Research Mentoring in STEM

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STEM retention is a general problem in the U.S. and western Europe

U.S. undergraduates who succeed in STEM:

- Asian Americans: 40%
- Caucasians: 32%
- African Americans & Hispanics: 20%

Source: U.S. National Academies
Similar percentages of African American and Caucasian Freshmen aspire to STEM Degrees (College Board)

Large numbers of well prepared URMs enter our colleges and universities but are not retained

UMBC typically receives:

- > 2,500 Meyerhoff nominations
- > 200 completed URM applications
  (> 80% are Maryland-area students)
- for ~45 available Freshman URM slots
STEM retention is a general problem in the U.S.

- R&D at U.S. universities relies increasingly on international students

<table>
<thead>
<tr>
<th>Field</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Physical Sciences</td>
<td>46%</td>
</tr>
<tr>
<td>Computer Science</td>
<td>56%</td>
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<tr>
<td>Physics/Astronomy</td>
<td>42%</td>
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<tr>
<td>Mathematics</td>
<td>56%</td>
</tr>
<tr>
<td>Engineering</td>
<td>65%</td>
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Source: NSF, Survey of Earned Doctorates
Are there needs for more PhDs?

- Unemployment rate (~2.5% in U.S.) far lower than other education levels and national average

- Francis Collins: not convinced that there is currently an overabundance of life science PhDs.

- Hard to argue that less education is beneficial
Demographics in the U.S. are Changing

Are we doing our best to educate and prepare the next generation?

U.S. Population Projections

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2030</th>
<th>2050</th>
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<tbody>
<tr>
<td>Caucasian</td>
<td>65%</td>
<td>56%</td>
<td>47%</td>
</tr>
<tr>
<td>African American</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Hispanic American</td>
<td>16</td>
<td>23</td>
<td>31</td>
</tr>
<tr>
<td>Asian &amp; Pacific Islander</td>
<td>5</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>American Indian &amp; Alaska Native</td>
<td>1</td>
<td>1</td>
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Source: US Census Bureau
Research is your top priority

Mentor by example

Mentor a small group

(Don’t want to be a great mentor for only 5 years)
Tenure-Track Faculty at Predominantly Undergraduate Institutions

- Research and mentoring are probably both high priorities
- Design appropriate experiments that require less oversight
- Partnering with research-1 institutions can sometimes help
Postdocs & Graduate Students

- Hopefully find local students who will work with you for more than one year

- Teach undergraduates to be good mentors so they can train additional students
Lab Structure at UMBC

- Research intensive lab
- 2 postdocs, 6 graduate students, 2 technicians
- 12 UMBC AY undergraduates
- 12 summer outreach undergraduates and high school students
- HHMI, NIH supported for > 20 years
Inverted pyramid

- I’m on the bottom
- Postdocs/grad students above me
- PD/Grads lead groups of 2-6 undergraduates
High expectations

- Full immersion research
- No “back burner” or “undergrad” projects
- First draft recommendations written by PD/Grad students
- Maintain work schedule
- Most undergraduates start the summer after their freshman year
Training mechanism

- UMBC undergraduates start in summer
- Two sequential summers, full time (no classes) plus 10 hr/week AY
- Trained in pairs
- Trained undergrads mentor summer outreach students
- Summer lab meetings - undergrads present
Age doesn’t matter

HIV-1 myr-MA:
Chun Tang (Missouri; Wuhan)
Isaac Kinde (MD-PhD, JHU)
Erin Loeliger (MD-PhD, Harvard)

HIV-1 myr-MA mutants:
Erin Loeliger, Paz Lunciaford (MD-PhD, Maryland)
Melissa Liriano (MD-PhD, Maryland)
• Participate in scientific conferences
• Annual summer crab picnic
• Annual retreat (usually skiing in Maine)
• Push-ups, cycling, competitions

Make it fun
Summer Crab Picnic
Race and Gender

- Actively reach out to women and minority groups
- Openly discuss issues of disparity
- No conversation topics are “off the table”

“We talk openly about the political, racial, and socioeconomic issues of the times - a practice that has led to strong working relationships, better communication, and an overall atmosphere of inclusiveness rather than simply tolerance”
Funding for Mentoring Activities

Research Credit (early days)

UMBC Programs (Meyerhoff)

Training grants (MARC, HHMI)

NIH R01s
Outcomes

Undergraduate Colleagues

• 268 undergraduates since 1990
• 51 high school students
• 65% women
• 45% from ethnic groups underrepresented in the sciences
• 21 undergraduates currently supported
Outcomes - Example senior class

Chelsea Stalling, MD-PhD, Penn
Cyl Soden, MD, Washington U.
Harvard  Dan Klein, PhD, Yale
PhD, Michigan
Eric Zollars, PhD, UCLA (not shown)

Ryan Turner, MD, Harvard
Danielle Smith, MD-PhD, Yale
Chika Madu, MD, Michigan

Becky Klein, PhD, Yale
Brian Turner, MD, Dinari Harris,

(12 publications, 1 in Science, 3 first-authors, 3 covers)
Roberto DeGuzman
Assoc. Prof., Kansas

Justin Wu
Assoc. Prof., Ohio State

Chelsea Pinnix
MD/PhD Asst. Prof., Radiation Oncology, MD Anderson
Conclusions

Undergraduate Mentoring has been a win-win for the lab

- Undergraduates benefit from the experience, income, academic and professional support network
- Graduates students and postdocs benefit from the long-term commitment of “extra hands” and mentoring experiences
- Undergraduates co-authored >65% of research articles over the past 15 years
- Lifetime mentoring/network relationships
Questions

Additional Resources
