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Building a Diverse Future in the Biological Sciences

October 17, 2012



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Al Bennett, Ph.D.

Hana and Francisco J. Ayala Dean

UCI School of Biological Sciences



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**Women and URM
in the Academic Pipeline
in the Biological Sciences**



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UCI Biological Sciences Undergraduate Students

- 2011 Enrollment
40% women; 16% URM

- 2011 Graduation
56% women; 19% URM



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UCI Biological Sciences Graduate Students

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

- 2011 Graduation
35 Ph.D. Graduates
60% women; 14% URM



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Faculty Demography

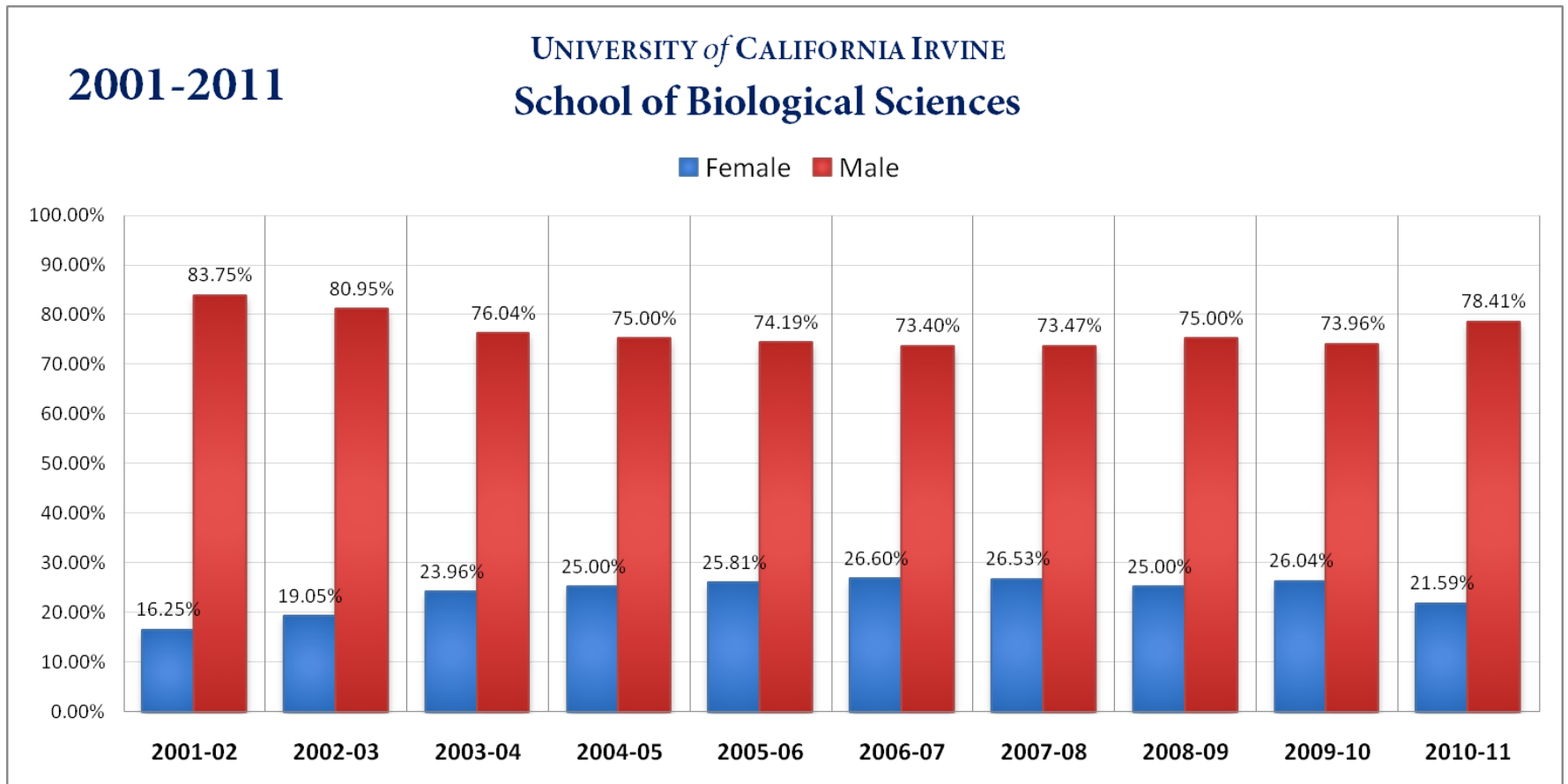
- In Biological Sciences within the UC system
26% women; 6% URM
- At UC Irvine, School of Biological Sciences
22% women; 8% URM



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Faculty Demography





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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



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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



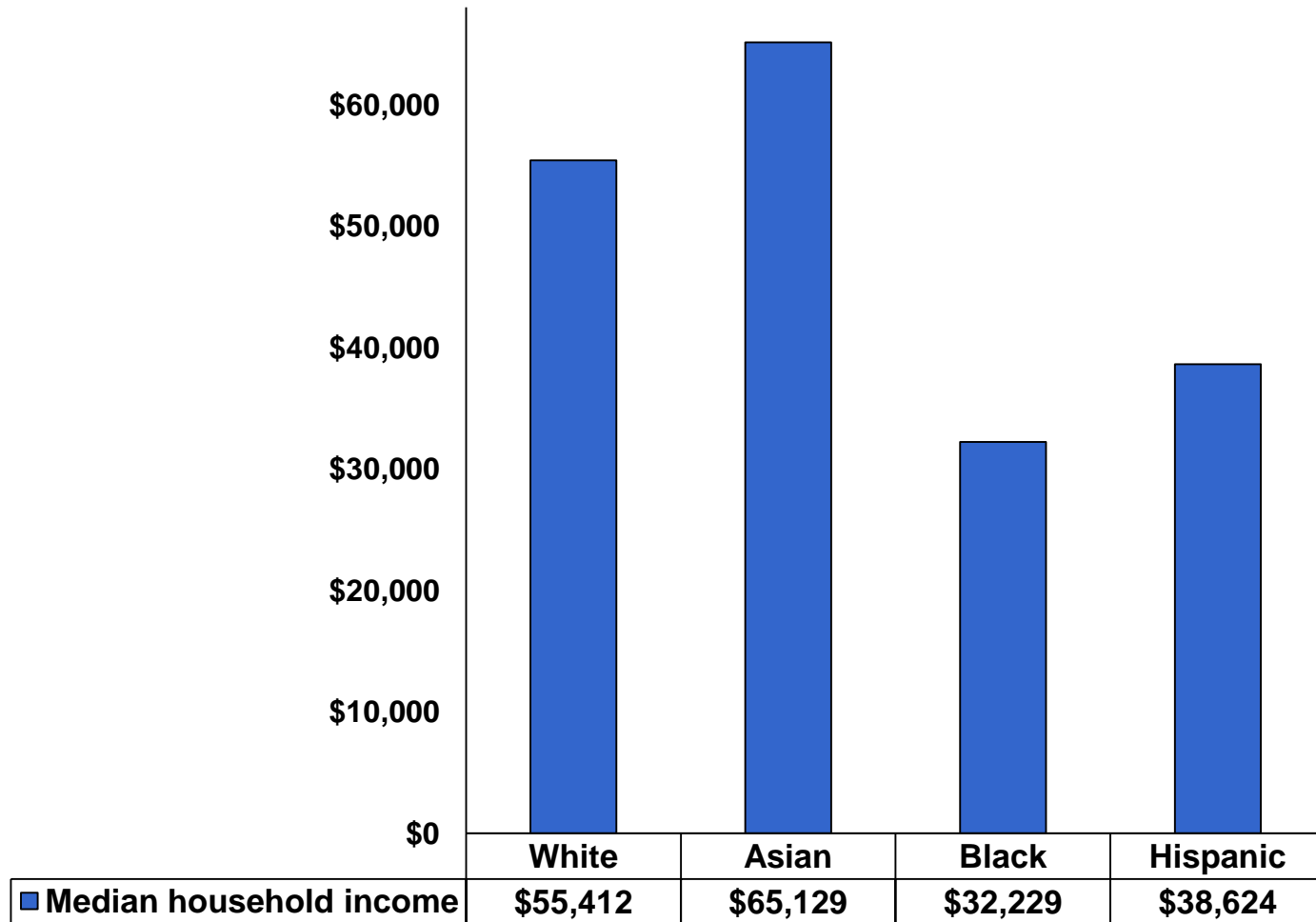
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Building a Diverse Future for the Biological Sciences

- 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

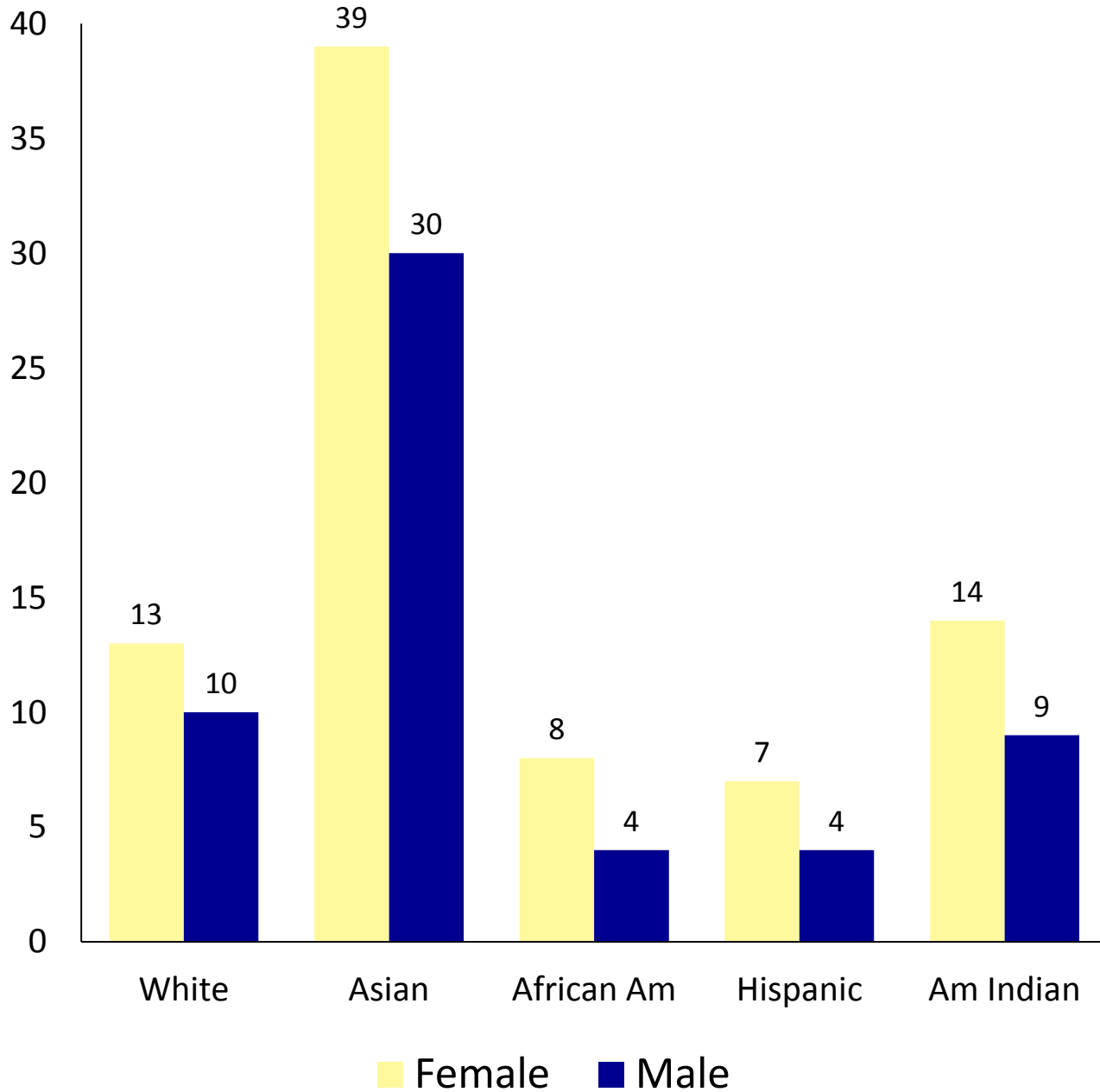
2011 US Median Household Income



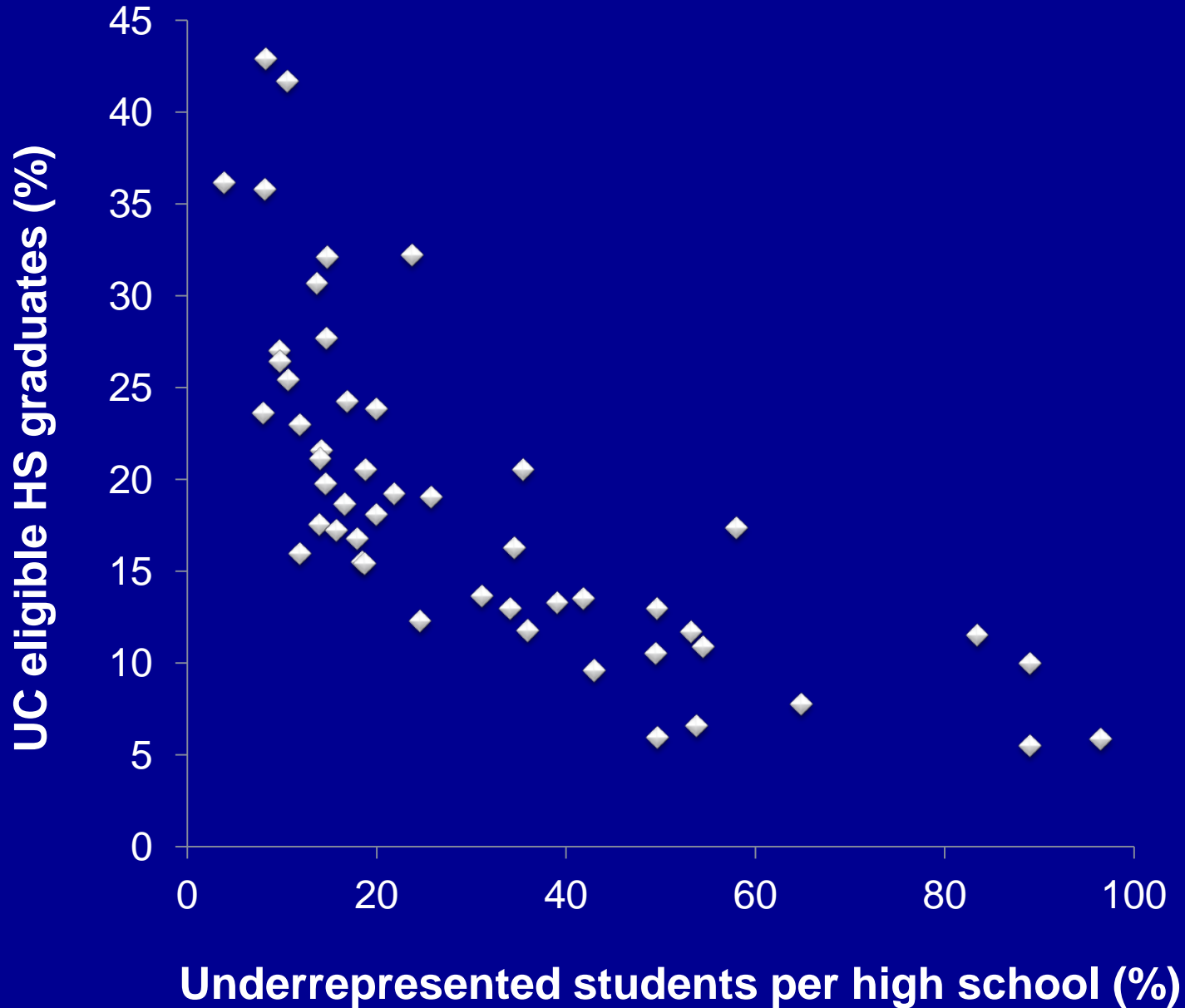
Minority

Underrepresented

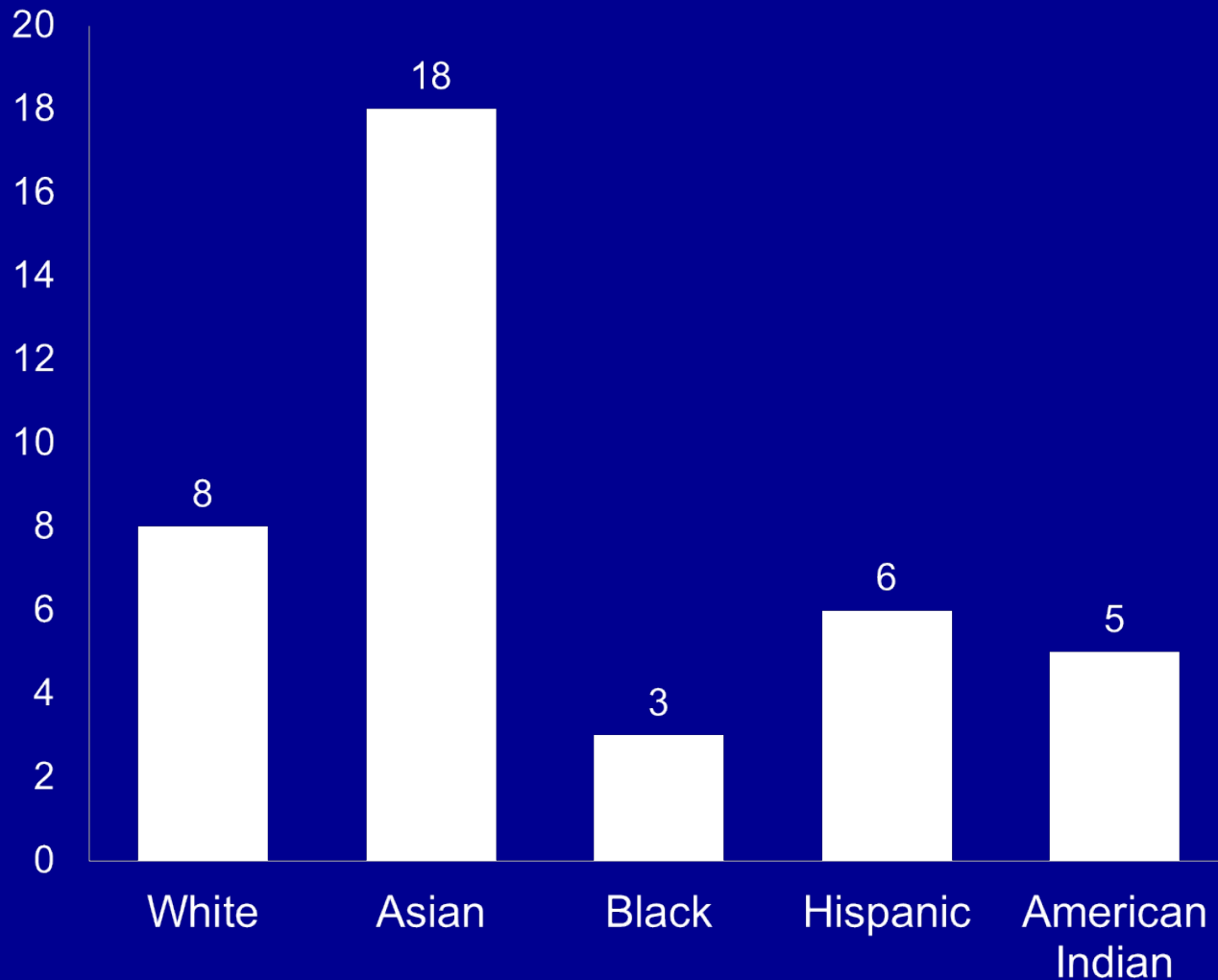
10th graders/UC Admits (%)



Orange County High Schools



National BS/BA to PhD in Bio Sci, Chemistry and Physics (%)





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Minority Science Programs (MSP)

OBJECTIVES

- 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)





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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



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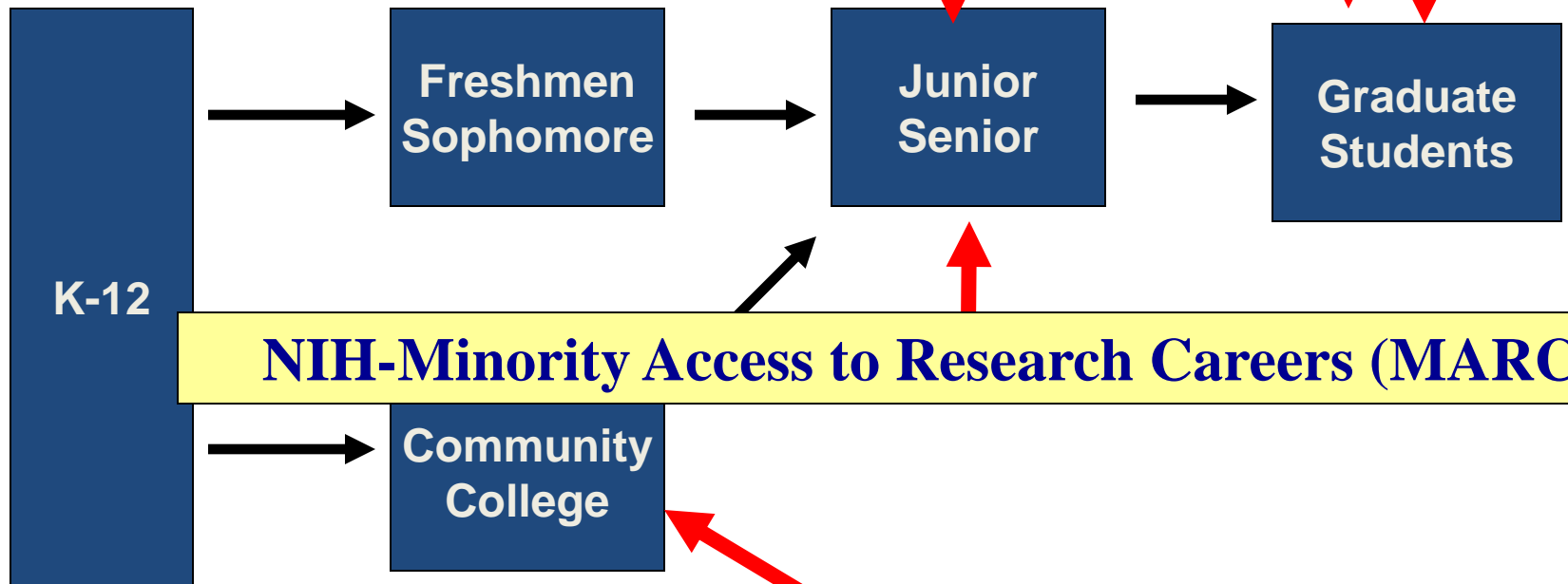
MSP Strategies, contin.

- 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 Research Training Initiatives

Minority Health and Health Disparities International Research Training (MHIRT)

NIH-Minority Biomedical Research Support (MBRS)



NIH-Minority Access to Research Careers (MARC)

Community College

NIH Bridges to Baccalaureate

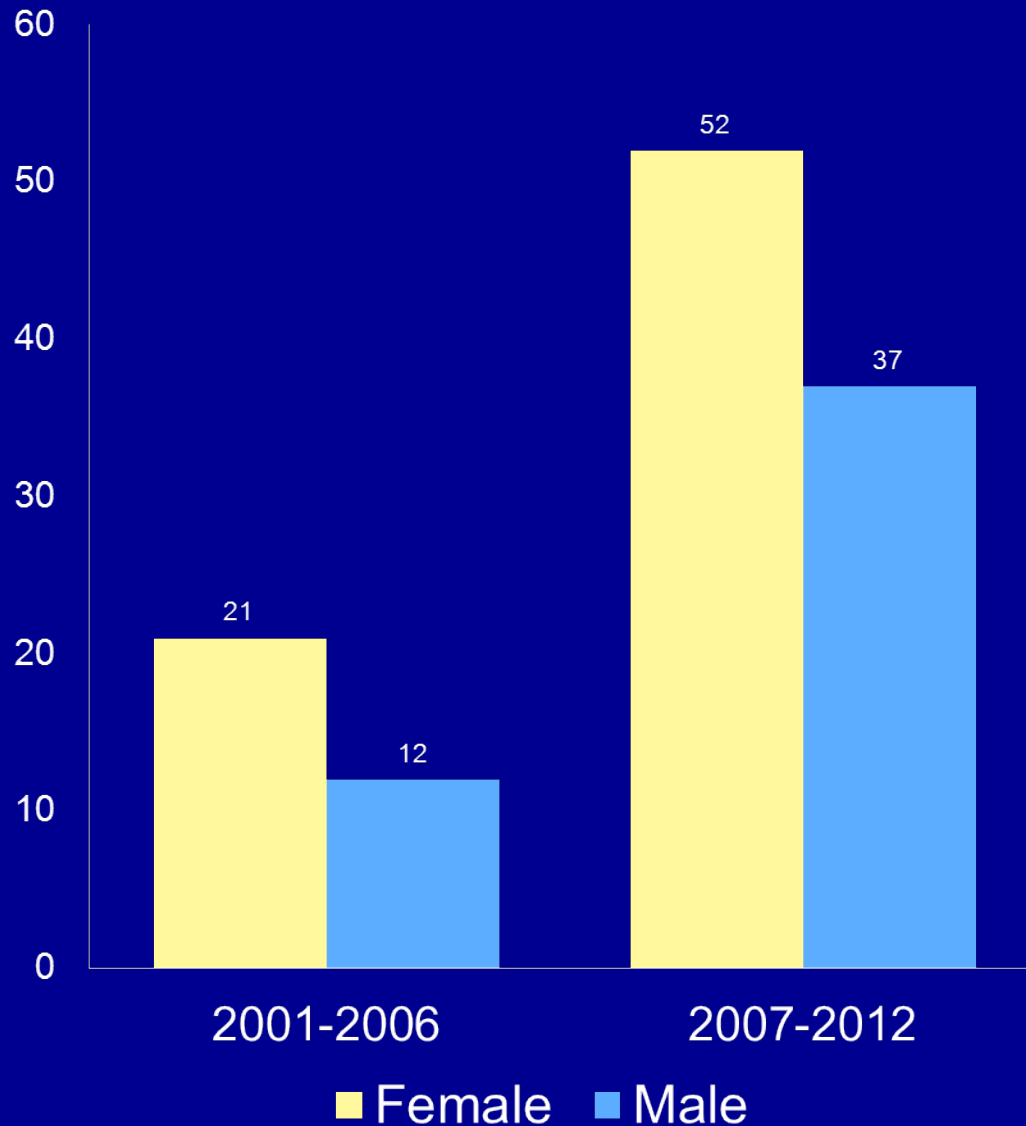
MSP Activities: Undergraduates

- 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)

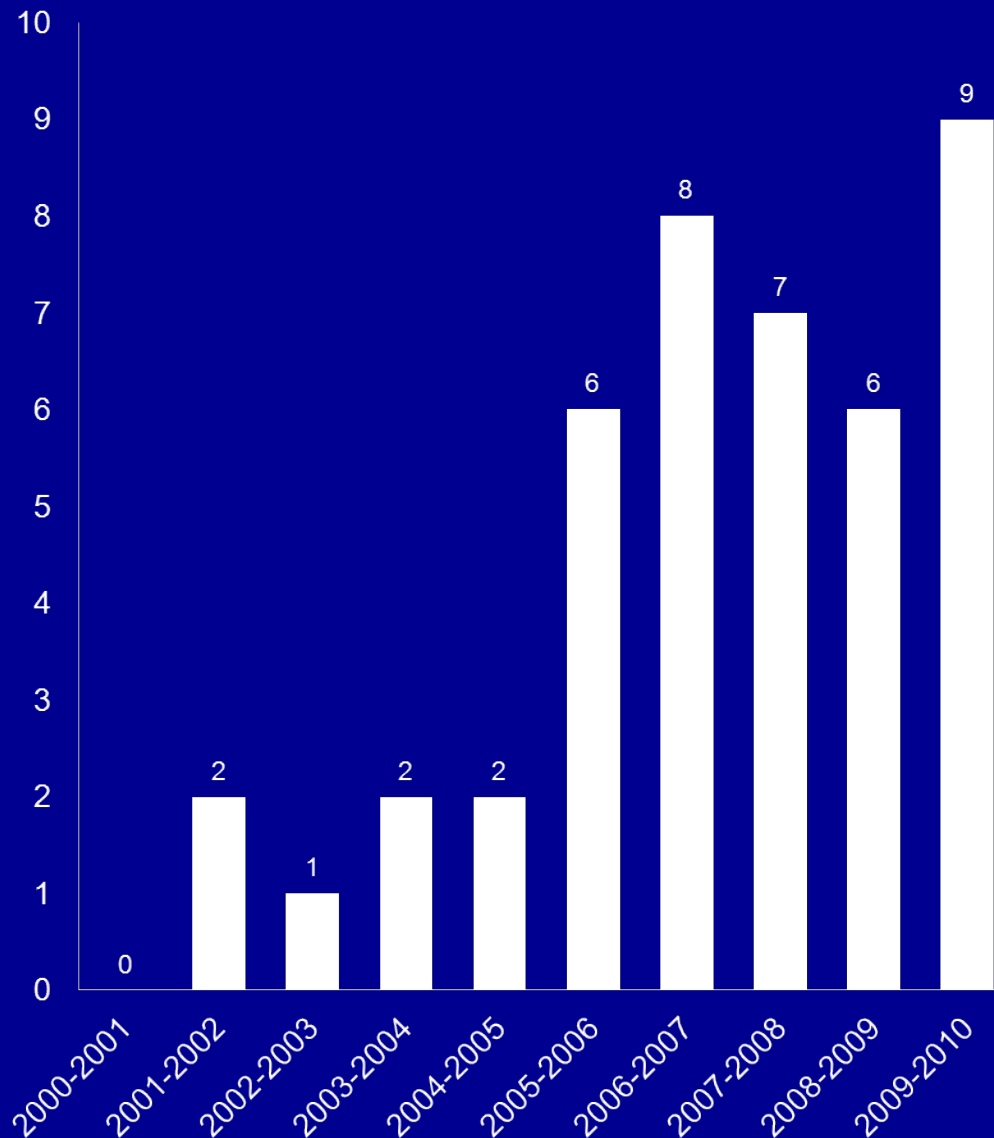
MSP Activities: Graduate Students

- 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



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



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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



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Diane O'Dowd, Ph.D.

HHMI Professor

Chair, Developmental and Cell Biology

UCI School of Biological Sciences



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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)



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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



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In class dialogue





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- **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



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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



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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?

- Don't have time to do reading
- Text book is too difficult to read
- Don't know what to focus on



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Develop learn before lecture (LBL) strategy

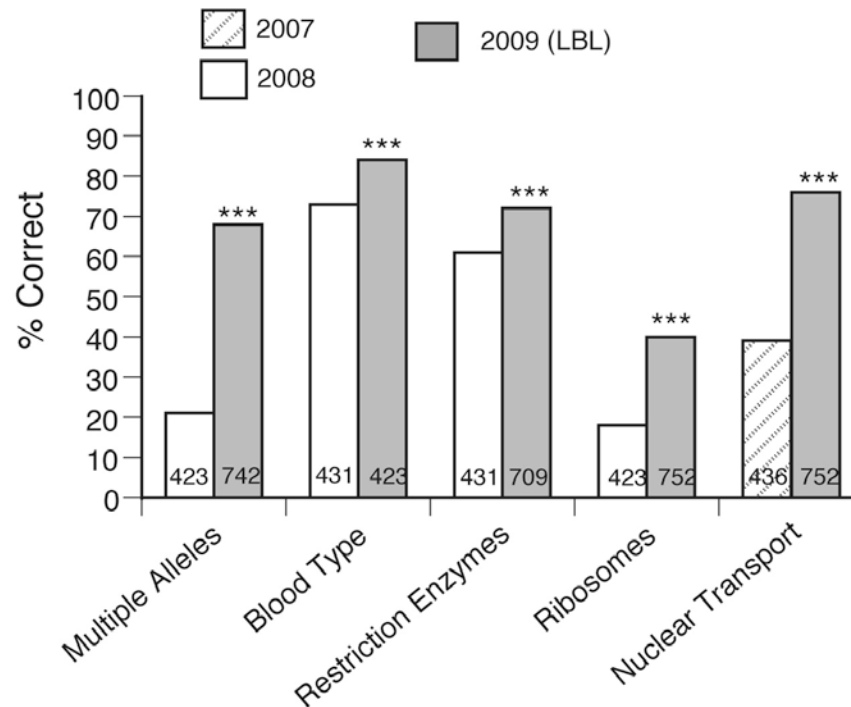
- Pre-class exposure to new material
 - Worksheet to guide learning of text book info
 - Pre-class online quiz
 - Assignment submitted; no faculty feedback or lecture revision
- Lecture
 - Active learning exercises/dialogue
 - In class problem solving
- Implementation: Incremental
 - LBLs added to 3 lectures in 2009
 - LBLs in 4 lectures in 2010, 2011



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Increase in performance on exam questions on topics presented in LBL vs. lecture format



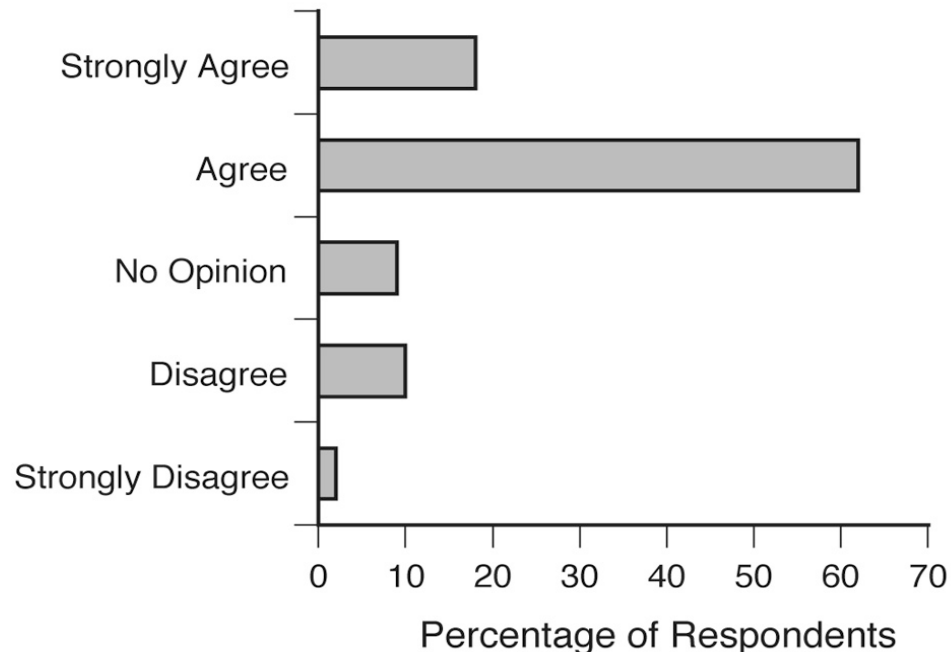


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LBLs were helpful in learning material

Survey question: Completing LBLs helped me learn the course material





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Some students still struggle to learn material

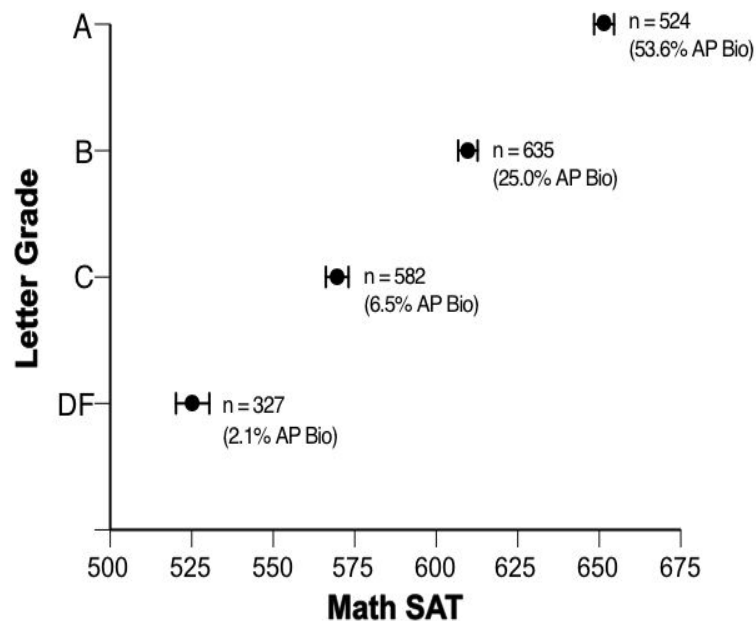
Can we identify performance predictors?



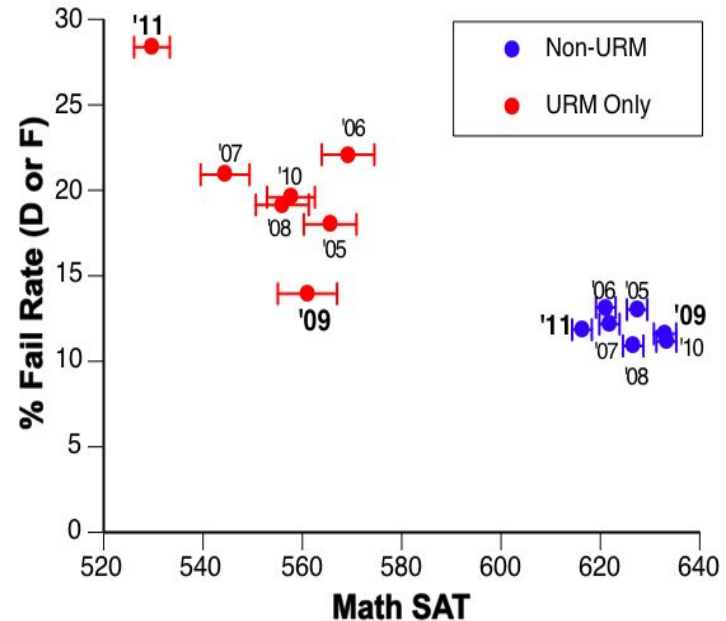
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Math and AP Bio Strong Predictors of Success in Bio 93



URMS disproportionately affected by low Math SAT

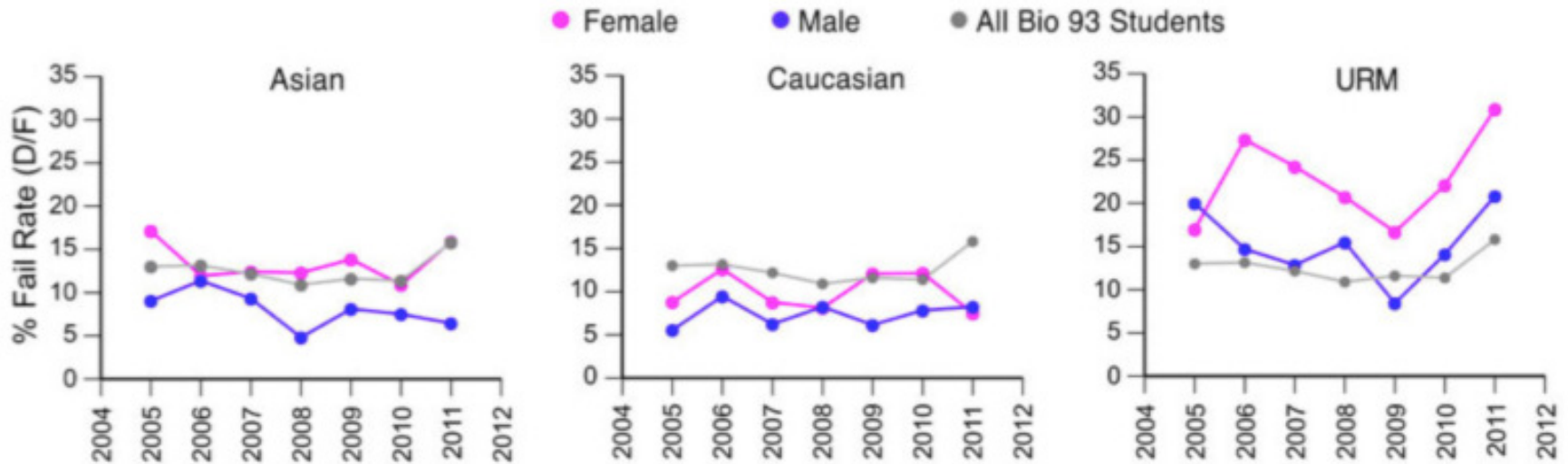




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Failure rate highest for female URM





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Describe one intervention at your institution that has increased success of URM students in introductory STEM courses?



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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



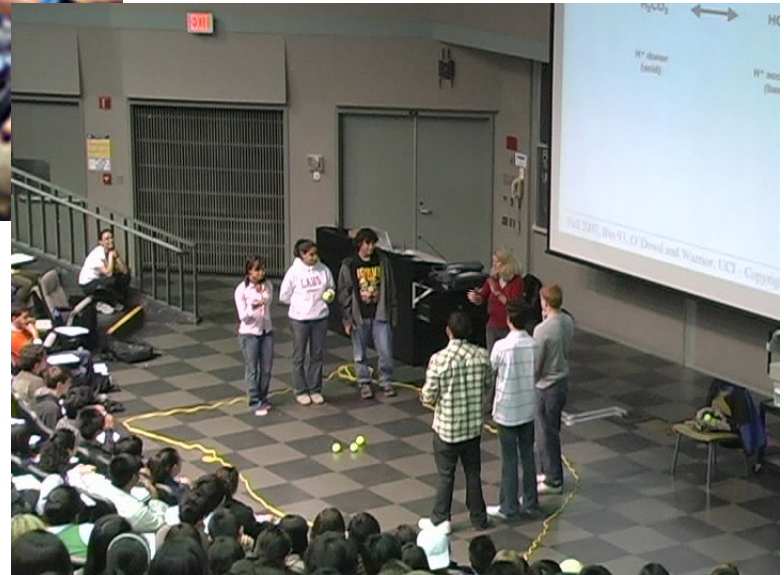
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Bio 93 Team



Andrea Roca
Sept. 2006 - Nov. 2009



Funding from HHMI Professor Program



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Recommended Reading

- Freeman, Haak, and Wenderoth (2011) Increased course structure improves performance in introductory biology. *CBE- Life Sciences Education*. 10: 175-86
- Moravec, M., Williams, A., Aguilar-Roca, N.M. and O'Dowd, D.K. (2010) Learn before lecture: a strategy that can increase learning outcomes in large introductory biology courses. *CBE-Life Sciences Education*. 9: 473-481
- Aguilar-Roca, N.M. Williams, A.E. and O'Dowd, D.K. (2012) The impact of laptop-free zones on student performance and attitudes in large lectures. *Computers & Education* 59: 1300-1308.



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Recruiting Tomorrow's Scientists



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**“Many Nations Passing U.S.
in Education, Expert Says”**

New York Times, March 2010

“California Schools Failing Science”

Orange County Register, November 2011

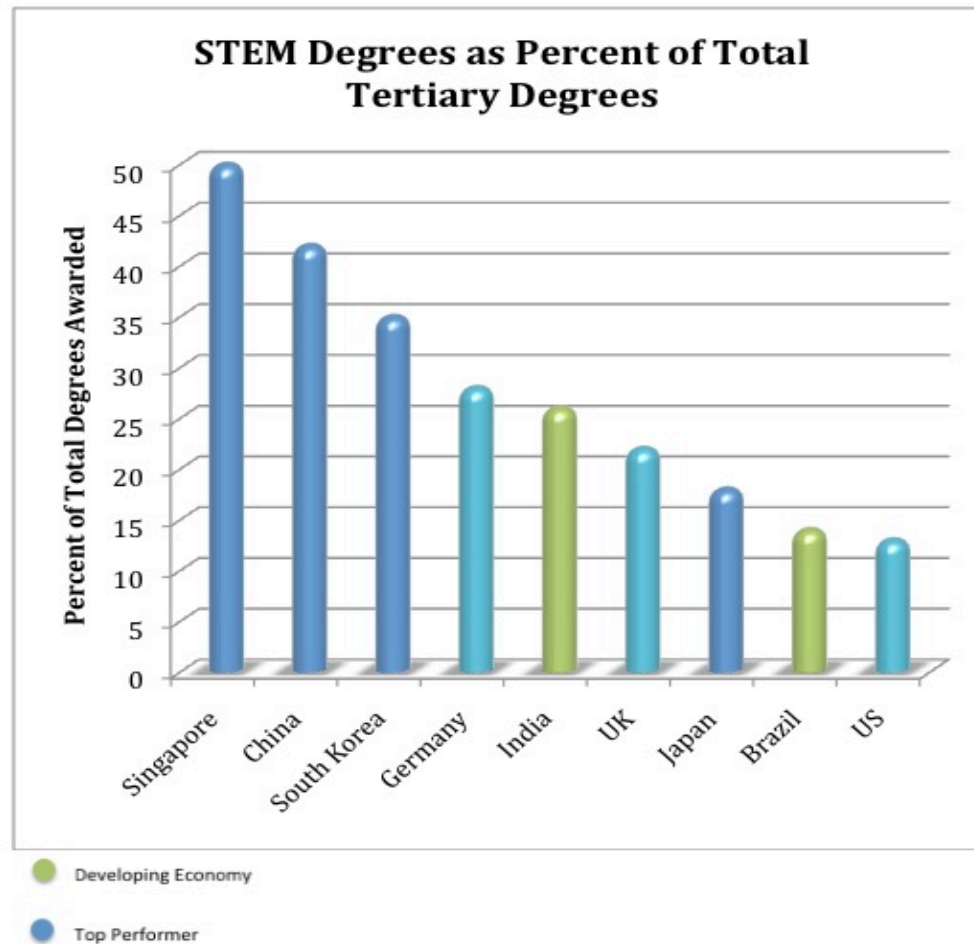
**“Science, tech preparation lagging in
U.S. schools”**

Orange County Register, August 2012



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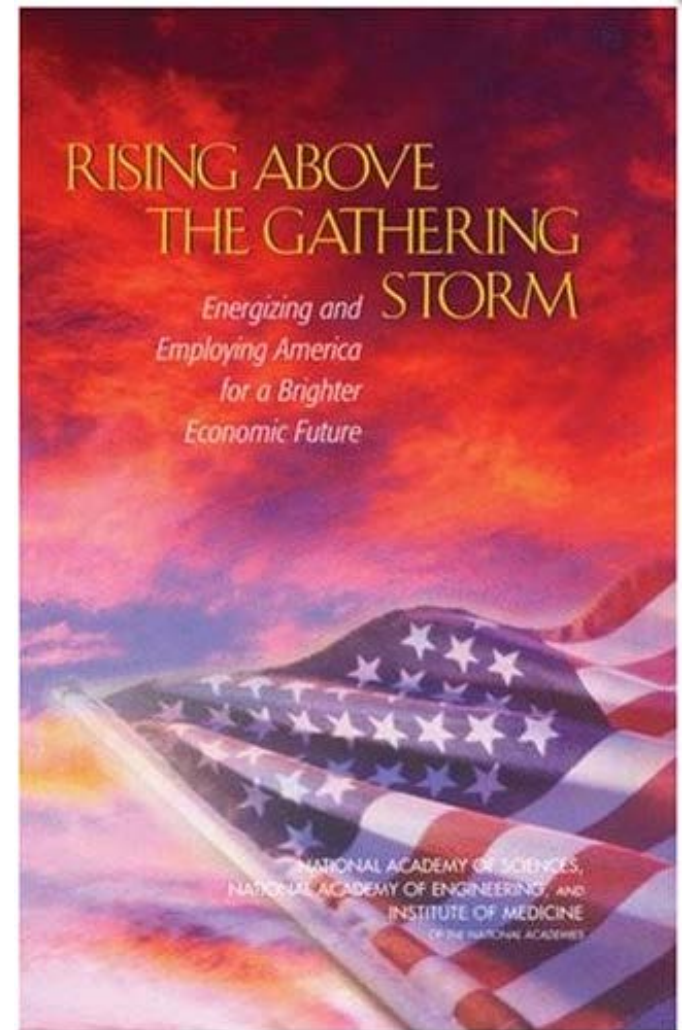




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**Rising Above the
Gathering Storm:
Energizing and Employing
America for a Brighter
Economic Future**

National Academies Press, 2007





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**Lack of science courses
and prepared science teachers**



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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.**



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**How is UCI
meeting this challenge?**



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**How is UCI
meeting this challenge?**

Cal Teach



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Cal Teach

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



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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





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Sample Cal Teach program in Biological Sciences

FRESHMAN		Units	Winter		Units	Spring		Units
Fall			Winter			Spring		
Bio Sci 93	4		Bio Sci 94	4		Chem 1C, LC	6	
Chem 1A	4		Chem 1B	4		Writing?/GE?	4	
Writing 39A/B	4		Writing 39B/C	4		Math 2A	4	
Bio Sci 14: Intro to Sci/Math Teaching (Offered every quarter)	3							
	15			12				14
SOPHOMORE			Winter			Spring		
Fall			Winter			Spring		
Bio 97	4		Bio 98	4		Bio 99	4	
Chem 51A, 1LD	6		Chem 51B, LB	6		Perspectives Sci and Math	4	
Bio Sci 101: Middle Schl Sci/Math Tchng (Offered fall & winter)	3		Research Methods	4		Math 2B	4	
	13			14				12
JUNIOR			Winter			Spring		
Fall			Winter			Spring		
Bio Required Major Course	4		Bio Required Major Course	4		Bio Required Major Course	4	
Physics 3A	4		Physics 3B/LB	5.5		Physics 3C/ LC	5.5	
Know & Learn Math/Sci	5		Classroom Interactions 1	4		Classroom Interactions 2	4	
Statistics 8	4		GE	4		GE	4	
	17			17.5				17.5
SENIOR			Winter			Spring		
Fall			Winter			Spring		
UD Bio Elective	4		UD Bio Elective	4		UD Bio Lab	4	
			Read & Lit in Secondary Classroom	4		GE	4	
UD Bio Lab	4		Student Teaching & Seminar 1	6		Student Teaching & Seminar 2	6	
Complex Ped. Design	6							
			GE	4				
Total Units	14			18				14



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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.



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A New Major Option

Biology/Education



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A New Major Option

Biology/Education

Fall Quarter 2012

> 700 Applicants

~ 200 Admitted

~70 Enrolled