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ASPB News

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President's Letter

A New Order for Plant Biology PhD Training

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The perspective article by Bruce Alberts, Marc Kirschner, Shirley Tilghman, and Harold Varmus, titled "Rescuing U.S. Biomedical Research from Its Systemic Flaws" (Alberts et al., 2014), went viral on the Internet just one hour after it was published online by the *Proceedings of the National Academy of Sciences USA* in mid-April. The article offers an honest, blunt view of the unsustainable trajectory of biomedical research in the United States, the blatant flaws that

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ASPB Executive Committee 2014 Election Results

Many thanks to those members who took the time to vote this spring, and hearty congratulations to our new officers! They will begin their term of service to ASPB on October 1, 2014. Look for more information about each winning candidate in an upcoming issue of the *ASPB News*.

Incoming President-elect
Rick Dixon
University of North Texas, Denton

Incoming Secretary-elect
Alice Harmon
University of Florida, Gainesville

Incoming Elected Member
Joe Kieber
University of North Carolina at Chapel Hill

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underlie this lack of sustainability, and some bold recommendations aimed at fixing what is broken. It is a must read paper, whether you are part of the U.S. research community or not, and it is the first time that prominent scientists have spelled out that simply providing more money is not, in the case of U.S. biomedical research, the fix.

The major flaw in the system, Alberts and coauthors write, is Malthusian, due to "demand for research dollars [that] grew much faster than the supply." This, they skillfully argue, is due to "perverse incentives [that] encourage grantee institutions to grow without making sufficient investments in their faculty and facilities." This perverse incentive applies, in particular, to the U.S. biomedical funding system. For those who may not be familiar with the U.S. approach, I will elaborate here what this means. For every dollar granted to the principal investigator (PI) to do the proposed research (to pay for salaries, supplies, and associated costs), the PI's institution, after negotiation, gets an additional amount called "indirect costs" that typically equates to at least 50% (and sometimes as much as 110%) of the amount the PI receives to spend on the project. In short, the institution has no incentive to support individual faculty and instead has an avid and perverse incentive to encourage further research spending: more grants = more overhead = more buildings = more PIs = more deans and administrators = more grants, as well as more PhDs in an increasingly out-of-control spiral. Figure 1 illustrates the huge increase in the number of life science PhDs in the United States, specifically in health-related areas. This is not sustainable, and we are now experiencing the consequences, with the most despairing being the lack of adequate jobs for biomedical postdocs and insufficient funding for all of us. In short, the unsustainable race to expand biomedical research with only limited resources has evidently crashed.

I find it ironic that the very Malthusian principle that drives us to work so hard—namely, to feed an exponentially growing population in a changing climate using an incrementally increasing crop supply—is, according to Alberts et al. (2014), the very mathematical principle that seems to challenge our efforts to meet that goal.

Or does it? The question is, how much of this gloomy scenario pertains directly to us in plant science? My April/May newsletter article laid out the plant research investments by country. However, other facts I did not discuss in that article need discussing now. There are several differences between the plant biology research and biomedical research systems that may represent rays of sunlight for plant biology if we can provide the necessary insight and vision to our governments (Jones, 2014). The most important is that there is a demand for PhDs in agriculture/plant biology research and development. The Coalition for a Sustainable Agricultural Workforce recently completed a confidential survey among AG biotech companies to ascertain near-term needs for hiring domestic agricultural scientists (2013). This survey generated an amazing result, given the tone of the Alberts et al. (2014) perspective. It is anticipated that by 2015 in the United States alone, 1,000 new employees are needed in the half-dozen largest companies in this area (Bayer CropScience, Dow AgroSciences, Dupont Pioneer Hi-Bred, Dupont Crop Protection, Monsanto, and Syngenta), with 84% in the disciplines of plant sciences, plant breeding/genetics, and plant protection. Almost half of these anticipated new hires will hold PhDs. In the United States, with what appears to be a dwindling pool of qualified applicants applying to plant science PhD programs, we may not be keeping up with this demand. The worry these companies articulate is the inability to recruit enough qualified applicants having the appropriate education and experience without needing considerable retraining.

Is academia training enough to meet the demands of the plant industry? Figure 2 shows that despite the steep increase in the number of PhDs in the life sciences, we have consistently trained roughly 1,000 PhDs in agricultural and natural sciences annually since 1982. Taking the analysis one step further, I extracted the number of PhDs relevant to plant science industries and compared them to a selected set of subdisciplines in the biomedical sciences. Again, it is clear that the glut of PhDs that Alberts et al. (2014) warn us about is not among the plant sciences; for more than a decade, about 100–200 basic plant science PhDs have been awarded per year. I worry that the plant sciences will get caught up in the lamenta-

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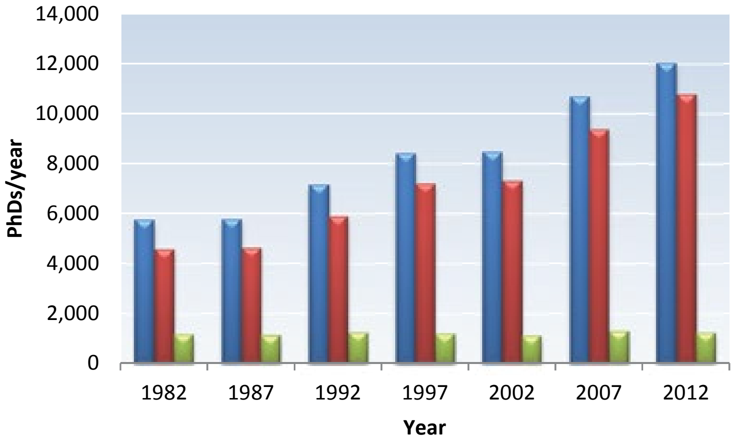

Figure 1. PhDs in the United States. *The data cover years 1982–2012. Total PhDs in the life sciences are shown in blue. These PhDs are predominantly in biological, biomedical, and health sciences. Analysis performed using data source http://www.nsf.gov/statistics/sed/2012/pdf/tab12.pdf. The rapid increase in the rate of PhDs in life sciences* ***(blue)*** *is consistent with the claim by Alberts et al. (2014) that a burgeoning increase of PhDs in the biomedical sciences* ***(red)*** *is both a manifestation and cause of the nonsustainable research system. However, this is not true for the agricultural and natural sciences* ***(green)****. Since 1982, approximately 1,000 PhDs in agricultural sciences (including animal related) are produced each year.*

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tions of Alberts et al. that we are producing too many PhDs and that we might suffer from the fix to what is, based on the data, a problem limited to biomedical research fields.

If there is such a dire need for plant biologists, and we are not training that many, why are academic careers in plant biology no longer flourishing? I believe it is because academic institutions want to hire faculty who have the highest chance of obtaining maximal federal funding; in other words, grantsmanship skills and hot research topics drive the current hiring decisions. Anecdotally, it seems to me that for two decades there has been a shift away from simply searching for and hiring the brightest colleagues, and I believe that this swing has affected plant biology hiring decisions disproportionately. This is because plant biologists in the United States, who historically have competed primarily for funds allocated by NSF and USDA, which have much smaller pots of money to distribute than NIH, are now expected to compete for biomedical funding too, especially since Arabidopsis was placed on par with other powerful genetic models that have had an impact on human health research (Jones et al., 2008). Along with that, Arabidopsis research is no longer nurtured by NSF, DOE is highly focused on bioenergy, and USDA primarily funds research on crop species, making it tough to obtain academic funding of basic "blue sky" plant research, at least in the United States. The paucity of funding for basic plant biology may also be felt in other ASPB-member countries, and understandably so if they are only fiscally able to focus on relevant crops. Consequently, basic research with model plants is not supported as much as we feel is needed globally either, nor are disciplines that study the basic fundamentals of agricultural systems and sustainable practice.

Just as Alberts et al. (2014) recommend for the biomedical sciences, we need predictable, long-term, stable funding for the basic plant sciences. However, unlike for the biomedical research community, we do not have the luxury to level off spending on plant biology research. The growing world population needs to eat, and it is past time that our governments elevate basic, translational, and applied plant research to the priority they give to biomedical research, or more boldly, defense spending. Indeed, stabilizing food supplies in a changing environment may serve to reduce global unrest, so I would argue that funding plant sciences is integral to the security of all our nations. One way to drive innovation is to shift government funds currently used for noncompetitive research opportunities to competitive-based research funding. Ideas alone, not spending formulas or pork-barrel politics, should drive research spending. At least for the U.S. system, we should revisit how overhead is defined in order to motivate academic institutions once again toward research output, not revenue growth.

Another approach toward predictable, long-term research funding is to build private–public partnerships. The United States is experimenting with this idea by forming a government–industry foundation to fund at least another $400 million of research related to agriculture (see the Policy Update in the March/April issue of the *ASPB News*). Another idea for funding is to get buy-in from the growers. An effective example of this approach is in Australia, which has a system whereby growers tax themselves, matched by the government, to fund one-third of all agricultural research (for example, see http://www.grdc.com.au/About-Us). These funds are competitively awarded by an independent body that has representatives from both the government and farmers (Alston et al., 1999).

As mentioned, there is a demand for PhDs in plant sciences, but there is also a call for focused training by making students and postdocs aware of and well prepared for opportunities in industry and elsewhere in society. We also need to make

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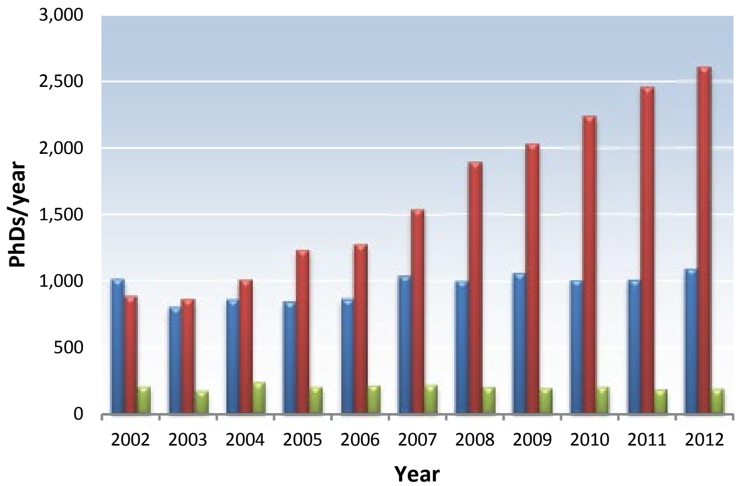

Figure 2. U.S. PhDs in selected subdisciplines relevant to a workforce in plant industry (blue and green) versus selected subdisciplines that are not plant science related. Red symbols *are the sum of PhDs in these biomedical subdisciplines each year: bioinformatics, biomedical sciences, biometrics and biostatistics, cancer biology, computational biology, developmental biology/embryology, neurosciences and neurobiology, structural biology, and virology.* ***Blue symbols*** *are the sum of PhDs in applied agriculture subdisciplines each year: agricultural and horticultural plant breeding, agricultural economics, agronomy and crop science, forest engineering, forest sciences and biology, forestry and related science, horticulture science, plant pathology/phytopathology (applied), plant sciences (other), soil chemistry/microbiology, soil sciences, entomology, plant genetics, plant pathology/phytopathology (applied), and plant physiology (applied).* ***Green symbols*** *are the sum of PhDs in basic plant biology subdisciplines each year: botany/plant biology, plant genetics, plant pathology/phytopathology, and plant physiology.*

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students aware of alternative career opportunities to the traditional academic track. Cornell University, assisted by a $1.8 million grant from NIH, is one of several institutions attempting to do just that with their biomedical students (http://www.best.cornell.edu/). They are training in four new areas: science communication, science policy, governance/risk, and industry/entrepreneurship. These areas pertain exactly to plant biology students and postdocs as well, and we should quickly adopt them in our training regime. Properly organized and funded training programs of this kind will be highly desirable; therefore, we can be more selective in admissions. Once admitted, these students should be supported by centralized funding for training rather than by individual research grants. By being far more selective in admissions, we will have less remedial training and we can produce better qualified PhDs in less time. Our training should reflect our needs, which differ from country to country. Customized training must begin as soon as possible in the PhD program. Traditional training in analytical skills is critical, but we should move our students into their specialized fields earlier. This means partnering with industry and the private sector for internships for our students. The Decadal Vision (ASPB, 2013) from the United States and Future Challenges from the United Kingdom Plant Science Federation (2014) clearly define this new training modality.

Finally, it is time to convene an academia–industry summit to discuss ways in which we can provide relevant training for our PhDs for successful, enjoyable, and productive careers that meet the needs of the world. Academia already knows how to train a workforce and is willing to prepare for our needs, so that is not the problem. The most difficult component of training our plant science workforce will be the ability to predict the marketplace's needs and adapt the requisite training quickly. Industry workforce needs are driven by volatile markets, and it will be challenging to retool training to meet future needs for that sector in real time. Consequently, I believe that the most difficult discussion at the proposed academia–industry summit will be how to cooperate effectively to meet that goal. I hope that ASPB will take the lead in this new endeavor, and I will do what I can to make this happen. If you are interested in getting involved, please let me know. ■

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