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, immersive internship in a stem cell laboratory at one of four partnering institutions. Preliminary evaluation data focused on student attitude and self-evaluation showed 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 attitude 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. Intensive, form, 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

Fall 2016

- BIOL 329 – Essential Techniques in Cell Biology
- BIOL 342 – Techniques in Stem Cell Biology (Lab)
- BIOL 480C – Internship Seminar
- BIOL 499 – Independent Research
- PHL 316 – Research Ethics

Spring 2017

- BIOL 427 – Stem Cell Biology Lecture
- BIOL 429 – Techniques in Stem Cell Biology (Lab)
- BIOL 480B – Research Seminar
- BIOL 499 – Independent Research
- PHL 316 – Research Ethics

Methods: Survey data was collected anonymously from the 46 BSCR scholars enrolled in 2015-2016. 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%.

Course Activities

- BIOL 329 – Basic Techniques in Cell Biology
- BIOL 429 – Techniques in Stem Cell Biology (Lab)
- BIOL 480C – Internship Seminar
- BIOL 499 – Independent Research
- PHL 316 – Research Ethics

Benefits

- Experience in a Lab setting prior to the internship.
- 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

Figure 1. Effectiveness of Biology Curriculum in Preparation for Internship during Post-Assessment (n=20). 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=20). 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.

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

<table>
<thead>
<tr>
<th>Scholar Career Path</th>
<th>Number of Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD Program</td>
<td>8</td>
</tr>
<tr>
<td>Medical School</td>
<td>9</td>
</tr>
<tr>
<td>Lab Technician</td>
<td>16</td>
</tr>
<tr>
<td>Professional Program (e.g., D.O.S.)</td>
<td>5</td>
</tr>
<tr>
<td>Healthcare Field Assistant</td>
<td>2</td>
</tr>
<tr>
<td>Other 1</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. BSCR Scholar Publications. Data shows the number of published papers from the 2015-2016 cohort. Many scholars publish during their internship with their mentors. Of the 25 publications 8 are directly related to the field of stem cell research.

Table 3. Overall Level of Confidence in Stem Cell Research. A survey was sent out to the 2015-2016 cohort. The data represents scholars as of August 2016. Overwhelming majority of BSCR program alumni remain in a healthcare/research related field.

<table>
<thead>
<tr>
<th>Number of Students</th>
<th>Below Expectations</th>
<th>Below Average Expectations</th>
<th>Average Expectations</th>
<th>Above Average Expectations</th>
<th>Well Above Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>9%</td>
<td>4%</td>
<td>38%</td>
<td>35%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Figure 3. Initial Mentor’s Assessment of Students’ Understanding of Basic Concepts in Stem Cell Research (n=30). Mentors were asked to rate their previous experience, during their students’ first two weeks at their internship site, of stem cell research and level of knowledgeability are demonstrated. Mentors were asked to rate how confident the BSCR scholars are of their previous experiences 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 2015-2015.

Figure 4. Comparison of BSCR Scholar to Other Undergraduate Students (n=30). Mentors at internship sites 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 mentors’ expectations, with only a few students performing below their expectations. Data represents five different cohorts from 2015-2015.

Figure 5. Comparison of BSCR Scholar to First Year PhD Students (n=30). Mentors were asked to compare the performance of BSCR scholars in the program to first year Ph.D. students. Results indicated that the scholars were meeting the expectations of the mentor. Positive responses indicated that students were just as good, if not better, than the majority of the Ph.D. students they had worked with previously. Data represents five different cohorts (2015-2015).

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