Graduate Education in the Plant Sciences
Supported by NSF

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“The real ceiling on our productivity of new scientific knowledge …is the number of trained scientists available.”
“The Government should provide a reasonable number of undergraduate scholarships and graduate fellowships in order to develop scientific talent in American youth.”

*Science: The Endless Frontier, Vannevar Bush, 1945*

“There is no clear human-resources policy for advanced scientists and engineers, so their education is largely a byproduct of policies that support research.”

*Reshaping Graduate Education in Science and Engineering, COSEPUP, NAS, 1995*
### Support for S&E Doctoral (non-MD) Recipients 2005

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>RA</th>
<th>Fellow/Trainee</th>
<th>TA</th>
<th>Grant/Stipend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non US citizen, temporary resident</td>
<td>10792</td>
<td>49.1%</td>
<td>13.2%</td>
<td>17.6%</td>
<td>5.6%</td>
</tr>
<tr>
<td>US citizen, national, permanent resident</td>
<td>17307</td>
<td>21.6%</td>
<td>22.5%</td>
<td>13.8%</td>
<td>14.4%</td>
</tr>
<tr>
<td>Total Doctoral</td>
<td>29751*</td>
<td>31.2%</td>
<td>23.5%</td>
<td>14.5%</td>
<td>15.6%</td>
</tr>
</tbody>
</table>

*1652 of unknown citizenship

Totals do not equal 100% due to unknown and use of personal funds
Grant/Stipend may include some traineeships

Source: NSF/SRS, Survey of Earned Doctorates, 2008, WebCASPAR
### NSF-supported Graduate Students

<table>
<thead>
<tr>
<th>Program</th>
<th>GRFP Fellow</th>
<th>IGERT Trainee</th>
<th>GK12 Trainee</th>
<th>Bridge to the Doctorate Trainee</th>
<th>Other NSF RA Etc.</th>
<th>Total US S&amp;E Grad Student</th>
<th>US Citizen S&amp;E Grad Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total #</td>
<td>2454</td>
<td>1570</td>
<td>799</td>
<td>ca. 250</td>
<td>ca. 25,000</td>
<td>583,226</td>
<td>436,530</td>
</tr>
<tr>
<td>US citizen</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>?</td>
<td>74.8%</td>
<td>100%</td>
</tr>
<tr>
<td>Female</td>
<td>53.6%</td>
<td>42.4%</td>
<td>53.3%</td>
<td>45.5%</td>
<td>?</td>
<td>47%</td>
<td>49.3%</td>
</tr>
<tr>
<td>URM</td>
<td>14.3%</td>
<td>13.9%</td>
<td>18.6%</td>
<td>100%</td>
<td>?</td>
<td>N/A</td>
<td>11%</td>
</tr>
<tr>
<td>Disabled</td>
<td>3.4%</td>
<td>2.2%</td>
<td>3%</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td>PhD in 10 yrs</td>
<td>83%</td>
<td>Eval in prog</td>
<td>Eval in prog</td>
<td>Eval in prog</td>
<td>?</td>
<td>60%</td>
<td>56%</td>
</tr>
</tbody>
</table>

“Other NSF” includes RAs and other graduate student participants funded by R&RA directorates such as Science and Technology Centers

URM = Underrepresented Minorities in S&E; NSF numbers = 2008; US = 2006

Source: NSF/SRS; Survey of Earned Doctorates, 2008; WebCASPAR; DGE
Most students received mixed sources of support

Implications of different models
RAship - research enterprise, apprenticeship
Traineeship - curricular focus
Fellowships - flexibility and independence

Cost/benefit - indirect costs, “time” costs, RA as “cost” of research, Fellow/Trainee as education

Critical stages of first and last years of degree
Freshmen interest in majoring in the physical sciences and mathematics/statistics has remained relatively constant over the past two decades, while interest in other fields, particularly the computer sciences, has fluctuated widely.

Some fields vary in numbers over time.

Many students change fields within the sciences.

Undergraduate research opportunities demonstrate possibilities.

Source: CPST, data derived from National Science Foundation, Science & Engineering Indicators, based on data from the Higher Education Research Institute, Survey of the American Freshman
### Agricultural Sciences in the 2009 GRFP Competition

<table>
<thead>
<tr>
<th>FIELD</th>
<th>APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>12</td>
</tr>
<tr>
<td>Agronomy</td>
<td>4</td>
</tr>
<tr>
<td>Plant Physiology</td>
<td>51</td>
</tr>
<tr>
<td>Agricultural Ecology</td>
<td>1</td>
</tr>
<tr>
<td>Forestry</td>
<td>10</td>
</tr>
<tr>
<td>Horticulture</td>
<td>3</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>26</td>
</tr>
<tr>
<td>Plant Pathology</td>
<td>25</td>
</tr>
<tr>
<td>Soil Science</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL &quot;PLANT SCIENCE&quot;</strong></td>
<td><strong>138</strong></td>
</tr>
<tr>
<td><strong>ALL</strong></td>
<td><strong>9012</strong></td>
</tr>
</tbody>
</table>

One of 32 panels - only 1.5% of all applications. Other panels (e.g., Ecology, Physiology, Genetics, Environmental Biology) may have reviewed other “agricultural” applications but the majority are here.
Changes in the Professoriate

Figure O-29
Faculty and tenure-track status of young academic S&E doctorate holders: 1975–2001

Percent

80
70
60
50
40
30
20
10
0

Faculty positions

Percent in academic employment

Tenure track


NOTE: Data are for individuals whose doctorates were earned 4–7 years earlier.

SOURCE: National Science Foundation, Division of Science Resources Statistics, Survey of Doctorate Recipients, special tabulations.

Science & Engineering Indicators – 2004

Figure 3-33
Doctorate recipients holding tenure and tenure-track appointments at academic institutions 4–6 years after degree, by field: 1993–2006

Percent

60
50
40
30
20
10
0

All S&E
Engineering
Life sciences
Mathematics/computer sciences
Physical sciences
Social sciences

1993 1995 1997 1999 2001 2003 2006

S&E Indicators - 2006
Research is central to PhD education
Masters curricula more varied

Broader scientific training - fundamentals of science and discipline, interdisciplinary work, fieldwork, theory and application

“practical things” - communication, teamwork, management, entrepreneurship, cross-cultural training, ethics, internships, other skill sets
Suggested Action Items

Recruit via undergraduate research activities

Encourage application to the GRFP

Consider traineeships through whatever mechanism

Explore all areas of NSF for support

Focus on graduate education, not “apprenticeship”
  - provide for alternate career pathways

Is 30-40% PhD attrition a cost to graduate enterprise?