Building a Diverse Future in the Biological Sciences

October 17, 2012
Al Bennett, Ph.D.
Hana and Francisco J. Ayala Dean
UCI School of Biological Sciences
Women and URMs in the Academic Pipeline in the Biological Sciences
UCI Biological Sciences
Undergraduate Students

• 2011 Enrollment
40% women; 16% URMs

• 2011 Graduation
56% women; 19% URMs
UCI Biological Sciences
Graduate Students

- 2010 Enrollment
  263 Ph.D. Candidates
  55% women; 19% URMs

- 2011 Graduation
  35 Ph.D. Graduates
  60% women; 14% URMs
Faculty Demography

• In Biological Sciences within the UC system
  26% women; 6% URMs

• At UC Irvine, School of Biological Sciences
  22% women; 8% URMs
Faculty Demography

**2001-2011**

**UNIVERSITY of CALIFORNIA IRVINE**
School of Biological Sciences

<table>
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<tr>
<th>Year</th>
<th>Female</th>
<th>Male</th>
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<tr>
<td>2001-02</td>
<td>16.25%</td>
<td>83.75%</td>
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<td>2002-03</td>
<td>19.05%</td>
<td>80.95%</td>
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<td>2003-04</td>
<td>23.96%</td>
<td>76.04%</td>
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<td>2004-05</td>
<td>25.00%</td>
<td>75.00%</td>
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<td>2005-06</td>
<td>25.81%</td>
<td>74.19%</td>
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<td>2006-07</td>
<td>26.60%</td>
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<td>2007-08</td>
<td>26.53%</td>
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<td>2008-09</td>
<td>25.00%</td>
<td>75.00%</td>
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<td>2009-10</td>
<td>26.04%</td>
<td>73.96%</td>
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<td>2010-11</td>
<td>21.59%</td>
<td>78.41%</td>
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Maintaining and Improving the Pipeline

Building a Diverse Future for Biological Sciences

Helping High School STEM Students Become Successful Undergraduate STEM Students

Improving K-12 Science Education
Building a Diverse Future for the Biological Sciences: From K-12 to PhD degree

Luis Mota-Bravo, Ph.D.
Director of Outreach, Research Training and Minority Science Programs (MSP)
School of Biological Sciences
University of California, Irvine
Building a Diverse Future for the Biological Sciences

- Educational opportunities
  - Females in the K-12 -> college pipeline
  - From the K-12 local educational environment to the University of California
  - Underrepresentation in PhD in Biological Sciences

- MSP: Successful Interventions
  - Undergraduates
  - Graduates
2011 US Median Household Income

<table>
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<tr>
<th>Race</th>
<th>Median Household Income</th>
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<tbody>
<tr>
<td>White</td>
<td>$55,412</td>
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<tr>
<td>Asian</td>
<td>$65,129</td>
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<tr>
<td>Black</td>
<td>$32,229</td>
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<td>Hispanic</td>
<td>$38,624</td>
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Minority

Underrepresented
10th graders/UC Admits (%)

- White Females: 13, Males: 10
- Asian Females: 39, Males: 30
- African American Females: 8, Males: 4
- Hispanic Females: 7, Males: 4
- American Indian Females: 14, Males: 9

Legend: Yellow = Female, Blue = Male
K-12 School and Home

- Academic preparation
- Educational resources
- Expectations
- Role models in STEM
- Understanding of the importance of higher education
- Knowledge about opportunities available for careers in science
National BS/BA to PhD in Bio Sci, Chemistry and Physics (%)
Objective: Increase the number and academic excellence of underrepresented minorities pursuing biomedical research careers and leadership positions.
Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM)
MSP Strategies

- Mentoring, high expectations and a culture of accomplishment

- Comprehensive effort, from K-12, community colleges, undergraduate and graduate students, to advance the careers of students

- Use a “pipeline” approach to identify supportive faculty and promising college students and fostering an interest in basic research through structured research experiences

- Partnerships with K-12 school districts, community colleges and other universities
MSP Strategies, contin.

• Professional staff with PhD degrees, teaching and research experience to develop programs activities

• Program institutionalization: seminars and research as a curricular activity

• Synergy with federal grants that require the participation of URM and K-12 students and teachers
MSP Activities: Undergraduates

• Training in
  – use of current scientific literature (journal club)
  – experimental research design
  – procedures for analyzing and interpreting data, and
  – preparation of scientific communications
• Paid research training at UCI laboratories
• Academic advising and career guidance
• Study groups and preparation in organic chemistry
• Research seminars presented by faculty
• Summer symposium
• National conferences (SACNAS, ABRCMS, AAAS)
• Graduate school application guidance
• Recommendations for opportunities (scholarships and training programs)
MSP Activities: Graduate Students

• Graduate research conference for prospective applicants
  – Faculty panel and one-on-one conversation with faculty
  – Graduate student panel
  – Guidance in the application process
• Summer program for incoming graduate students
  – Lab rotation
  – Journal Club
  – Oral presentations and reports of lab rotations
• Academic year
  – Study groups for core classes
  – Academic advising
  – Recommendations for opportunities (fellowships and grants)
  – Postdoctoral panel
Number of MSP undergraduates pursuing PhD degrees in biomedical sciences

- 2001-2006:
  - Female: 21
  - Male: 12

- 2007-2012:
  - Female: 52
  - Male: 37
PhD degrees awarded by UCI Schools of Biological Sciences and Medicine to URM
MSP Mentoring Philosophy

• Definition
  – Series of actions, conducted by individuals and institutions, to encourage and prepare students to advance toward productive careers and leadership positions as research scientists

• Encourage
  – Provide confidence
  – Provide support: economic and motivational
  – Promote personal growth
  – Advice and persuasion

• Preparation include, formal and informal components, curricular and extracurricular activities to learn:
  – Analytical thinking
  – Scientific inquiry
  – Critical reading
  – Quantitative reasoning
  – Data collection using instrumentation
  – Statistical analysis of results and
  – Scientific oral and writing proficiency
What can it be done to increase underrepresented groups in STEM?

• Award competitive State funded proposals to increase underrepresented groups in STEM that generate synergy with federal initiatives
• Develop a set of measurable goals
• Develop a set of short term and long term indicators of success
• Develop a UC database to track the careers of students
Diane O’Dowd, Ph.D.
HHMI Professor
Chair, Developmental and Cell Biology
UCI School of Biological Sciences
Goal: Help successful high school STEM students become successful UCI STEM students

Challenge: Introductory classes at UCI are
- Large (>400 students/section)
- Diverse (ethnicity, socio-economic, academic preparation, learning style)
Strategies to improve student learning in a large introductory Bio class, Bio 93

- Class period organized into 3-4 segments
  - Mini-lectures to introduce new material
  - Active learning exercises to engage students and promote dialogue in class
    - Clicker questions
    - Small group discussion
    - Garage Demos
In class dialogue
• Result
  – Increased time for problem solving in mentored setting
  – Increase in student and faculty satisfaction

• Challenge
  – Creating more time active learning in class without losing content
Move first exposure to material out of class

1. **Just-in-time-teaching (JiTT)**
   - Pre-class assignments to prompt thinking about upcoming lecture
   - Student submissions reviewed by instructor prior to lecture
   - Lecture adjusted to address areas students need most help with

• **Barriers to using this approach**
  - Implementation requires major overhaul of class
  - Substantial investment in time-sensitive manner
2. Pre-class reading assignments

– Pre-class online quiz
– 90% take quiz if worth points
– No change in exam performance

Why don’t reading assignments help students master knowledge level material before lecture?

A. Don’t have time to do reading
B. Text book is too difficult to read
C. Don’t know what to focus on
Develop learn before lecture (LBL) strategy

- Pre-class exposure to new material
  - Worksheet to guide learning of textbook info
  - Pre-class online quiz
  - Assignment submitted; no faculty feedback or lecture revision

- Lecture
  - Active learning exercises/dialogue
  - In class problem solving

- Implementation: Incremental
  - LBLs added to 3 lectures in 2009
  - LBLs in 4 lectures in 2010, 2011
Increase in performance on exam questions on topics presented in LBL vs. lecture format
LBLs were helpful in learning material

Survey question: Completing LBLs helped me learn the course material

- Strongly Agree
- Agree
- No Opinion
- Disagree
- Strongly Disagree

Percentage of Respondents
Some students still struggle to learn material

Can we identify performance predictors?
Math and AP Bio Strong Predictors of Success in Bio 93

URMS disproportionately affected by low Math SAT
Failure rate highest for female URMs
Describe one intervention at your institution that has increased success of URM students in introductory STEM courses?
Next Steps in Bio 93

- Can a small, flipped, high scaffold/feedback class increase performance of URM and/or non-URM students?
  - Fall 2012, concurrent Bio 93 classes, small flipped vs large
  - Compare performance on identical exams
  - Follow progression through later classes

- Can a pre-Bio 93 MOOC increase performance of URM and/or non-URM students?
  - Summer 2013 MOOC available
  - Fall 2013, compare performance of students electing to take MOOC vs. those that don’t
Bio 93 Team

Team Andrea
Running for Bio 93 students UC Irvine Fall 2009
OC Marathon/Half Marathon May 2nd, 2010

Andrea Roca
Sept. 2006 - Nov. 2009

Funding from HHMI Professor Program
Recommended Reading


Recruiting Tomorrow’s Scientists
New York Times, March 2010

“California Schools Failing Science”
Orange County Register, November 2011

“Science, tech preparation lagging in U.S. schools”
Orange County Register, August 2012
STEM Degrees as Percent of Total Tertiary Degrees

- Singapore
- China
- South Korea
- Germany
- India
- UK
- Japan
- Brazil
- US

Developing Economy
Top Performer
Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future

National Academies Press, 2007
Lack of science courses and prepared science teachers
In California…

• More than 40% of eighth-grade algebra teachers lack a math credential or are teaching outside their field of training.

• Only 30% of high school physics teachers majored or minored in physics.
How is UCI meeting this challenge?
How is UCI meeting this challenge?

Cal Teach
Cal Teach

An interdisciplinary program in science education involving the Schools of Biological Sciences, Education, and Physical Sciences
Cal Teach

Bachelor of Science degree in

- Biological Sciences
- Chemistry
- Earth Systems Science
- Mathematics
- Physics and Astronomy

and

California State Teaching Credential in 4 years
### Sample Cal Teach program in Biological Sciences

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<td>Spring</td>
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<td>Bio Sci 94</td>
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<td>Bio Sci 94</td>
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<tr>
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<td>Chem 1B</td>
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<td>Writing 39A/B</td>
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<td>Writing 39B/C</td>
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<td>Bio Sci 14: Intro to Sci/Math Teaching (Offered every quarter)</td>
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<td>Research Methods</td>
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<td>Classroom Interactions 1</td>
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<td>Statistics 8</td>
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<td>Read &amp; Lit in Secondary Classroom</td>
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<td>Complex Ped. Design</td>
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<td>Student Teaching &amp; Seminar 1</td>
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Total Units: **14** **18** **14**
Advantages of Cal Teach Program

- California K-12 science teachers trained by world’s leading scientists.
- Recruit the top echelon of CA students into the teaching profession.
- Real classroom experience starting Freshman year.
- A clear pathway to employment.
- Students can explore teaching without limiting options.
- Cal Teach students are part of a special interactive cohort.
- Cal Teach students work with Master Teachers.
- Cal Teach builds a life-long mentoring and networking program.
A New Major Option

Biology/Education
A New Major Option

Biology/Education

Fall Quarter 2012

> 700 Applicants
~ 200 Admitted
~ 70 Enrolled