Understanding the Network of Interventions Shaping Successful Scientists Through to the Doctorate in Biology Before and After the REU

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Purpose of Talk

• To examine a specific REU program and its outcomes as a potential illumination of the larger issue of underrepresentation in biomed careers

• Study population is of 114 of 125 undergraduate students participating in the UC Berkeley MCB/IB NSF REU for 12 years, 2006-2017

• To understand:
  1. career outcomes
  2. the events, circumstances or network of supportive activities before and after the REU contributing to present situation—the whole student
  3. Specific contributions of REU experiences

Suggest how interventions might utilize this knowledge
Description of UC Berkeley REU Program Discussed

• NSF Summer Research Site in Cell, Developmental and Evolutionary Biology, PI David Weisblat, MCB 2006-12
• NSF Summer Research Site in Integrative Biology: From Molecules to Ecosystems, PI Tyrone Hayes, IB 2013-17, NSF No. 1359472
• 200-400+ applications for 10-14 awards
• 10 week, 40 hr/wk research
• Ongoing seminars by participating PIs on both science and career
• Comprehensive professional development
• Staffed by 3 faculty, program coordinator and evaluator
My observation angle

• Co-authored grant proposal, continuous program design input
• Participated in most non-lab activities
• Created and delivered professional development program with faculty, grad students, bio professionals
• Demystified writing, grad school, GRE, presentations, etc
• Conducted intake and exit interviews, designed, administered post-program survey, NSF USSRA
• Interacted with students over 10 week period and afterward
• Stayed in contact with many, tracked others
Questions for Consideration in this Talk:

• Why is it so difficult to increase the number of particularly Black Ph.D.s? and in Biology
• What could be missing from intervention design?
• Why could something be missing?
• Could it be that how many programs are conceptualized might be the problem?
• Or what has been the focus of the intervention?
• Why are some programs such as the Meyerhoff and Biology Scholars Program so successful?
• How should intervention success be measured?

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Organization

• Introduction: Background on underrepresentation

• Method:
  • 1. Grounded theory (1986) or historical methods, or CHAT, cultural historical activity theory. Collect & understand data, then see emergent patterns. Qualitative, observational, weighed against large literature
  • 2. Mixed methods: surveys, interviews, participant observation

• Findings: Characteristics of REU participants and post-program outcomes: Derive from qualitative retrospective longitudinal study

• Discussion:

• Implications and further research
Introduction: What Current Studies Show about Underrepresentation in Biology

• HBCUs and HSIs produce a disproportional number of BS degrees relative to their size (Reeves & Joo, 2017; Upton & Tanenbaum 2014)

• That the two greatest breaks in transition to an advanced degree are from BS to graduate school, from postdoc to faculty (Meyers, et al.2018)

• A trend to not seek academic jobs after Ph.D. (Gibbs, et al.2014)

• At the doctoral level Hispanic/Latino degrees increasing, those of Blacks very little, whites stagnant, Asian increasing (Yamaner, 2018)

• Faculty everywhere disproportionately white (Finkelstein et al. 2016)
## Earned Doctorate Degrees by Ethnicity

<table>
<thead>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>US + PR S&amp;E</strong></td>
<td>19,401</td>
<td>23,113</td>
<td>24,106</td>
<td>29,338</td>
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<tr>
<td><strong>Agriculture</strong></td>
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<tr>
<td>All</td>
<td>553</td>
<td>611</td>
<td>639</td>
<td>888</td>
</tr>
<tr>
<td>Black</td>
<td>20</td>
<td>19</td>
<td>47</td>
<td>31</td>
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<tr>
<td>Latino</td>
<td>13</td>
<td>14</td>
<td>33</td>
<td>47</td>
</tr>
<tr>
<td>Non Hispanics</td>
<td>540</td>
<td>597</td>
<td>606</td>
<td>841</td>
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<tr>
<td><strong>Biology</strong></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>All</td>
<td>3724</td>
<td>4330</td>
<td>5447</td>
<td>5720</td>
</tr>
<tr>
<td>Black</td>
<td>106</td>
<td>152</td>
<td>206</td>
<td>219</td>
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<tr>
<td>Latino</td>
<td>149</td>
<td>216</td>
<td>326</td>
<td>425</td>
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<tr>
<td>Non Hispanics</td>
<td>3575</td>
<td>4114</td>
<td>5121</td>
<td>5295</td>
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<tr>
<td><strong>Medical + Hsci</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>1995</td>
<td>5284</td>
<td>3536</td>
<td>4667</td>
</tr>
<tr>
<td>Black</td>
<td>94</td>
<td>229</td>
<td>266</td>
<td>488</td>
</tr>
<tr>
<td>Hispanic</td>
<td>56</td>
<td>148</td>
<td>138</td>
<td>280</td>
</tr>
<tr>
<td>Non Hispanics</td>
<td>1899</td>
<td>5136</td>
<td>3393</td>
<td>4387</td>
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</tbody>
</table>

*Science and Engineering Indicators 2018. Appendix Table 2-32.*
## Life Science/Biology Doctorates Awarded 2001-2016 by Ethnicity

<table>
<thead>
<tr>
<th>Field of study, ethnicity, and race</th>
<th>2001</th>
<th>2006</th>
<th>2011</th>
<th>2016</th>
<th>%2016</th>
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</thead>
<tbody>
<tr>
<td>All fields</td>
<td>28,894</td>
<td>29,028</td>
<td>31,726</td>
<td>35,719</td>
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<tr>
<td>Life sciences</td>
<td>5,956</td>
<td>6,506</td>
<td>7,892</td>
<td>8,697</td>
<td>24.0%</td>
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<tr>
<td>Hispanic or Latino</td>
<td>220</td>
<td>306</td>
<td>471</td>
<td>655</td>
<td>7.4%</td>
</tr>
<tr>
<td>Not Hispanic or Latino</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian or Alaska Native</td>
<td>21</td>
<td>16</td>
<td>25</td>
<td>27</td>
<td>0.3%</td>
</tr>
<tr>
<td>Asiana</td>
<td>666</td>
<td>696</td>
<td>853</td>
<td>915</td>
<td>10.5%</td>
</tr>
<tr>
<td>Black or African American</td>
<td>211</td>
<td>299</td>
<td>428</td>
<td>510</td>
<td>5.9%</td>
</tr>
<tr>
<td>White</td>
<td>4,588</td>
<td>4,927</td>
<td>5,753</td>
<td>6,118</td>
<td>70.3%</td>
</tr>
<tr>
<td>Other</td>
<td>55</td>
<td>97</td>
<td>180</td>
<td>472</td>
<td>5.4%</td>
</tr>
</tbody>
</table>

Source: NSF Survey of Earned Doctorates 2016, Table 23
The REU Program Structure

- Intense initial orientation
- Housing together
- Prior stud PI contact
- Entrance into lab first day
- Mornings 1st week series of biology overviews
- Weekly professional development
- Weekly seminars by participating faculty on research and career
- Final presentation
- Ethnically and gender mixed team
- Events with other Bay Area REUs—ethics training, museum visit, botanical garden, Monterey Aquarium, California Academy of Science
The Program and Population Discussed: UCB NSF REU Participants 2006-2017

- 12 cohorts from 5-14 students, cohort both dynamic and significant
- Total participation: 125 students, 114 pathways discussed
- Gender: 81 women, 44 men—women always the majority
- Largely first 1\textsuperscript{st} generation, most eligible for financial aid,
- 3 rising sophomores, 38 juniors, 66 seniors, 13 5\textsuperscript{th} year seniors
- Vast range of undergraduate institutions from liberal arts colleges, MA granting state systems, HBCUs, MHIs, RU Is, community colleges
The Program and Population Discussed: UCB NSF REU Participants 2006-2017 con’t

• Almost half (56) had formal research experience prior to UCB REU: MARC 21, [other] REU 17, McNair 6, MBRS 4, other 8
  • Only a few each year had no research experience at all. In between were students working with a PI at home college informally

• About one quarter took one or more years off after the BS:
  • Most frequent reason to learn more biology, science, develop research skills achieved by working in labs at places like Cornell, Harvard, UW etc.

• All earned their B.S. degrees
## UCB REU Students by Ethnicity 2006-2017

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Count</th>
</tr>
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<tbody>
<tr>
<td>Mexican American</td>
<td>22</td>
</tr>
<tr>
<td>African American</td>
<td>37</td>
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<tr>
<td>Caucasian</td>
<td>21</td>
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<tr>
<td>Pacific Islander</td>
<td>3</td>
</tr>
<tr>
<td>Native American</td>
<td>1</td>
</tr>
<tr>
<td>Asian American</td>
<td>10</td>
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<tr>
<td>Latino</td>
<td>7</td>
</tr>
<tr>
<td>Filipino</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>11</td>
</tr>
</tbody>
</table>

**Important Note:**
Many students identifying with one or other ethnic group have a very mixed background. Identification for US purposes obscures overseas origins as program includes Permanent Residents.
UCB REU Students by Ethnicity 2006-2016

- Mexican American: 18%
- African American: 30%
- Caucasian: 17%
- Pacific Islander: 2%
- Native American: 1%
- Asian American: 8%
- Latino: 5%
- Filipino: 2%
- Puerto Rico: 9%
- Other: 6%
- More than one race: 2%

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Degree Attainment and Program Enrollment of UCB REU Participants 2006-2016

<table>
<thead>
<tr>
<th>REU Year</th>
<th>B.A., B.S*</th>
<th>MA, MSc.</th>
<th>Ph.D.</th>
<th>M.D. &amp; related</th>
<th>Total</th>
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<tbody>
<tr>
<td>2006</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>12</td>
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<td>2007</td>
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<td>2</td>
<td>11</td>
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<tr>
<td>2008</td>
<td>5</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>2009</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>2010</td>
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<td>3</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>11</td>
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<tr>
<td>2013</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2014</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>2015</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>2016</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>10</td>
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<tr>
<td>Totals</td>
<td>38</td>
<td>20</td>
<td>36</td>
<td>20**</td>
<td>114</td>
</tr>
</tbody>
</table>

*An earned BS is the fallback attribution for participants who did not pursue further education or in a few cases, for those students who cannot be found. All other degrees listed are either already earned or student is enrolled and confirmed directly with the student.

**Includes 3 D. Pharm. and 1 DDS
Paths after earning a bachelors degree

• Took time off from academy: to improve their preparation for graduate school, understand science better. Few, if advanced degree bound did non-science work.

• Entered a Ph.D. or MD program

• Earned a Ph.D. M.D. or D. Pharm or DDS

• Earned a M.S. or M.Sc. In a technical science field
  • Or, left a Ph.D. program with an M.S. and left graduate trajectory

• Went to grad school in some other field

• Work in biology related positions
Less evident characteristics of students

• Differing degrees of commitment to “science”
• Education for social and economic mobility
• Motivated by forms of altruism and service
• Dealing with life as a young adult
• Great variation in financial well-being from extreme poverty to wealth
• Coping with intimidation: Berkeley, prestige of PI, white institution, size
• Growing from background: first time not under parent’s roof, first time on airplane, first time having a preformed reference group, first time interacting with students from different backgrounds, first time eating new food, first time thinking about grad school...that professionals broader than MDs,
The Network of Support from Positive Aspects of background (sometimes)

- Usually 2 parent stable family, overwhelmingly a source of support
- Strong, very strong support from mothers-single or in family
- Childhood neighborhood supportive (mostly of same ethnicity)
- Strong mentorship in environment, not always at college
- Some idea about research
- Allowed, encouraged to be curious
- Some recognition of capability in spectrum from 1 event to ongoing
- For some strong religious beliefs
- Close identity with ethnic group, a few activist
Motivation of Students

• Love of science, intrigued with a particular problem
• Contribute to understanding and curing of particular disease
• Serve their own communities “I have a dream . . .”
• Acquire a helping profession in medicine more generally
• Move up economically, class mobility
• Become a stable professional AND help their families
• To develop a particular talent-art, counseling, teaching
REU in a spectrum of achievement and reinforcement

• Impact of prior formal research experiences: (Questions: How much did your participation in these other programs influence your interest or commitment to science or have an effect on your academic development? 77 responses

  • A great deal 54%
  • Somewhat 18%
  • A little 2%
Short-term Impact of UCB REU

• From post-program survey:

• Has your participation in this REU this summer influenced your interest or commitment to science? 116 responses
  
  A great deal   93   80.2%
  Somewhat       21   18.1%
  A little        2    1.2%

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Typical Comments on Program from Students

• G: A packed experience, impactful, definitely gave a lot of perspective—got a lot out of the 10 weeks, can’t imagine packing much more into it. Everything new—research, place, level of institution, very definitely loved it!

•

• E: Still crystalizing what is the most impactful of the summer: fantastic network, working in a lab, learning about grad school, future plans for the next 4-5 years—it has been an incredibly valuable learning experience and I am grateful for it.

•

• A: A lot of help from 1st gen perspective, really helpful getting info about grad school, doing research in the best university, grateful to be here and to be given the opportunity. Learned a lot, grown as a person, have a better idea of what wants to do. Good connections in cohort and team, an amazing opportunity and very grateful to a have been part of it. REU impacted my life . . .Now confident after 9-5 in the lab and that can do research, really enjoy it, excited to continue using what learned here. Best summer of life so far!!

•
Typical Comments on Program from Students

• B: Came with no expectations—did not want to raise them to be disappointed. Surprised that so well organized and planned out, really effective. Really enjoy research, confidence improved in terms of getting out of comfort zone, communication skills. Wish had known about such programs so could have applied to others. Had a great time, thank staff, welcoming since 1st day, felt very supported. Than everyone for giving me the opportunity.

• K: Great networking opportunity, really showed me which direction to take in research. Made more confident in research, more aware of other researcher and collaborations. Great group of people, ended up in great lab, overall more confident.

• H: Got so much experience that came here for. Feel confident, lab skills, resume, knowledge of different fields, grad school-how to apply what to focus on—so much clearer. I had no idea about the future, how have a plan developing, program provided me with a structure that need in life. So grateful, found out so many things about myself—going on a plane, doing research at UCB, blows my mind. Hard work pays off, nothing in life handed to me—to see it all come together is so rewarding. Thank you! I don’t want to leave and am not going home as the same person, a new individual, feel changed.
Typical Comments on Program from Students

• F: The best summer in life so far—the people, the program and how the REU works and its people. The things I could do here, go to LA, go on GG Bridge, etc. Know now that more passionate about home field having been exposed to something else. Am 100% confident about grad school, being in Berkeley great to talk to so many professors and hopes to apply here. Thank you! Will remember this summer for the rest of my life, definitely appreciate the work, grew this summer.

• C: Best summer of my life – a lot outside program being in Berkley, encouraged to do everything—Yosemite, SF & LA. Appreciate program, project and placed with a PI and lab culture is as good as it gets. They care, made me care and become passionate about what can accomplish. Made friends, met cool people, positive experience.

• E: An extremely rewarding opportunity, difficult to imagine, best summer so far, increased opportunities, am thankful. Once here no imposter syndrome, one here felt belonged, humble about it, making the most of the experience. Thank you
Beyond Comments, Issues

• PIs: Finding enough PIs, one student wants to work with, one on site most of summer. Not always a good match, not always there
• Addressing newness of coming to a white institution of such repute
• Invisible language issues: English for non-native speakers, language of biology for those not really prepared
• Becoming a “minority” for first time . . .being minoritized
• Leading to how students understand, clarify, intensify identity—as a scientist, a black female scientist, a Latina, a gay, a ....scientist
• Labs differ greatly, provide uneven experiences
More Comments, Issues

• Perceptions of racism/disrespectful behavior
• Student culture and background shape knowledge acquisition
• Implicit message that science universal and trumps all other identities
• Intensity and length of lab work can be off putting, long hours, closed nature, potential insensitivity of lab cultures
• Little recognition of student ethnic culture—the few grad students who look like the students tend to fill in
How translates into an Intervention affecting both Structure and Content

• Allow focus to include more than science and research; acknowledge difference in cultural backgrounds, recognize social construction of science

• Address whole student and her motivations, idiosyncratic form of her scientific efficacy. Becoming a professor is not everyone’s dream

• Make no assumptions on the basis of any “category” from ethnicity

• Recognize real age of students—young, still forming, not whole adults

• Realize that students have limited experience which can be expressed in their own biases
Implications for long and short interventions

• Affects actual teaching, increases student success in basic courses
• Should be incorporated into any form of student/faculty/RA work so that mentoring is culturally informed, sensitive to student needs
• Diversity of career options should always be made apparent beyond medical school or Ph.D. programs
• Success in science is presented in multiple forms and these are acknowledged as legitimate
• For PWIs especially encourage faculty to cultivate awareness of the multiplicity of student background and talents
• Training, training, training for faculty, changing faculty culture
Acknowledgements

• David Weisblat, Tyrone Hayes, John Matsui, Caroline Kane, Gian Garriga, Nipam Patel, Mei Nguyen, Erin Conner, David Philoxene, Dax Kangas

• Successive Division of Biology Deans

• All the students of the REU

• NSF, UIC Organizers
Thank You! Questions?

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