my research will be used later in research, and will eventually aid in a technological advancement for society. It made my time and effort amount to something of value to me and many other people, knowledge that never existed before I found it. In a way, I feel like I am promoting myself, my professor, and my school with each extra effort I put into more data I can find for them. That's why I enjoyed working in the lab. That's why I hope to work in a lab again.

For the 13 students who did not express interest in pursuing future lab work and/or research, analysis yielded 13 coded responses. The main reasons students provided were: previously decided a non-research path (46.2%), and enjoyed the experience but no future interest (23.1%).

Over a quarter of the students did not express interest in pursuing future lab work and/or research. However, as one student explained, while research was exciting, s/he planned to continue with a pre-selected career path.

Before taking this course, I honestly did not fully comprehend the appeal of doing research as a full-time occupation and way of life. However, after being immersed in laboratory research and the environment for just 10 weeks, I understand all too well the appeal and excitement involved in this field. However, for a career, I still want to pursue one that consists of immediate interaction with patients, communities, etc. to help improve various communities' conditions of living and individuals' well-being (pediatrics, public health).
**E) Student Plans for Pursuing Future Courses and Graduate Programs**

This questionnaire item asked about “Student plans for pursuing future courses and graduate programs.” Data are from 2006, 2008, and 2009 questionnaires. A total of 25 questionnaires were analyzed, which yielded 27 coded responses, as presented in Figure 14. Almost all students (92%) expressed plans for future courses or graduate programs. The main reasons students provided were: plans for taking additional science courses and/or pursuing future lab work/research (29.6%) and changing their major or concentration of major to science or related discipline/topic (22.2%).

**Figure 14. Student plans for pursuing future courses and graduate programs (N=27)**

Overwhelmingly, students plan to take future courses and/or enroll in graduate programs. As one student noted, the course gave him/her the confidence to take challenging science courses.

After taking this course, I think I will try to take more courses that deal with scientific topics, and not be afraid that they are too difficult. I used to think advanced science was unapproachable, but now I know that I have the ability to understand if I put in the hard work. I shouldn't be afraid to take on the challenge if I know the rewards are going to be amazing.

**F) Whether Students Would Recommend HC70A and AL to Fellow Undergraduates**

This questionnaire item asked “Whether students would recommend HC70A and AL to fellow undergraduates.” Data are from 2003, 2004, and 2005 questionnaires. A total of 32 questionnaires were analyzed, which yielded 31 coded responses, as can be seen in Figure 15. Overwhelmingly, 31 out of 32 students (97%) would highly recommend the course or lab. The main reasons students provided were: it was gratifying, fun, and an incredible learning experience for non-science majors (19.4%), it was a huge time/work commitment and challenging but definitely worth it, personally rewarding, and increases confidence in doing research (19.4%), and everyone could benefit from the unique experience of taking this course (12.9%).
Overall, almost all students would highly recommend the course or lab to a peer. The following quote describes one student’s sense of accomplishment for all s/he achieved in the series.

Definitely. If a fellow undergraduate chose to take this lab, I would warn them that it is some of the hardest work they will ever do at UCLA. They will be dedicating most of their spare time to experiments in the lab, and will constantly be challenged to think critically. However, I would tell the student that what they will learn is phenomenal. They will be doing real research and will be discovering things about their gene and plants that no one else has done before. And, at the end of the ten weeks, they will be able to turn in a binder and give a research presentation, both full of their own research and data!

3. Teaching Assistant/Fellows Interviews

For the final assessment component, CEA researchers interviewed former HC70A and AL students who served as Teaching Facilitators (TFs) or Peer Research Mentors (PRMs) for the course. Interview data corroborated findings from analyses of course surveys and exit questionnaires, suggesting the uniqueness of the course experience, its extreme rigor, and numerous substantial positive impacts for not only HC70A and AL students but also its student leaders. Specifically, findings are organized into four areas: (a) Unique or atypical aspects of the HC70A and AL experience, (b) Impacts of the HC70A and AL experience on undergraduate academics, (c) Impacts of the experience on graduate school and career plans, and (d) Learning outcomes.

Unique or atypical aspects of the HC70A and AL experience

Interviews revealed numerous atypical or unique aspects of the HC70A and AL courses and of participants’ teaching experiences. First, unlike other courses, undergraduates taught other undergraduates (i.e., “peers teaching peers”). Second, both taking and teaching the courses were extremely challenging and time consuming. Third, Dr. Goldberg’s teaching and mentorship were exemplary. Examples of excellent teaching and mentorship include using the Socratic Method, offering...
Assessment of HC70A and AL hands-on and creative in-class activities during lectures, inviting dynamic guest speakers, giving frequent and individual feedback on student teaching, and fostering out-of-class interaction through dinners with the professor and guest speakers. Fourth, non-science majors engaged in advanced science. Fifth, students conducted and presented original research. Sixth, students learned how science fits the bigger picture—how it relates to society, to their everyday lives, and to controversial and current issues. Finally, a culture of cooperation, not competition, pervaded both lecture and lab, where students functioned as a team. These unique and atypical features give a sense of student, TF, and PRM experiences, and may help account for the impacts discussed below.

Impacts of the HC70A and AL experience on undergraduate academics

The majority of participants shared that involvement in HC70A and AL raised their excitement or interest in science. As a result, they persisted in the field. For example, a student who was “always interested in science” but “didn’t have the greatest science classes,” shared that involvement in HC70A and AL “really got me excited about science again.” Taking the lab encouraged her “to keep going with science and wanting to apply to medical school.” Likewise, another student expressed, “[This class] revealed to me that I love molecular biology.” Taking the courses resulted in her decision to choose the Molecular Cell and Developmental Biology major. A third participant expressed broad interest in biology as a freshman combined with uncertainty as to what major to pursue. The HC70AL lab course, which was “much more exciting” than other lab courses, “cemented” her interest in science. She is now pursuing an advanced degree in Microbiology, Immunology, and Molecular Genetics (MIMG). And for a fourth participant, the PRM experience—specifically exposure to a group of enthusiastic students in the lab—“brought the excitement back for all of us.”

In addition to increasing excitement, interest, and willingness to persist in science, the HC70A and AL experience enhanced more specific aspects of participants’ undergraduate academics. TF and PRM involvement improved such things as motivation and focus, work habits, and time management skills.

Impacts of the HC70A and AL experience on graduate school and career plans

For all participants, the HC70A and AL experience had a substantial impact on graduate school and career plans. Both of the undergraduate participants expressed a desire to continue their education after graduating. One participant, who planned to attend medical school, decided to incorporate research into her future studies: “I did a lot of lab work because I just enjoy doing it. And it’s made me want to pursue research when I go to medical school. . . . I’m going to try and seek out some cool research.” The second undergraduate participant learned from HC70A and AL “how science really infiltrates all degrees of society and almost all professions.” She planned to attend graduate school and do research, with a newfound awareness of different career options in molecular biology: “I do want to do research, but . . . I really could go into any field. I could go into law—I could do IP law. I could go into agriculture.”

The MIMG graduate student attributed her graduate school and career path to HC70A and AL. “If I hadn’t interacted with the course at all,” she said, “I don’t think that I would be in graduate school.” TF and PRM work also sparked an interest in educating people about science, and she will be incorporating some form of science teaching into her future career.

Another participant, who is currently a medical resident, explained how HC70A and AL involvement directed her future plans—“it sort of focused my career path.” At the time of the interview she was choosing between two career options, both related to molecular biology and genetics. “Either of the two fields I end up going into within gynecology are going to be . . . based on molecular biology of cancer cells or on the molecular biology of infertility.”
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Aside from impacting future goals, experience in HC70A and AL gave these four students a variety of tools to achieve their goals. Some of these tools are discussed below in the section on learning outcomes.

Learning outcomes

From being better prepared for medical school interviews and oral qualifying exams to learning the aesthetics and presentation required for “clear and conceptual” research figures, and from writing better abstracts and giving lab meetings to living the medical residents’ motto of “see one, do one, teach one,” every participant pinpointed valuable gains in teaching, presentation, and/or verbal communication skills. As one explained, “Presenting all the lectures and reading the discussions, you definitely have to be on top of your game, especially with Dr. Goldberg.” They also commented on benefits of using the Socratic Method to teach non-science majors challenging subject matter. One student stated, “It became a really big issue to be able to convey clearly and efficiently what I meant and to be able to ask questions that lead to a clear answer.” Another commented that presentations and writing assignments “just felt easier” because she “had spent so much effort trying to explain things conceptually to non-[science] major students.”

Participants also described gains in scientific knowledge and awareness. The following quote articulates one student’s amazement with the knowledge she gained.

You’re at the end of the quarter and you’re looking back to week one when you had no idea what DNA even stood for. And now you can describe in detail the structure of the molecule and how it was discovered and the history behind it and the people involved in the discovery and how it can be manipulated. It was just incredible to me that I had acquired that much knowledge.

Learning the “positive applications” of science was repeatedly mentioned during interviews as well. Seeing connections between science and society was described as “eye-opening” and “[putting] a lot of stuff in context.” According to one participant, “Everyone walks away from the class thinking differently than they have before they took the class.”

Increased confidence was an additional outcome cited by participants and commonly associated with meeting the high level of challenge presented by the course:

Had I not been challenged in … the way that Dr. Goldberg challenges his students, I wouldn’t have reached or exceeded the potential that I have. . . . It enables me to have confidence in myself, that I can learn anything.

Discussion

Overall, students praised HC70A and Dr. Goldberg. They noted that the course was an amazing experience and that it was the best course they had taken. Students learned a lot from the course and even nominated the instructor as an exemplary professor. They appreciated the value he placed on student learning. Students engaged in critical thinking, group work, and interactive discussions that raised their interest in science. A small number of students expressed concern that the Socratic Method was intimidating and that the workload was too heavy. While the workload was demanding, students claimed that the course and experience were worthwhile.

Similarly, students enjoyed the lab course, HC70AL. About half of all comments praised the lab course, professor, and teaching assistants, emphasizing that the teaching style in the lab course was extraordinary and that HC70AL provided an invaluable, phenomenal experience. In addition, many student discussed an increased interest, engagement, and learning in science as a result of taking the lab course. Students
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reported mastering difficult scientific concepts and research techniques. They found the challenging, intense lab work to be rewarding. The gene discovery lab provided a unique opportunity for non-science and entering-science undergraduate students to gain first-hand laboratory research experience.

Upon completing both HC70A and AL, students responded positively to questions about (a) what they learned about how science is carried out, (b) their views of scientists and scientific discovery, (c) how HC70A and AL impacted their knowledge of genes and gene activity processes, (d) their interest in pursuing future lab work or research, (e) their future academic plans, and (f) whether they would recommend this course to their peers. All students gained a better understanding of how science is carried out after completing HC70A and AL. Similarly, all students expanded their views about scientists and scientific discovery. They also gained knowledge of genes and gene activity processes.

The majority of students had a greater appreciation for the large amount of time, effort, and discipline required to carry out complex scientific processes. They gained lots of respect for the hard work, passion, and curiosity of scientists. As a result of working first-hand with genes in the lab, students learned about genetic research, its applications, and the vast impact that scientific discovery has on the world. The knowledge and experience gained from HC70A and AL increased students’ confidence in their science ability and built a solid foundation for learning more about genes.

Given that HC70A and AL are geared toward non-science majors, it is significant that over half of the students expressed interest in pursuing future lab work or research, upon completion of the series. These students explained that they had discovered an enjoyment and interest in research and science. They also gained a greater awareness of research and future opportunities in science and developed the skills and confidence necessary to conduct research as a result of these courses. Meanwhile, other students expressed that while they enjoyed the course, they had previously decided on a non-research path. Almost all students commented on their desire to take additional science and research courses, with some even hoping to change their major to pursue a science degree and attend graduate school in the sciences. Finally, all but one student enthusiastically recommended that their peers take HC70A and AL.

Teaching Fellows and Peer Research Mentors conveyed having exceptionally positive and unique experiences both as students and student leaders in HC70A and AL. They not only praised the course, instructors, and fellow students, but also shared a multitude of positive influences and outcomes that resulted from their experience with the honors collegium series. The course and teaching experience substantially contributed to their current paths in graduate and professional school. It also led to mastery of scientific knowledge, both conceptual and topical; gains in teaching, presentation, and verbal communication skills; increased confidence; and an awareness of the relationship between science and society. All the TFs and PRMs interviewed expressed a strong desire to see HC70A and AL continue to provide all undergraduates, science and non-science majors, with such a rewarding experience.