High Impact Interventions to Enhance Student Learning of Stem Cell Biology Specific Knowledge and Skills

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Abstract

The Bridges to Stem Cell Research program (BSCR) at California State University, Fullerton (CSUF) is a CIRM-funded internship program that provides undergraduate students with an intensive and rigorous learning experience in the field of stem cell biology. The BSCR program prepares students through a series of high impact interventions including a stem cell-focused curriculum, one-on-one faculty mentoring, and hands-on workshops during a seven-month period at CSUF. The students then complete their full-time, intensive internship in a stem cell laboratory at one of four partnering institutions. Preliminary evaluation data focused on student attitude and self-evaluation suggest that the training plan is very effective. We are currently exploring ways to make entry-level stem cell skills and knowledge more accessible to other students who are not part of the BSCR internship program. We are also working on more systematically capturing the effectiveness of the interventions. Possible ideas include the development of a "stem cell concept inventory", the examination of student attitudinal change such as STEM-related interest, self-concept, research-efficacy, and STEM career aspirations.

Program Overview

California Institute for Regenerative Medicine (CIRM) Goals Include the Acceleration of Stem Cell Research by:

1. Finding novel treatments relating to or using stem cells
2. Preparing the next generation of scientists
3. Increasing stem cell related research

BSCR Program Goals are to Prepare Students for an Intensive Stem Cell Research Internship by:

1. Intensive, formal, stem cell-related coursework (Summer/Fall semesters)
2. Independent research projects for six months in a selected CSUF lab
3. Research proposal under their internship mentor's supervision
4. Internship sites: Children's Hospital of Orange County, UC-Irvine, Stanford University, University of Southern California

Course Activities	Benefits
Summer 2016	
• BIOL 329 – Essential Techniques in Cell Biology • Full time research in a CSUF lab (volunteer)	• Experience in a Lab setting prior to the internship.
Fall 2016	
• BIOL 427 – Stem Cell Biology Lecture • BIOL 429 – Techniques in Stem Cell biology (Lab) • BIOL 480C – Profession Seminar • BIOL 499 – Independent Research • PHIL 316 – Research Ethics	• Courses apply towards B.S. in Biology • Experience in cell/molecular research, stem cell culturing, and differentiation protocols • Improved communication, goal setting, and strategic planning skills
Spring 2017	
• Fulltime enrollment in internship related courses (BIOL 299, BIOL 480, BIOL 499, and BIOL 495L) • Research at internship site	• Possibility of strong recommendation letters for the BSCR scholar • Stipends of $2,500 a month for a total of $17,500 • Tuition reimbursement

Methods: Survey data was collected anonymously from the 46 BSCR scholars enrolled in 2010-2015. The data captured their first self-perceptions before and after BSCR participation, with an average response rate of >85%. Internship site mentors were also surveyed during the same 5-year period with a survey completion rate of <75%.

Students' Experiences

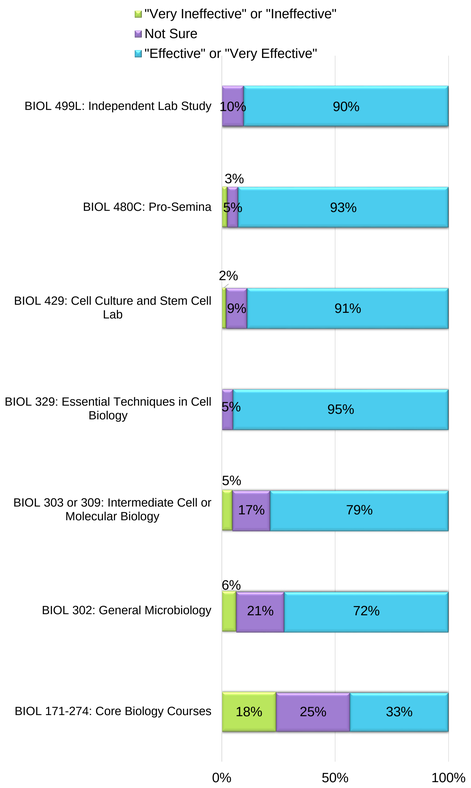

Figure 1. ***Effectiveness of Biology Curriculum in Preparation for Internship during Post-Assessment (n>35)***. Students were asked how effective the Biology curriculum was at CSUF at the end of their internship. BSCR Scholars report that the stem cell courses and program-specific courses (BIOL 480C and BIOL 329) were *effective* or *very effective* in preparing them for their stem cell research internship.

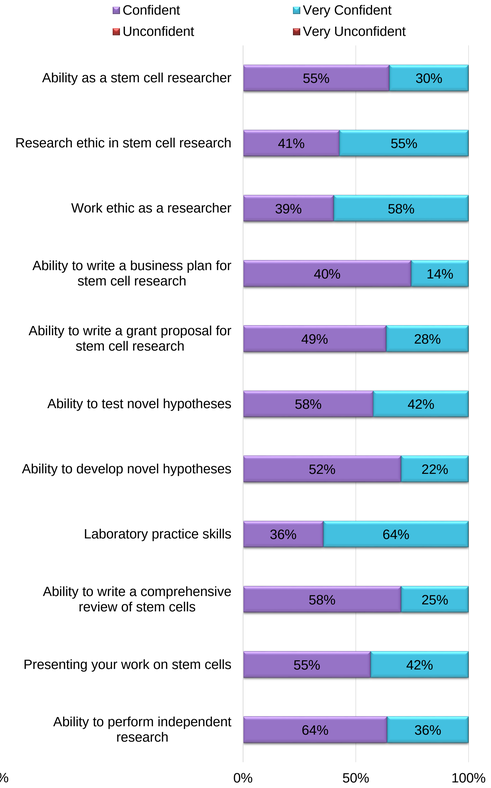

Figure 2. ***Perceived Confidence Levels for Students during the Post-Assessment (n>35).*** Students were asked to rate their confidence in different areas. During the post CSUF training survey, student responses indicated that they felt confident in their abilities to perform independent research projects, present their work on stem cell research, develop practical laboratory skills, develop an ability to test novel hypotheses, and become a stem cell researcher. Note: no student gave a response below confident.

Scholar Career Path	
PhD Program	4
Medical School	9
Lab Technician	16
Professional Program (e.g. D.D.S.)	5
Healthcare Field Assistant	2
Other	1

Table 1. ***BSCR Scholar Career Path Post-Internship.*** Scholars career data was collected from the 2010-2015 cohorts. The data represents status of scholars as of August 2016. Overwhelming majority of BSCR program alumni remain in a healthcare/research related field.

Scholar Publications	
Number of Publications	35
Scholars With Publications	15
Publications With Internship Mentor	14
Stem Cell Related Publications	8

Table 2. ***BSCR Scholar Publications Data.*** Table shows the number of publications BSCR alumni from the 2010-2015 cohorts have released. Many scholars publish during their internship with their mentors. Of the 35 publications 8 are directly related to the field of stem cell research.

Mentors' Evaluation

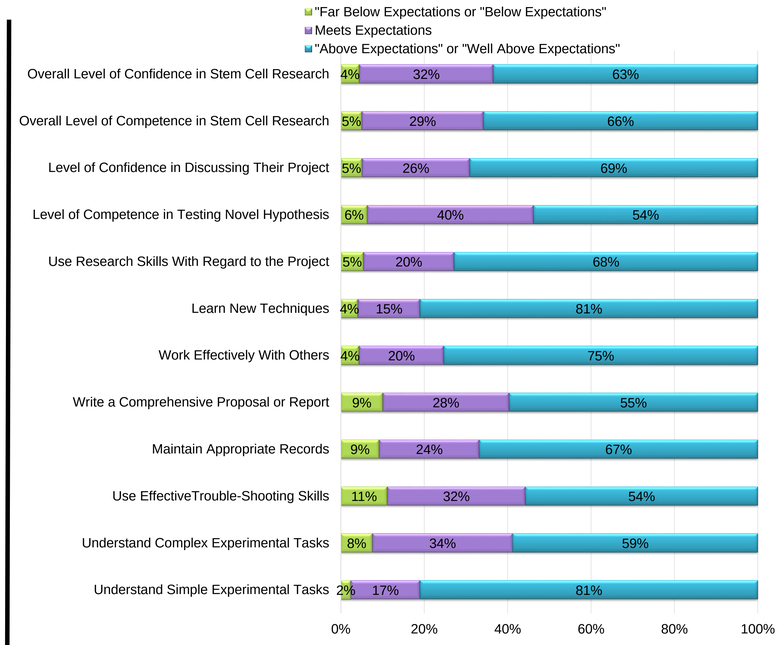

Figure 3. ***Initial Mentor's Assessment of Students' Understanding of Basic Concepts in Stem Cell Research (n>35).*** Mentor evaluations of students' initial understandings, during the students' first two weeks at their internship site, of stem cell research and level of knowledge/ability are demonstrated. Mentors were instructed to compare the BSCR scholars to their previous experience with upper division undergraduate students, recent college graduates, or PhD students as a reference. Overall, results showed that mentors believed their students either met or exceeded their expectations for the basic practices of stem cell research. Data represents five different cohorts from 2010-2015.

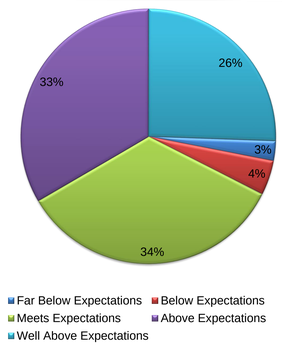

Figure 4. ***Comparison of BSCR Scholar to Other Undergraduate Students (n>35).*** Mentors at internship site were asked to rate BSCR students compared to other undergraduate students regarding progress made during internship. Results indicated that students were either meeting or exceeding the mentors' expectations, with only a few students performing below their expectations. Data represents five different cohorts (2010-2015).

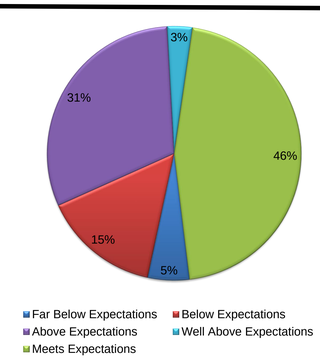

Figure 5. ***Comparison of BSCR Scholar to First Year PhD Students (n>35).*** *Mentors were asked to compare* the performance of BSCR scholars in the program to first year Ph.D. students. Results indicated that the scholars are meeting the expectations of the mentors . Positive responses indicated that students were just as good, if not better, than many of the Ph.D. students they had worked with previously. Data represents five different cohorts (2010-2015).

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